January 2007

GIPSA Livestock and Meat Marketing Study

Contract No. 53-32KW-4-028

Glossary

Final Report

Prepared for

Grain Inspection, Packers and Stockyard Administration
U.S. Department of Agriculture
Washington, DC 20250

Prepared by

RTI International
Health, Social, and Economics Research
Research Triangle Park, NC 27709

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This report and the study on which it is based were completed under a contract with the Grain Inspection, Packers and Stockyards Administration (GIPSA), U.S. Department of Agriculture (USDA). Any opinions, findings, and conclusions or recommendations expressed in this report are those of the authors and do not necessarily reflect the views of GIPSA or USDA.

Glossary

This glossary provides definitions of terms developed for use in the study. In some cases, definitions for these terms are readily available in the literature; in other cases, working definitions were developed based on information collected during the study and discussions conducted with industry participants.

Term	Stage of Production[a]	Definition
Alliances	All	Relationship formed by two or more industry participants to meet common production or marketing objectives and to improve information flows.
Alternative procurement (purchase) methods	All	See AMA.
Alternative sales methods	All	See AMA.
AMA	All	Alternative Marketing Arrangement: Purchase or sales methods other than the cash or spot market. These include procurement or marketing contracts, production contracts, forward contracts, marketing agreements, packer-fed/owned arrangements, custom feeding/backgrounding, and custom slaughter.
Backfat	Producer, packer	Average fat thickness, measured in inches or millimeters, between the 3rd and 4th rib from the last rib, 7 centimeters from the carcass split.
Backgrounding	Producer	The process of keeping ruminant animals on pasture or range for grazing before moving them into a feedlot.
Barrow	Producer	A male pig castrated before it reaches sexual maturity.
Benchmarking	All	Comparing the base price used in the formula to some market or reported price or comparing the current pricing arrangement to bids from other companies that entities buy from.
Boxed meat	All	Meat that has been cut into primals or subprimals, vacuum packed, and placed into boxes (e.g., boxed beef).
Branded	Packer, processor, downstream	Product sold with a national, regional, or store brand name.
Breaker	Processor	Meat processors that specialize in breaking down carcasses but do not slaughter (most common in the lamb industry).
Bundling	Packer, processor, downstream	Buyer must purchase other related products to receive a lower price.
By-products	Packer, processor, downstream	Hides (pelts), offals, bones, grease, and all other beef, lamb, or pork products *not* included in fresh, frozen, or processed meat.
Carcass	All	The dressed or slaughtered animal consisting of the skeleton with its attendant muscle and fat.
Carcass merit pricing	Producer, packer	Prices are adjusted by premiums or discounts based on characteristics of the carcass, such as lean percentage, weight, backfat thickness, and loineye depth (also known as grid pricing).
Carcass weight	Producer, packer, processor	Dressed or rail weight.
Case ready	Packer, processor, downstream	Meats packaged in a centralized facility and shipped to supermarkets for display in refrigerated cases.
Cash or spot market	Packer (sales), processor	Purchasing (selling) product directly from (to) a seller (buyer) less than 3 weeks forward at list or negotiated price, including any specified discounts or premiums.

(continued)

Term	Stage of Production[a]	Definition
Cash or spot market	Producer, packer (purchases)	Purchasing (selling) livestock through direct trade, auctions, or dealers within 2 weeks of delivery or kill date.
CBOT	Producer, packer	Chicago Board of Trade: a company that facilitates the trade of futures market contracts, particularly crop commodities.
Certification programs	All	Programs that certify livestock breed, carcass characteristics, product (meat) characteristics (e.g., Kosher), or product-processing method.
CME	Producer, packer	Chicago Mercantile Exchange: a company that facilitates the trade of futures market contracts, particularly livestock commodities.
Combo	Packer, processor, downstream	Large bins constructed of cardboard and plastic used to carry bulk meat products.
Cooperative	Producer, packer	A formal group of individual producers that joins together for collective purchasing, marketing, or other related activities.
Cow	Producer, packer	Female bovine that has given birth to at least one calf.
Cow-calf operations	Producer	Operations that specialize in maintaining a cattle breeding herd for the production of beef calves.
Custom processing or copacking	Processor	Processing of meat products by a manufacturer other than the company whose name appears on the product label. Examples include outside contracting and private labeling.
Custom slaughter	Producer, packer	Providing slaughter services for a fee (also known as toll kill).
Direct trade	All	Cash- or spot-market transaction between an individual buyer and seller of livestock (pork producers: including buying stations) within 2 weeks of delivery or kill date, or between an individual buyer and seller of meat within 3 weeks of delivery.
Dressed weight	Producer, packer	Weight of an animal carcass (also known as carcass weight or rail weight).
Dressing percentage	Producer, packer	Percentage of an animal's liveweight that results in dressed weight; calculated as dressed weight divided by liveweight (also known as yield percentage).
Evergreen	All	Agreement or contract that continues indefinitely until either party decides to terminate.
Ewe	Producer, packer	Mature female sheep.
Ewe-lamb producer	Producer	Producers who maintain a sheep-breeding herd for the production of lambs.
Exclusive dealings	Packer, processor	Requirement in which a buyer is prohibited from buying and selling the same products from another supplier.
Exclusive dealings	Downstream	Requirement in which a buyer is prohibited from buying and reselling the same products from another supplier.
Fabrication	Packer, processor	Fashioning one or more pieces of meat into an end or intermediate meat product.
Farrow-to-wean operations	Producer	Operations that specialize in maintaining a swine-breeding herd for the production of weaner pigs.
Fat-o-Meat’er	Packer	A type of optical probe used in the pork industry to estimate the lean percentage of a carcass.

(continued)

Term	Stage of Production[a]	Definition
Fed livestock	Producer, packer	Livestock raised specifically for the production of fresh meat products that are ready for slaughter (also known as finished, slaughter, or market animals), such as finished cattle, slaughter lambs, market hogs.
Feeder livestock	Producer	Livestock raised specifically for the production of fresh meat products that are ready to enter the final stage of production (also known as stockers)
Feeders	Producer	Individuals that operate feedlots.
Feeder-to-finish operations	Producer	Swine operations that specialize in raising pigs from feeder pigs to finished hogs.
Feedlot	Producer	A location where cattle and sheep are fed a high-energy ration in preparation for slaughter (also known as feedyards).
Finished livestock	Producer, packer	See fed livestock.
Finishing operation	Producer	A location where hogs are fed a high-energy ration in preparation for slaughter.
Flat pricing	Downstream	Buyer and seller agree to a specific dollar per pound for a specified time period.
Floor and ceiling pricing	Downstream	Agreed upon purchase (sales) price increases and decreases with market prices but has a lower limit and an upper limit for a specified time period.
Food service establishment	All	Restaurants, hotels, institutions, or other food service establishments located in the United States.
Foreign buyers	All	Foreign distributors, retailers, or food service.
Formula pricing	All	Using another price as the base for the purchase (sale) of livestock (product) (e.g., USDA price). (Producer: The formula can include grid or nongrid values.)
Forward contract	Producer	Oral or written agreement between a buyer (packer) and seller for the *future* purchase of a specified quantity of livestock at either a fixed or base price more than 2 weeks before delivery or kill date.
Forward contract	Packer	Oral or written agreement between a buyer (packer) and seller for the *future* purchase of a specified quantity of livestock at either a fixed or a base price. Contract is entered into at any time between placement of livestock on feed and 2 weeks before kill date or delivery.
Forward contract	Processor, downstream	Oral or written agreement between a buyer and seller for the *future* purchase of a specified quantity of livestock (product) at either a fixed or base price.
Further processing	Packer, processor	Activities beyond fabrication of primals, subprimals, and cuts (e.g., grinding, cooking, and curing).
Futures contract	Producer, packer	An agreement to buy or sell a commodity at a future date in accordance with contract terms.
Futures markets	Producer, packer	Exchange where futures contracts are traded under formal and regulated conditions.
Futures price	Producer, packer	Commodity prices determined in a futures market.
Gilt	Producer	Female swine that has not given birth to a litter of pigs.[b]
Grid	Producer	Prices are adjusted by premiums or discounts for specific carcass-quality characteristics, such as grade and yield.

(continued)

Term	Stage of Production[a]	Definition
Grid pricing	Packer	Prices are adjusted by premiums or discounts for specific carcass-quality characteristics, such as grade and yield.
Ground, including trimmings	Packer, processor, downstream	Raw meat that has been ground but has not received any additional processing, including case-ready ground product.
Grower	Producer	Individual who raises animals (typically used in reference to a hog grower).
Heifer	Producer, packer	Young female bovine that has not had a calf.[c]
Hot weight	Producer, packer	Weight of a carcass before it has been chilled (also known as carcass or rail weight).
Individually negotiated pricing	All	Negotiations between a buyer and seller, *excluding* negotiated formula pricing.
Internal transfer	Producer	Transfer of livestock to (from) another business unit owned by the same company (not including packer fed/owned).
Internal transfer	Packer (procurement)	Transfer of packer-owned livestock from a feedlot (finisher) to the slaughter plant.
Internal company transfer	Packer (sales), processor, downstream	Transfer of product to (from) another business unit owned by the same company.
Isowean pigs	Producer	Pigs that have been weaned from a sow early and placed into a nursery
Joint venture	All	A business and one or more other businesses joining together under a contractual agreement for a *specific* venture, such as use of specific animal genetics or brand names.
Lean percentage	Producer, packer	Value equal to the average percentage of the carcass weight comprising lean meat.
Loin depth	Producer, packer	Average muscle depth, measured in inches, between the 3rd and 4th rib from the last rib, 7 centimeters from the carcass split.
Loin-eye area	Producer, packer	Surface area, in square inches, of the *Longissimus dorsi* muscle at the 10th rib of a pork carcass.
Marketing agreement	All	*Long-term* oral or written agreement between a buyer and seller where a buyer agrees to purchase product under specific terms (processor: including preferred vendor programs).
Marketing contract	Producer, packer	See procurement contract.
Matrix	Producer, packer	See grid.
Meat	All	Edible part of muscle from cattle, sheep, or swine-dressed carcasses (excludes offal and by-products).
MPR	Producer, packer	Mandatory Price Reporting: a program operated by the USDA-Agricultural Marketing Service for the reporting of information regarding the marketing of cattle, swine, lambs, and livestock products from beef packers slaughtering 125,000 head, pork packers slaughtering 100,000 head, lamb packers slaughtering or processing 75,000 head, and lamb importers importing 5,000 metric tons annually.
Mutton	All	Meat from mature sheep.

(continued)

Term	Stage of Production[a]	Definition
National or regional brand	All	Brand that is sold by various retailers throughout the country or in a specific region.
No roll	Packer	Carcasses that were not federally graded because of low quality.
Nurseries	Producer	Swine operations that specialize in raising pigs from isoweans to feeder pigs.
Offal	Packer	Viscera removed at slaughter.
Or-better pricing	Downstream	Buyer and seller agree to a specific dollar per pound for a specified time period; however, if the market price decreases over the time period, then the purchase (sales) price decreases as well.
Outs and culls	Producer, packer	Atypical livestock that have been sorted out because of poor quality.
Packer fed/owned	Producer	Livestock are owned by the packer and fed for slaughter at either a custom feedlot or a packer-owned or controlled feedlot (or company-owned farms).
Packer fed/owned	Packer	Transfer of packer-owned livestock from either a custom feedlot or a packer-owned or controlled feedlot.
Partner arrangement	Producer	Arrangement between two parties at the same level of production for the purchase of livestock.
Pay weight	Producer, packer	Weight used to calculate payment (e.g., liveweight minus shrink).
Pelt	Packer	Hide with wool removed from sheep at slaughter.
Portion cuts	Packer, processor, downstream	Steaks, chops, and other cuts of meat that have been cut to uniform sizes or weights and packaged in bulk.
Price list	All	Using a seller's price list without negotiation.
Primal cuts	Packer, processor, downstream	Groups of muscles from the same area of the carcass; also referred to as wholesale cuts (e.g., beef loin, beef chuck).
Private label brand	All	Product brand that is sold exclusively by one retailer.
Processed meats	Packer, processor, downstream	Meat products that were produced from carcass meats by drying, curing, smoking, cooking, or other similar practices (e.g., cold cuts, sausages, ham, bacon).
Processed, not ready to eat	Packer, processor, downstream	Meat products that have received further processing and require cooking to achieve food safety (e.g., partially cooked meat patties).
Processed, ready to eat	Packer, processor, downstream	Meat products that have received further processing and do *not* require cooking to achieve food safety (e.g., lunch meats, cooked sausages, and precooked meat).
Processing	Packer, processor, downstream	Manufacturing meat products from carcass meats by drying, curing, smoking, cooking, or other similar practices.
Procurement or marketing contract	Producer, packer	Formal agreement specifying the terms for the (*future*) transfer of livestock between a seller and buyer using a prespecified price or payment formula.
Production contract	Producer, packer	Formal agreement between a packer or integrator and grower for the production and delivery of pigs or hogs (market hogs) where the ownership of the animals (hogs) is retained by the packer or integrator and the grower gets compensated for housing and husbandry.

(continued)

Term	Stage of Production[a]	Definition
PSE	Producer, packer	Pale, Soft, Exudative: a condition, most frequently found in pork, in which meat is very light in color, has a soft texture, and a high degree of drip loss.
Quality grade	Producer, packer	Assessment of meat palatability determined by a USDA inspector who evaluates the carcass. The most common beef quality grades are Prime, Choice, and Select. Choice is the most common lamb quality grade. Pork grades are numbered 1 through 4 but are seldom used.
Retail cuts	Packer, processor, downstream	Steaks, roasts, chops, ground meat, and other products sold from refrigerated cases by retail food stores and specialty meat shops.
Retail establishments	All	Grocery stores, meat markets, warehouse clubs, or other retail establishments located in the United States.
Sales method	All	Transfer of product from a plant's physical location to another physical location, including internal product transfers to another business unit owned by the same company.
Sealed bid	All	Price is determined by a sealed bidding process between multiple buyers and sellers.
Shackle space	Producer, packer	Refers to the hooks used to hang carcasses on the slaughter line; the space occupied by a carcass in a slaughter plant
Shared ownership	All	Arrangement in which the original owner and an operation (business) both retain partial ownership of livestock or meat products (that is, a vertical arrangement).
Shrink	Producer, packer	Loss in weight of live animals during transport or moisture loss in meat products.
Slide	Producer	Adjustment made to prices based on an animal's weight relative to a target weight.
Sort loss	Producer, packer	Average discount, in $/cwt, for hogs slaughtered that are outside the packer's established carcass weight range or lot variation range.
Sow	Producer	Female hog that has given birth to at least one litter of pigs.
Steer	Producer, packer	Male bovine castrated within the first six months from birth.
Subprimal cuts	Packer, processor, downstream	Smaller cuts of meat taken from primal cuts, but from which even smaller cuts can be made (e.g., beef sirloin, beef chuck arm half).
Swine integrator	Producer, packer	Business that owns or contracts with producers or other businesses to perform specific steps in the swine production process, such as breeding and birthing, nursery care, growing and finishing, transportation, processing, and marketing.
Trimmings	Packer, processor	Small portions of meat and fat removed from larger meat cuts.
Two-part pricing	Packer, processor, downstream	Pricing that includes a fixed payment (e.g., slotting allowance) and a per-unit price.
USDA Process Verified	All	Suppliers are able to make marketing claims—such as breed, feeding practices, or other raising and processing claims—and market themselves as "USDA Process Verified."
Volume discounts	Packer, processor, Downstream	Pricing in which larger shipments have lower per-unit prices.

(continued)

Term	Stage of Production[a]	Definition
Weaned pigs	Producer	Pigs that have been removed (weaned) from the sow.
Weaner-to-feeder operations	Producer	Swine operations that specialize in raising pigs from weaned pigs to feeder pigs.
Yield grade	Producer, Packer	Assessment of a carcasses cutability determined by a USDA inspector who evaluates the carcass. Yield grades are numbered 1 through 5, with 1 providing the most edible percentage and 5 the least.
Yield percentage	Producer, Packer	See dressing percentage.

[a]Downstream includes wholesalers, exporters, food service establishments, and retailers.

[b]In some cases, “gilt” may include young female swine that have had one litter.

[c]In some cases, “heifer” may include young female bovine that have had one calf.

Source: Some of the definitions were derived from: Urner Barry's Yellow Sheet. A Glossary of Meat Industry Terms. Bayville, NJ: Urner Barry Publications, 2004.

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Volume 1: Executive Summary and Overview

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Abstract

Over time, the variety, complexity, and use of alternative marketing arrangements (AMAs) have increased in the livestock and meat industries. Marketing arrangements refer to the methods by which livestock and meat are transferred through successive stages of production and marketing. Increased use of AMAs raises a number of questions about their effects on economic efficiency and on the distribution of the benefits and costs of livestock and meat production and consumption between producers and consumers. This final report focuses on AMAs used in the beef, pork, and lamb industries from the sale of live animals to final meat sales to consumers and addresses the following parts of the Grain Inspection, Packers and Stockyard Administration (GIPSA) Livestock and Meat Marketing Study:

- Part C. Determine extent of use, analyze price differences, and analyze short-run market price effects of AMAs.
- Part D. Measure and compare costs and benefits associated with spot marketing arrangements and AMAs.
- Part E. Analyze the implications of AMAs for the livestock and meat marketing system.

This final report follows the publication of an interim report for the study that used qualitative sources of information to identify and classify AMAs and to describe their terms, availability, and reasons for use. The portion of the study contained in this final report is based on quantitative analyses using industry survey data from producers, feeders, packers, processors, wholesalers, retailers, and food service operators; transactions data and profit and loss (P&L) statements from packers and processors; Mandatory Price Reporting (MPR) data; and a variety of other published data sources.

The final report contains separate volumes that describe the data collection methods and results (Volume 2) and the analysis results for the beef industry (Volume 3), the pork industry (Volume 4), the lamb industry (Volume 5), and meat distribution and sales (Volume 6). Volumes 3 through 6 address the effects of AMAs on prices, costs, quality, risk, and consumers and producers, to the extent feasible given the availability of data.

The principal contributors to this study are the following:

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This report and the study on which it is based were completed under a contract with GIPSA, U.S. Department of Agriculture (USDA). Any opinions, findings, and conclusions or recommendations expressed in this report are those of the authors and do not necessarily reflect the views of GIPSA or USDA.

Contents

Executive Summary

As part of the congressionally mandated Livestock and Meat Marketing Study, this volume of the final report presents the results of analyses of the effects of alternative marketing arrangements (AMAs) in the fed cattle and beef, hog and pork, and lamb and lamb meat industries. This final report focuses on determining the extent of use of AMAs, analyzing price differences and price effects associated with AMAs, measuring the costs and benefits associated with using AMAs, and assessing the broad range of implications of AMAs. The analyses in this volume were conducted using results of industry interviews, industry survey data, transactions and profit and loss (P&L) statement data from meat packers, Mandatory Price Reporting (MPR) data, and data from other publicly available sources. Analyses are limited to the economic factors associated with AMA use, and the report does not analyze policy options or make policy recommendations.

In this report, AMAs refer to all possible alternatives to the cash or spot market. AMAs include arrangements such as forward contracts, marketing agreements, procurement or marketing contracts, production contracts, packer ownership, custom feeding, and custom slaughter. Cash or spot market transactions refer to transactions that occur immediately, or "on the spot." These include auction barn sales; video or electronic auction sales; sales through order buyers, dealers, and brokers; and direct trades.

It is important to note that the data collection period for the study, October 2002 through March 2005, was an unusual time for the U.S. meat industry. The beef industry experienced a turbulent market because of the discovery of bovine spongiform encephalopathy (BSE) in North America. The initial BSE case in Canada in May 2003 stopped imports of live cattle to the United States. The first U.S. case of BSE in December 2003 blocked U.S. beef exports until July 2005. Cattle prices set annual record highs in 2003, 2004, and 2005. Packers experienced significant losses because of tight cattle supplies and continued imports of Canadian boxed beef. While hog prices were not at record highs, hog producer returns, which were negative during 2002 and much of 2003, turned positive from February 2004 through the end of 2006. The higher hog prices in 2004 and 2005 came at a time of record production, while demand for pork improved. Lamb prices increased sharply—setting record highs in the first quarter and second quarters of 2005—while the supply of lambs declined.

ES.1 GENERAL STUDY CONCLUSIONS

Within the context of these market conditions, the general conclusions of the study are as follows:

- Use of AMAs during the October 2002 through March 2005 period, including packer ownership, is estimated at 38% of the fed beef cattle volume, 89% of the finish hog volume, and 44% of the fed lamb volume sold to packers.
- Packer-owned livestock accounted for a small percentage of transactions for beef and lamb (5% or less), even when the small percentage of partial ownership arrangements is included, but accounted for a large percentage of transactions for pork (20% to 30% depending on assumptions).
- Given the current environment and recent trends, we expect moderate increases in use of AMAs in the lamb industry, but little or no increase in the beef and pork industries.
- Cash market transactions serve an important purpose in the industry, particularly for small producers and small packers. In addition, reported cash prices are frequently used as the base for formula pricing for cash market and AMA purchases of livestock and meat.
- The use of AMAs is associated with lower cash market prices, with a much larger effect occurring for finished hogs than for fed cattle.

- Many meat packers and livestock producers obtain benefits through the use of AMAs, including management of costs, management of risk (market access and price risk), and assurance of quality and consistency of quality.
- In aggregate, restrictions on the use of AMAs for sale of livestock to meat packers would have negative economic effects on livestock producers, meat packers, and consumers.

Primary conclusions for this final report by species are described below.

ES.2 FED CATTLE AND BEEF INDUSTRIES

The primary conclusions for this final report, as they relate to the fed cattle and beef industries (Volume 3), are as follows:

- **The beef producers and packers interviewed believed that some types of AMAs helped them manage their operations more efficiently, reduced risk, and improved beef quality.** Feedlots identified cost savings of $1 to $17 per head from improved capacity utilization, more standardized feeding programs, and reduced financial commitments required to keep the feedlot at capacity. Packers identified cost savings of $0.40 per head in reduced procurement cost. Both agreed that if packers could not own cattle, higher returns would be needed to attract other investors and that beef quality would suffer in an all-commodity market place.
- **Eighty-five percent of small producers surveyed used only the cash market when selling to packers, compared with 24% for large producers, and pricing methods also differed by size of operation.** Large producers used multiple pricing methods, including individually negotiated pricing (74% of producers), public auction (35%), and formula pricing (57%). In comparison, small producers used individually negotiated pricing (32%), public auction (84%), and formula pricing (6%). Four times as many large producers sold cattle on a carcass weight basis with a grid compared with small producers.
- **Ten percent of large beef packers surveyed reported using only the cash or spot market to purchase cattle, compared with 78% of small beef packers**. Large packers relied heavily on direct trade and less on auction barns and dealers or brokers for their cattle procurement compared with small packers.

Conversely, small packers used AMAs for approximately half as much on a percentage basis as large packers. Both large and small packers used multiple pricing methods when buying cattle, including individually negotiated prices, formula pricing, public auction, and internal transfer pricing. While nearly all packers bought some cattle on a liveweight basis, 88% of large packers purchased cattle based on carcass weight with grids, while almost no small packers used this type of valuation.

- **Neither the producers nor packers surveyed expected the use of AMAs to change dramatically in the next 3 years.** In addition, they indicated that their use of AMAs had not changed significantly from 3 years earlier. Auction markets were the predominate marketing method across all producers selling cattle and calves. Based on the survey results, which tend to represent smaller packers, 19% of fed cattle are purchased through auctions. This is a substantially higher percentage than the estimate based on the transactions data obtained from larger packers.
- **The producers surveyed that used AMAs identified the ability to buy/sell higher quality cattle, improve supply management, and obtain better prices as the leading reasons for using AMAs.** In contrast, the producers surveyed that used only cash markets identified independence, flexibility, quick response to changing market conditions, and ability to buy at lower prices and sell at higher prices as primary reasons for using only cash or spot markets.
- **The packers surveyed that used AMAs said that their top three reasons for using AMAs were to improve week-to-week supply management, secure higher quality cattle, and allow for product branding in retail stores.** Much like producers, packers that used only cash markets identified independence, flexibility, quick response to changing market conditions, and securing higher quality cattle as reasons for using only the cash or spot market.
- **Transactions data summarized from the 29 largest beef packing plants during the time period of the study included more than 58 million cattle and 590,000 transactions and indicated that the cash or spot market was the predominate purchase method used.** Specific estimates of the percentage of cattle purchased through each type of marketing arrangement are as follows:

> Note: To ensure the confidentiality of the companies that provided data for this study, the packer ownership category is often combined with other categories in the summary statistics presented in this volume. Results of analysis for the packer ownership category are provided in cases for which the results do not reveal company-specific confidential information.

- 61.7% cash or spot market
- 28.8% marketing agreements
- 4.5% forward contracts
- 5.0% packer owned, other method, or missing information

Thus, marketing agreements are the primary AMA used in the fed cattle and beef industries, but other types of AMAs are used extensively by individual firms for specific reasons that benefit their operations.

- **Transactions data indicate that packing plants in the Cornbelt/Northeast used AMAs less frequently than plants in the High Plains or West regions.** High Plains plants procured 61% of cattle by direct trade, 30% through marketing agreements, and a very small percentage through auctions and forward contracts. Cornbelt/Northeast plants bought the majority of their cattle by direct trade, but some were purchased through auctions and marketing agreements. Plants in the West bought a lower percentage by direct trade compared with the other regions and a higher percentage through marketing agreements and auction barns.

- **Individually negotiated pricing was the most common method used to determine purchase prices for fed cattle**. Specifically, 60% of cattle purchased by plants in the High Plains used individually negotiated pricing, with a similar percentage in the Cornbelt/Northeast and a substantially lower percentage in the West. Formula pricing was used to purchase 34% of the cattle in the High Plains, with a higher percentage in the West and a substantially lower percentage in the Cornbelt/Northeast. The formula was based most often on either U.S. Department of Agriculture (USDA)-reported prices or subscription service prices. Cornbelt/Northeast packers purchased the largest percentage of cattle on a liveweight basis (47%) in comparison with the High Plains (40%) and the West (25%). Packers in the West purchased more than half of their cattle using carcass weight with grid valuation, while packers in the High Plains and Cornbelt/Northeast used this valuation method for 42% and 44% of their purchases, respectively. The remainder were predominately purchased on a carcass weight basis without a grid.

- **Regression analysis of the relationship between all fed cattle transactions prices and use of marketing arrangements indicates that, relative to direct trade transactions, prices for fed cattle sold through auction barns tended to be somewhat higher and prices for fed cattle sold through forward contracts tended to be somewhat lower.** These results are likely due, in part, to the differences in risk associated with the two methods: auction barn sales are subject to greater price risk, but forward contracts ensure market access and a guaranteed price for cattle producers. However, the results also are influenced by the period of the analysis, during which fed cattle prices were at record highs. The prices for fed cattle sold through marketing agreements and transferred through packer ownership were relatively similar to direct trade. Prices for cattle under packer ownership are internal transfer prices that are typically based on external market prices; thus, implications of the results for packer-owned cattle are less clear.
- **Regression analysis of the relationship between cash market (auction barns, dealers and brokers, and direct trade) transactions prices for fed cattle and use of marketing arrangements suggests that if capacity utilization within a plant increases through the use of AMAs, firms pay slightly less per pound for cattle purchased in the cash market.** Specifically, a 10 percentage point increase in capacity utilization through AMAs is associated with a 0.4 cent per pound carcass weight decrease in the cash market price. Furthermore, if more cattle are available through AMAs within the following 21 days, cash market prices decrease slightly. Specifically, a 10% reduction in the volume of cash market transactions, assuming that volume is shifted into AMAs, is associated with a 0.11% decrease in the cash market price.
- **Beef packer plant-level P&L data showed significant economies of scale in beef packing, and costs were decreasing across the entire data range analyzed.** When both are operated close to capacity, smaller plants are at an absolute cost disadvantage compared with larger plants. When larger plants operate with smaller volumes, they have higher costs than smaller plants operating close to capacity and, thus, have an incentive to increase throughput. For all plants, large and small, average total cost increases sharply as volumes are reduced. A representative plant operating at 95% of the maximum observed volume is 6% more

efficient than a plant operating in the middle of the observed range of volumes and is 14% more efficient than a plant operating at the low end of the observed range.

- **Based on an analysis of P&L statements, procurement of cattle through AMAs results in production cost savings to the plants that use them.** However, the results differ across firms and plants. Some plants benefited substantially from AMAs and other plants did not appear to capture any benefits. The weighted average industry total production cost savings associated with AMAs was approximately $6.50 per animal. For an industry with an average loss of $2.40 per head during the 30-month sample period, this is a substantial benefit.
- **Marketing agreements are the most widely used AMAs in the beef industry, and thus restrictions on the use of marketing agreements would have the greatest negative effects on costs of production in the beef packing industry.** Forward contracts and packer-owned cattle were used, but to a much lesser extent. Therefore, restrictions on the use of packer ownership and forward contracts for cattle would have lesser effects on costs of production.
- **While the results differ by plant and firm, simulation analysis indicates that reducing or eliminating AMAs would result in higher average total cost (ATC) for slaughtering and processing beef cattle and, likewise, reduced gross margins and packer profits.** The average increase to beef slaughter and processing ATC would be 4.7% with a hypothetical elimination of AMAs and 0.9% with a hypothetical 25% reduction is use of AMAs. Packer profits are estimated to decrease by 6.0% and 1.5% if AMAs were reduced by 100% or 25%, respectively.
- **Beef quality has a positive effect on beef demand, the producers and packers interviewed and surveyed believe that AMAs are important for beef quality, and quantitative analyses suggest that AMAs are often associated with higher quality.** Regression analysis of MPR data found a small but positive relationship between formula and packer ownership procurement and USDA Quality Grade and found no statistical relationship between cash purchases and USDA Quality Grade. Regression analysis on transactions data found that marketing agreement cattle had a higher percentage Choice and Prime carcasses without increasing the percentage of Yield Grade 4 and 5

carcasses and had only modest declines in Yield Grade 1 and 2 carcasses. Other procurement methods had a greater trade-off between preferred quality grade and preferred yield grade. Furthermore, marketing agreement cattle and packer-owned cattle were associated with relatively higher quality compared with direct trade cattle, as measured by a composite quality index, but the small percentage of cattle sold through auction barns was associated with the highest quality and the highest variability in quality. The small percentage of cattle sold through forward contracts was associated with the lowest quality but also the lowest variability in quality.

- **The producers and packers surveyed that use AMAs value them as a method of dealing with production, market access, and price risks.** More specifically, feedlots believed that AMAs allow them to secure or sell better quality cattle and calves and improve operational management, efficiency, and capacity utilization. Packers identified AMAs as an important element of branded products and meeting consumer demand by producing a higher quality, more consistent product.
- **Regression analysis accounting for cattle quality and sales month found that auction market and forward contract prices were more volatile than direct trade, marketing agreement, and packer-owned cattle prices.** Furthermore, the volatility of prices for direct trade and marketing agreement cattle were relatively similar. Results were generally consistent for fed beef cattle and fed dairy cattle.
- **Hypothetical reductions in AMAs, as represented by formula arrangements (marketing agreements and forward contracts) and packer ownership, are found to have a negative effect on producer and consumer surplus measures.** Beef and cattle supplies and quality decreased and retail and wholesale beef prices increased because of reductions in AMAs. However, feeder and fed cattle prices decreased because of higher slaughter and processing costs resulting from the AMA restrictions. The short-run, long-run, and cumulative present value surplus for producers and consumers associated with reduced AMA volumes are all negative. Over 10 years, a hypothetical 25% restriction in AMA volumes resulted in a *decrease* in cumulative present value of surplus of
  - 2.67% for feeder cattle producers,

- 1.35% for fed cattle producers,
- 0.86% for wholesale beef producers (packers), and
- 0.83% for beef consumers.

A hypothetical 100% restriction in AMA volumes resulted in a *decrease* in cumulative present value surplus of

- 15.96% for feeder cattle producers,
- 7.82% for fed cattle producers,
- 5.24% for wholesale beef producers (packers), and
- 4.56% for beef consumers.

Thus, feeder cattle producers lose more surplus relative to the other sectors under either scenario. In addition, the estimated changes would imply a reduction in the competitiveness of beef relative to other meats.

- **The cost savings and quality improvements associated with the use of AMAs outweigh the effect of potential oligopsony market power that AMAs may provide packers.** In the model simulations, even if the complete elimination of AMAs would eliminate market power that might currently exist, the net effect would be reductions in prices, quantities, and producer and consumer surplus in almost all sectors of the industry because of additional processing costs and reductions in beef quality. Collectively, this suggests that reducing the use of AMAs would result in economic losses for beef consumers and the beef industry.

ES.3 HOG AND PORK INDUSTRIES

Primary conclusions for this final report, as they relate to the hog and pork industries (Volume 4), are as follows:

- **AMAs are an integral part of hog producers' selling practices and pork packers' procurement practices.** There are significant regional differences in the observed patterns of use of AMAs: a stronger reliance on cash/spot markets and marketing contracts is apparent in the Midwest, and a stronger reliance on production contracts and packer ownership of hogs is apparent in the East. The pattern of future use of AMAs is not expected to change dramatically; hence, we do not expect that hog industry industrialization will emulate the industrialization of the poultry sector.
- **Based on individual transactions data, there are substantial differences in daily hog prices paid by packers on a carcass weight basis.** On average, the

price dispersion is about 40% of the average value of the transaction prices each day. One part of such strong price dispersion can be explained by factors such as region, quality, or plant size. However, even after controlling for these factors, the remaining differences must be due to organizational issues related to supply chain management in the pork processing sector.

- **Results indicate that, on average, plants that use a combination of marketing arrangements pay lower prices for their hogs relative to plants that use the cash/spot market only.** In addition, comparing the magnitudes of the portfolio effects to the magnitudes of the individual marketing arrangement effects shows that individual marketing arrangements have minimal additional impact on the average price after accounting for the portfolio effect. That is, the portfolio system categorical variables capture almost the entire effect on lowering the average price.
- **Of particular interest for this study is the effect of both contract and packer-owned hog supplies on spot market prices; as anticipated, these effects are negative and indicate that an increase in either contract or packer-owned hog sales decreases the spot price for hogs.** Specifically, the estimated elasticities of industry derived demand indicate
  - a 1% increase in contract hog quantities causes the spot market price to decrease by 0.88%, and
  - a 1% increase in packer-owned hog quantities causes the spot market price to decrease by 0.28%.

  A higher quantity of either contract or packer-owned hogs available for sale lowers the prices of contract or packer-owned hogs and induces packers to purchase more of the now relatively less expensive hogs and purchase fewer hogs sold on the spot market.
- **Based on tests of market power for the pork industry, we found a statistically significant presence of market power in live hog procurement.** However, the results regarding the significance of AMA use for procurement of live hogs in explaining the sources of that market power are inconclusive. Whereas the model based on farm–wholesale price spread data shows that a higher proportion of AMA use leads to increased market power, the model estimated with company-level individual transactions data indicates that AMA use may not be a source of market power in pork packing.

- **Estimated total and average cost functions indicate that economies of scale diminish as the pork packing firm size increases.** The estimates indicate that the scale economies are exhausted well within the sample output range such that the biggest plants already exhibit negative returns to scale. That is, they operate on the upward-sloping portions of their average cost curves. The observed patterns of procurement portfolio choices by packers also indicate that certain combinations of marketing arrangements may reduce costs and/or increase economies of scale. In particular, relative to using spot market procurements alone, all other combinations of marketing arrangements improve the efficient scale of production.
- **Based on the observation that packers use marketing arrangements in clusters (portfolios), we hypothesized that marketing arrangements may be complementary to each other in the sense that implementing one procurement practice may increase the marginal return of the other practice; however, the analyses of the complementarity of marketing arrangements produced inconclusive results.** Simpler tests based on the correlation/association approach indicate that marketing contracts are in fact complementary to production contracts and/or packer owned arrangements. Also, the portfolio coefficients in the performance equations based on either the earnings before insurance and taxes (EBIT) or the gross margin show that all marketing arrangement portfolios improve plant performance relative to simple spot market purchases. However, the coefficient associated with the portfolio of three marketing arrangements is smaller than the coefficient associated with portfolios of two marketing arrangements, thus violating the complementarity requirement. More conclusive formal tests were not feasible given data limitations.
- **To analyze quality differences in live market hogs across alternative procurement methods (AMAs), we tested whether various quality attributes used by the industry are significantly different across AMAs and found that different AMAs are associated with different levels of quality of hogs.** Even though the rankings are not unique, we found that marketing contracts (especially other purchase arrangements and other market formula purchases) are consistently associated with higher quality hogs than negotiated (spot market) purchases.

- **An examination of the relationship between the proportion of AMAs used to procure live hogs and the quality of resulting pork products indicates that a higher proportion of AMA use is associated with higher quality pork products.** We measured pork product quality using Hicks' composite commodity index and hypothesized that a higher percentage share of the AMAs (essentially marketing contracts and packer-owned hogs) should produce higher quality pork products. The correlation coefficient showed that these two series are positively correlated, thus confirming our hypothesis.
- **An analysis of risk associated with different marketing arrangements shows that different types of marketing arrangements exhibit different price volatilities as measured by the variance of prices.** Therefore, hog producers selling hogs using different types of marketing arrangements experience different levels of risk. From the hog producers' point of view, the ordering of marketing arrangements in decreasing order of risk is as follows: (1) spot/cash market sales; (2) marketing contracts in which the pricing formula is based on spot market prices; (3) marketing arrangements in which the pricing formula is based on some futures or options price; (4) other purchase arrangements containing ledgers, windows, and other pricing mechanisms, which may serve as a cushion against price volatility; and (5) production contracts.
- **In analyzing the importance of hog producers' risk aversion for contract choice, we found that hog producers who use production contracts are more risk averse than producers who use cash/marketing arrangements.** The difference in risk exposure between contract producers and independent farmers is substantial because production contracts eliminate all but 6% of total income volatility. Therefore, the utility losses associated with forcing producers to market their hogs through channels different from their risk-aversion-preferred marketing arrangement choice are substantial.
- **In analyzing the economic effects of hypothetical restrictions on the use of AMAs in the hog and pork industries, we found that hog producers would lose because of the offsetting effects of hogs diverted from AMAs to the spot market, consumers would lose as wholesale and retail pork prices rise, and packers would gain in the short**

run but neither gain nor lose in the long run. The results applied to three different simulations: (1) 25% reduction in both contract- and packer-owned hogs, (2) increase the spot/cash market share to 25%, and (3) complete ban of packer-owned hogs. The reason that producers and consumers lose in all three simulation scenarios is because of efficiency losses from reducing the proportion of hogs sold through contracts and/or packer owned channels. Although a reduction in AMAs leads to an improvement for hog producers through a reduction in the degree of market power, the loss in cost efficiencies offsets the gains from reduced market power. In all instances, the price spread between farm and wholesale prices would be expected to increase because of the net increase in the costs of processing. Moreover, wholesale, and hence retail, prices would increase, causing pork to become more expensive for consumers.

ES.4 LAMBS AND LAMB MEAT INDUSTRIES

Primary conclusions for this final report, as they relate to the lamb and lamb meat industries (Volume 5), are as follows:

- **Lamb packers procure fed lambs primarily through formula pricing arrangements and auctions.** According to MPR data, lamb packers procure 42.2% of fed lambs through formula pricing arrangements and 39.4% through auctions. Negotiated sales account for 12.0% of fed lamb procurement, and packer ownership represents 4.9%. Contracted procurement represents only 0.8% of lamb procurement, while imports represent only 0.7%. These data are similar to those obtained from the lamb packer survey.
- **The means and standard deviations of fed lamb prices from MPR data for formula pricing and cash arrangements were similar during the sample period.** The price series were highly correlated with an estimated correlation coefficient of 0.970. A reduced-form model of the difference between normalized formula pricing and cash fed lamb prices indicated that lamb inventories, lamb carcass price risk, and seasonality were the primary determinants of variations in the difference.
- **Changes in procurement methods for lamb would impose costs on the lamb marketing system by reducing efficiencies, but may also provide some benefits by altering potential market power effects.** If formula pricing procurement is restricted,

lamb acquisition costs would rise. However, some of this increase in costs may be offset by a reduction in potential oligopsony power. Ultimately, a combination of these effects yields net changes in lamb prices, quantities, and producer surplus.

- **Given that lamb markets are relatively thin, the primary effect of MPR may have been to reduce price risk rather than to influence price levels.** The implementation of MPR in 2001 increased slaughter lamb price by only 0.129%.
- **AMAs were found to have statistically significant although economically small effects on lamb prices.** A 10% increase in formula pricing lamb procurement would increase the slaughter lamb price by an estimated 2.54%; this effect is likely due to risk reductions. A 10% increase in cash lamb procurement increases slaughter prices by an estimated 2.68%. A 10% increase in packer ownership reduces slaughter lamb prices by an estimated 0.23%.
- **Increases in formula pricing and cash procurement methods reduce lamb procurement costs, while increases in packer ownership increase procurement costs.** The effects of formula pricing and cash procurement methods on procurement costs for lambs were similar and not statistically different from one another.
- **Technological change has likely increased lamb quality over time.** However, there does not appear to be any statistically significant difference in the quality of lambs procured through formula pricing and cash procurement methods.
- **Price risk shifting from lamb producers to lamb packers and breakers has not occurred as a result of AMAs.** No statistical difference was found between the variances of prices for each type of AMA.
- **Restrictions on the use of AMAs cause almost every sector in the lamb industry to lose producer surplus, even if potential market power (if it exists) is reduced or eliminated.** Reductions in the use of AMAs have both positive and negative effects on the lamb industry. Reductions in potential market power (a positive effect) do not offset the increases in processing costs and reductions in lamb quality (negative effects).
- **Restrictions on the use of AMAs would likely reduce the competitiveness of the lamb industry.**

Although lamb is not a strong substitute for beef and pork, restrictions on the use of AMAs would place it at a competitive disadvantage to these other meats. More importantly, however, it appears that imported lamb is a strong substitute for domestic lamb. Hence, the loss of competitiveness in response to restrictions on the use of AMAs is much more pronounced with respect to lamb imports.

- **AMAs may have multiple effects on accessing the lamb market.** Ease of entry may be affected by the availability of AMAs, because financing of production operations often depends on the assurance of market access and price risk management. However, for small producers, it may be more difficult to secure AMAs because it is more costly for packers to negotiate with many small producers relative to fewer large producers. Hence, if AMAs reduce the viability of public auctions, small producers may find that their market access is limited.
- **Restrictions on the use of AMAs may increase concentration of various segments of the lamb industry, but the effect of increased concentration on market power is unknown.** There are no clear effects of the changes in the use of AMAs on concentration in the lamb industry. Concentration in the lamb packing industry has remained relatively flat, even though the use of AMAs has increased. However, increased use of AMAs may reduce the viability of auctions and could lead to increased concentration in the lamb feeding sector. In addition, if restrictions on AMAs reduce the competitiveness of domestic lamb meat relative to lamb imports, then concentration in the lamb packing and processing industry is likely to increase in response to declining domestic demand.

ES.5 MEAT DISTRIBUTION AND SALES

Primary conclusions for this final report, as they relate to meat processing, distribution, and sales (Volume 6), are as follows:

- **Transactions data on meat processor purchases indicate a much larger use of AMAs than do the survey data.** Based on transactions data, only 21% of beef and pork products were purchased on the spot market. Internal transfers were a large factor for pork but were virtually nonexistent for beef. Forward contracts were 28% of beef purchases, but less than 1% of pork purchases. The type of purchase method used is either not important to meat processors or they did not understand the meaning of the categories, because 39% of beef and 32% of pork purchase methods were listed as "other or missing."

- **Approximately 99% of pork and 55% of beef product pounds that were priced using formula pricing used a USDA-reported price as the base.** The other base used for purchased beef was a subscription service. Although nearly all pork pricing formulas are based on USDA-reported prices, it is worth noting that wholesale pork, while reported by USDA, is not covered under Mandatory Price Reporting (MPR).
- **Meat processors play an important distribution role in the meat value chain by purchasing large lots from a few sources and selling small lots to many firms.** Transaction purchase data included 53,831 records from 32 firms, averaging 22,800 pounds per transaction. Sales transactions from 11 firms included 848,295 records, averaging 771 pounds per transaction, and these were all case ready or RTE. A high percentage of these transactions did not identify the sales method, indicating that processors either did not understand the meaning of the categories that were listed or do not track this information.
- **When examining data specific to the beef industry, aggregate cattle purchase and beef sales transactions data suggest no relationship between cattle purchase methods and branded beef sales, although this relationship may be important to individual firms.** Plants that sold 0% to 20% of their beef as branded product purchased approximately the same percentage of their cattle on the spot market as did plants that sold 21% to 40% of their beef as branded product. Although the differences were small, the 21% to 40% plants used more forward contracts and less packer ownership than did the 0% to 20% plants. Shares of marketing agreement cattle were nearly identical across the two groups. In addition, 60% of the meat purchased on the spot market by processors was branded product compared with none through marketing agreements and internal transfers.
- **Although potentially important to some beef industry firms, aggregate transaction data suggest that downstream marketing arrangements have no relationship to cattle purchase methods.** Beef plants were divided into two groups based on beef sales methods–0% to 50% and 51% to 100% cash or spot market beef sales. Transactions from both groups indicated that they each bought 60% of their cattle

through the spot market and 40% using AMAs. The 0% to 50% cash sales group used more marketing agreements, and the 51% to 100% cash sales group had more packer-owned cattle.

- **Aggregate transactions data for the beef industry suggest some relationship between meat buyer type and cattle purchase methods.** Packers that sold more beef to meat processors bought fewer cattle on the spot market but about the same number of cattle through AMAs (with the difference resulting from a larger percentage of other purchases or missing information). Packers that sold a larger amount of beef to retailers and food service operators bought a larger percentage of their cattle on the spot market and a slightly lower percentage of cattle through AMAs.
- **The pork industry is more vertically integrated than is the beef industry.** Pork packers produce a higher percentage of the animals that they slaughter than do beef packers, and pork processors acquire much more of their product through internal transfer than do beef processors.
- **Meat processor buyers mix and match purchase and pricing methods.** Formula pricing was used as the pricing method for spot market, forward contracts, and marketing agreements. Likewise, individually negotiated prices were more common in forward contracts than in spot markets.

ES.6 LIMITATIONS OF THE ANALYSES

Decisions regarding methodologies, assumptions, and data sources used for the study had to be made in a short period of time. The analyses presented in this final report are based on the best available data, using methodologies developed to address the study requirements under the time constraints of the study. Some analyses were limited because of availability and quality of the transactions and P&L statement data. However, secondary data were used, as available, to supplement primary data in order to conduct the analyses.

1 Introduction

AMAs include all possible alternatives to use of cash or spot markets for conducting transactions.

Over time, the variety, complexity, and use of AMAs have increased in the livestock and meat industries. Marketing arrangements refer to the methods by which livestock and meat are transferred through successive stages of production and marketing. A marketing arrangement also designates a method by which prices are determined for each individual transaction. The increased use of AMAs raises a number of questions about their effects on economic efficiency and on the distribution of the benefits and costs of livestock and meat production and consumption between producers and consumers.

USDA's GIPSA is charged with facilitating the marketing of livestock, meat, and other agricultural products. This agency also promotes fair and competitive trading practices for the overall benefit of consumers and American agriculture. In fulfilling its mission, GIPSA evaluates, among other things, the implications of the evolving landscape of AMAs and pricing methods.

In 2003, Congress allocated funds to GIPSA to conduct a broad study of the effects of AMAs on the livestock and meat industries.

In 2003, Congress allocated funds to GIPSA to conduct a broad study of the effects of AMAs on the livestock and meat industries. GIPSA developed the specific scope and objectives of the study, and following a competitive bidding process, RTI was awarded a contract to conduct the Livestock and Meat Marketing Study.

The questions posed by the Livestock and Meat Marketing Study included the following: What types of marketing arrangements are used? What is the extent of their use? Why do firms enter into the various arrangements? What are the terms and characteristics of these arrangements? What are the effects and implications of the arrangements on participants and on the livestock and meat marketing system?

The study examined the following species and meat types:

- fed cattle and beef,
- hogs and pork, and
- lambs and lamb meat.

The study comprised five main parts:

- Part A. Identify and classify types of spot marketing arrangements and AMAs.
- Part B. Describe terms, availability, and reasons for use of spot marketing arrangements and AMAs.
- Part C. Determine extent of use, analyze price differences, and analyze short-run market price effects of AMAs.
- Part D. Measure and compare costs and benefits associated with spot marketing arrangements and AMAs.
- Part E. Analyze the implications of AMAs for the livestock and meat marketing system.

The interim report released in August 2005 addressed Parts A and B of the study. This final report focuses on Parts C, D, and E.

An interim report released in August 2005 addressed Parts A and B of the study (Muth et al., 2005). The report described marketing arrangements used in the livestock and meat industries and defined key terminology.[1] Results presented in the interim report were preliminary because they were based on assessments of the livestock and meat industries using published data, review of the relevant literature, and industry interviews.

Concurrent with conducting Parts A and B of the study, the study team developed and pretested information collection plans for obtaining transactions data and P&L statements from packers, processors, and downstream market participants. In addition, the study team developed and pretested a set of 10 industry survey questionnaires to obtain additional information beyond what could be obtained in transactions data and P&L statements. We received approval for both information collection requests from the Office of Management and Budget (OMB) in October 2005.

[1] Terms used in the study are included in the glossary.

This final report describes the results of quantitative analyses addressing Parts C, D, and E of the study, using data from the industry surveys across all stages of livestock and meat production, transactions data and P&L statements from packers and processors, production contract settlement data from packers, and a variety of publicly available data. According to the Performance Work Statement (PWS) in the contract with GIPSA, the results of these analyses will provide information to

- livestock producers to help them make more informed production and marketing decisions,
- the general public to help them understand the roles and reasons for using these arrangements,
- GIPSA for its role in enforcing the Packers, and Stockyards Act, and
- USDA and Congress to help them determine whether policy changes affecting livestock marketing methods that were originally considered during the development of the 2002 Farm Bill are warranted.

The Livestock and Meat Marketing Study was limited to economic factors associated with spot marketing arrangements and AMAs and did not analyze policy options or make policy recommendations.

The study is national in scope, but it considered regional differences among marketing arrangements, if applicable, and international dimensions related to marketing arrangements, if significant. All stages of production and marketing were addressed, including farm level, slaughtering, processing, wholesaling and distribution, retailing, food service, and export. The Livestock and Meat Marketing Study was limited to economic factors associated with spot marketing arrangements and AMAs and did not analyze policy options or make policy recommendations.

2 Overview of Parts C, D, and E of the Study

Throughout the report, industry participants are grouped into the following categories:

- livestock producers and feeders
- meat packers and processors (or breakers)
- wholesalers and distributors
- exporters
- food service or restaurant establishments
- retail establishments

Parts C, D, and E include complementary analyses of the effects of AMAs in each industry. The aims of Part C were to determine the extent to which various types of spot marketing arrangements and AMAs are used, to analyze price differences among the marketing arrangements, and to analyze the effects of alternative arrangements on short-run spot market prices as follows:

- Determine the volume of livestock and meat transferred through the various types of spot and alternative arrangements by type, size, and location of market participants.
- Report average price levels and differences in prices by type, size, and location of market participants.
- Determine price differences associated with the various types of spot marketing arrangements and AMAs, adjusting for quality differences, lot size, and other relevant factors that may affect prices, and determine how price differences vary with market conditions.
- Determine if packers' use of alternative procurement and pricing arrangements for fed cattle, slaughter hogs, and lambs is causally related to spot market prices for these animals in the short run and determine the nature of the relationship.

The aims of Part D were to measure and compare possible costs and benefits associated with the various types of spot marketing arrangements and AMAs as follows:

- Determine cost and efficiency differences and measure size and other economies and diseconomies associated with the use of AMAs.
- Determine the extent to which any differences in animal and meat quality are associated with differences in spot marketing arrangements and AMAs.[2]
- Determine if the various types of marketing arrangements shift risks among market participants or alter risk levels.[3]

The aims of Part E were to analyze the implications of AMAs for the livestock and meat marketing system, using the models developed in Parts C and D, as follows:

- Assess system-wide economic implications of restrictions on AMAs used by packers to purchase livestock.
- Assess the relative overall strength of positive and negative economic incentives for increased or decreased use of the various types of marketing arrangements.
- Examine the implications of expected changes in the use of various marketing arrangements over time.

[2] As noted in the PWS, quality measures might include meat grades, tenderness, taste, nutritional characteristics, consistency, and conformity to specifications.
[3] As noted in the PWS, risk might relate to price, quality, loss of product, loss of supplier, loss of buyer, reduced credit rating, or less reliable trading partners.

3 Information Sources Used for Parts C, D, and E of the Study

The analyses conducted for the final report build on information obtained for and summarized in the interim report. The interim report was based on information from the empirical agricultural economics and management literature, information from the development and pretesting of the data collection instruments for the transactions data collection and the industry surveys, available contract forms for beef cattle and hogs, discussions with trade associations, and discussions with industry participants.

The analyses presented in this final report use the following types of data:

- purchase and sales transactions data from meat packers and processors
- P&L statements from meat packers and processors
- production contract settlement data from hog packers
- industry survey responses from livestock producers, meat packers, meat processors, meat wholesalers, meat exporters, grocery retailers, and food service operations
- a broad range of publicly available data, including MPR data

4 Organization of the Report

This final study report provides information and quantitative results for Parts C, D, and E of the Livestock and Meat Marketing Study. The volumes of the final report are as follows:

- Volume 2: Data Collection Methods and Results
- Volume 3: Fed Cattle and Beef Industries
- Volume 4: Hog and Pork Industries
- Volume 5: Lamb and Lamb Meat Industries
- Volume 6: Meat Distribution and Sales
- Appendix A: Glossary

The results from Volume 2 are incorporated into all volumes, in the relevant sections. Volumes 3 through 5 have a similar structure, which follows the requirements of the study, as specified in the PWS. Volume 6 has a different structure to include additional analyses beyond the species-specific analyses included in the previous volumes.

5 References

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GIPSA Livestock and Meat Marketing Study

Contract No. 53-32KW-4-028

Volume 2: Data Collection Methods and Results

Final Report

Prepared for

Grain Inspection, Packers and Stockyard Administration
U.S. Department of Agriculture
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Abstract

Over time, the variety, complexity, and use of alternative marketing arrangements (AMAs) have increased in the livestock and meat industries. Marketing arrangements refer to the methods by which livestock and meat are transferred through successive stages of production and marketing. Increased use of AMAs raises a number of questions about their effects on economic efficiency and on the distribution of the benefits and costs of livestock and meat production and consumption between producers and consumers.

This final report follows the publication of an interim report for the Grain Inspection, Packers and Stockyards Administration (GIPSA) Livestock and Meat Marketing Study that used qualitative sources of information to identify and classify AMAs and to describe their terms, availability, and reasons for use. This volume of the final report is based on quantitative analyses using industry survey data from producers, feeders, packers, processors, wholesalers, exporters, retailers, and food service operators, as well as transactions data and profit and loss (P&L) statements from packers and processors.

This volume of the final report describes the data collection methods for the industry survey and the collection of transactions data and P&L statements from packers and processors. This volume also presents and summarizes the results of the industry survey. Where relevant, these survey results are also incorporated in the report volumes for each species included in the study.

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1 Introduction

> This volume
> - describes the industry survey procedures,
> - presents the industry survey results, and
> - describes the data collection procedures for the transactions and P&L statement data collection.

As part of the congressionally mandated Livestock and Meat Marketing Study, this volume of the final report describes the data collection methods for the study and presents the results of the industry survey. RTI International conducted an industry survey at multiple levels of production and marketing in the fed cattle, hog, lamb, and meat industries. The voluntary survey was national in scope and collected information from fed cattle, hog, and lamb producers and feeders; beef, pork, and lamb packers; meat processors; meat wholesalers; meat exporters; food retailers; and food service operators. The survey was administered by mail, with initial and follow-up contacts made by telephone to help encourage response.

We also collected procurement and sales transactions data from the largest meat packers and processors and downstream market participants (wholesalers, exporters, retailers, and food service operators) for the 2.5-year period from October 6, 2002, through March 31, 2005. Additionally, we collected weekly profit and loss (P&L) statements from meat packers and processors for the same time period. Response to the transactions data collection[1] was required for meat packers and processors as a special report under the Packers and Stockyards Act (7 U.S.C. § 222) and was voluntary for the downstream market participants. Meat packers and processors were required to provide daily procurement and sales transactions data, and downstream market participants were asked to provide weekly summaries of sales and purchases of

[1] Throughout the report, we collectively refer to the collection of procurement and sales transactions data and the weekly P&L statements as the “transactions data collection.”

beef, pork, and lamb products. We did not receive transactions data from any downstream market participants.

The Grain Inspection, Packers and Stockyard Administration (GIPSA) received clearance from the Office of Management and Budget (OMB) to conduct the industry survey and the transactions data collection in October 2005. We started data collection for the voluntary industry survey in November 2005, and started data collection for the transactions data collection in February 2006, as we were completing the data collection for the industry survey.

Sections 2 through 5 of the report describe the sample design, survey design and administration procedures, response rates, and data set preparation for the industry survey. Sections 6 through 9 provide tables with weighted tabulations for each survey question, cross tabulations by size (small versus large) for selected industry segments and questions, and a brief summary of the survey findings for each industry segment. Sections 10 through 12 describe the sample design, study design and data collection procedures, and data set preparation for the transactions data collection.

Appendixes A, B, and C contain the survey questionnaires and other materials used to conduct the industry survey. Appendixes D, E, and F contain the instruction booklets and other materials for the transactions data collection.

2 Sample Design for the Industry Survey

This section describes the sample design for the industry survey. Consistent with the categories of market participants included in the study, we selected a sample of establishments or companies from each of the following industry segments:

- livestock producers and feeders
  - fed cattle
  - hogs
  - lamb
- meat packers
  - beef
  - pork
  - lamb
- meat processors
- downstream market participants
  - meat wholesalers
  - meat exporters
  - food retailers (grocery stores and other retailers)
  - food service operators (restaurants and other food service establishments)

We describe below the respondent universe and the methodology for constructing the sampling frames, as well as the stratification and sample selection procedures for each industry segment.

2.1 RESPONDENT UNIVERSE, SAMPLING FRAME, AND STRATIFICATION

For many of the industry segments, we constructed sampling frames for the industry survey on the basis of Standard Industrial Classification (SIC) codes. Table 2-1 provides the SIC codes and the corresponding North American Industry Classification System (NAICS) codes, along with the universe size for each industry segment.[1]

2.1.1 Livestock Producers and Feeders

> We used the most current D&B database to construct the survey sampling frames for livestock producers and feeders. We constructed sampling frames by species on the basis of the establishment's primary SIC code. For each species, we took a census of the approximately 50 largest establishments and a sample of establishments from the remaining population (i.e., small establishments).

We used the most current D&B database (http:\www.dnb.com) to construct the survey sampling frames for livestock producers and feeders.[2] The D&B database provides detailed financial and other information for all businesses in the United States.

The sampling unit for livestock producers and feeders was defined as the establishment because establishment-level data were needed for the analysis. Using the D&B database, we constructed sampling frames by species on the basis of the establishment's primary SIC code. We excluded establishments without reported revenue or number of employees from the sampling frame because our previous experience using the D&B database suggests that most such business units are not currently operating.

To ensure proper representation of feedlots and different sizes of operations in the sample for fed cattle, we stratified the sample by type of operation on the basis of SIC code and by three size categories (small, medium, large) on the basis of annual sales revenues. For the large size category, a complete census was taken, while small operations were undersampled to allow a larger sample of medium operations relative to

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[1] Although the NAICS codes replaced the SIC codes in 1997, Dun & Bradstreet (D&B) continues to classify establishments using SIC codes. The tables found at http://www.census.gov/epcd/naics02/N2SIC42.HTM were used to map each NAICS code(s) to the appropriate SIC code(s).

[2] Early in the survey development process, we evaluated the feasibility of working with the U.S. Department of Agriculture's (USDA's) National Agriculture Statistics Service (NASS) to draw the sample for livestock producers and feeders. However, using the NASS data would have required that NASS obtain informed consent from the selected establishments prior to providing RTI with the identities of the establishments. Because of time constraints for conducting the study, this option was considered infeasible.

Table 2-1. Respondent Universe Description and Size for Each Industry Segment

Industry Segment	NAICS Codes	SIC Codes	Universe Size	Percentage of Total Industry Volume
Livestock producers and feeders				
Fed cattle				
Feedlots	112112	0211	14,166	N/A
Ranching and farming	112111	0212	35,442	N/A
Hog	11221	0213	7,384	N/A
Lamb	11241	0214[a]	1,267	N/A
Packers	311611[b]	2011[b]		
Beef			482	99%
Pork			489	99%
Lamb			202	96%
Processors	311612[b]	2013[b]	4,050	N/A
Wholesalers	42242, 42247	5142[c], 5147[d]	3,562	N/A
Exporters	N/A	N/A	46	N/A
Retailers	44511, 44512, 44521, 45291	5411[e], 5421[f], 5399[g]	28,559	N/A
Food service operators	72211, 722211, 722212, 72231, 72111, 72112	5812[h], 7011[i]	44,246	N/A

Sources: Dun and Bradstreet (D&B). <http:www.dnb.com>.
U.S. Department of Agriculture, Food Safety and Inspection Service. 2005. Enhanced Facilities Database. Washington, DC: U.S. Department of Agriculture (USDA).
U.S. Meat Export Federation. 2005. *2005 Membership Directory*. Denver, CO: Meat Export Federation.

N/A = Not available.

[a] For SIC code 0214 (sheep and goats), the following subcategories were included in the sampling frame: sheep, lamb feedlot, sheep feeding farm, and sheep raising farm.

[b] NAICS and SIC codes were not used to identify the respondent universe for packers and processors but are included in the table for completeness.

[c] For SIC code 5142 (packaged frozen foods), the following subcategories were included in the sampling frame: frozen meat, frozen meat pies, and packaged frozen meat.

[d] For SIC code 5147 (meats and meat products), the following subcategories were included in the sampling frame: meats and meat products, excluding lard.

[e] For SIC code 5411 (grocery stores), the following subcategories were included in the sampling frame: supermarkets (chains and independents) and grocery stores (chains and independents).

[f] For SIC code 5421 (meat and fish markets), the following subcategories were included in the sampling frame: meat markets, including freezer provisioners.

[g] For SIC code 5399 (miscellaneous general merchandise stores), the following subcategories were included in the sampling frame: warehouse club stores.

[h] For SIC code 5812 (eating places), the following subcategories were included in the sampling frame: fast-food restaurants (chains and independents), family restaurants (chains and independents), steak and barbecue restaurants, and contract food services.

[i] For SIC code 7011 (hotels and motels), the following subcategories were included in the sampling frame: hotels (franchised and independents), casino hotels, and resort hotels (franchised and independents).

their population counts. Table 2-2 provides the initial sample design for fed cattle producers and feeders. After drawing the sample, we compared the sample for large operations with lists maintained by the National Cattlemen's Beef Association (NCBA) of the largest feeding and cow-calf operations.[3] Based on this comparison, we replaced the selected sample with the operations on the NCBA lists (n = 25 for feedlots and n = 25 for cow-calf operations), because the selected sample did not include some of the operations on the lists.

For hog and lamb producers and feeders, we took a census of the approximately 50 largest establishments[4] and a sample of

Table 2-2. Initial Sample Design for Fed Cattle Producers and Feeders

Size Category	Sales	Population	Percentage of Population	Percentage of Sample	Required Sample
Feedlots (SIC 0211)					
Small	≤$999,999	13,384	94.5	90	100
Medium	$1,000,000–$24,999,999	762	5.4	10	11
Large[a]	≥$25,000,000	20	0.1	All	20
Total		14,166 (29%)	100.0		131
Ranching and farming (SIC 0212)					
Small	≤$19,999	31,622	89.2	78	211
Medium	$20,000–$2,499,999	3,768	10.6	22	60
Large[a]	≥$2,500,000	52	0.1	All	52
Total		35,442 (71%)	100.0		323
Total fed cattle producers and feeders		49,608			

[a] For large operations, we subsequently replaced the selected sample with operations from lists maintained by the NCBA (n = 25 for feedlots and n = 25 for cow-calf operations).

[3] According to NCBA, the lists include member and nonmember operations.

[4] Our target sample size for large producers was 50 establishments; however, because revenue is reported as categories in the D&B database, it was necessary to select more than 50 establishments. For example, for lamb producers, the 24 largest producers had revenue of more than $500,000, so we had to select all of the lamb producers in the next revenue category (56 producers) to have a sample of at least 50. The resulting total sample was 80 lamb producers.

establishments from the remaining population (i.e., small operations). Information was not available to stratify by type of operation. We used annual revenue as the size criterion. The large hog operations selected have annual revenue greater than $2.5 million, and large lamb operations have annual revenue greater than $200,000. After drawing the sample, we compared the sample for large hog producers and feeders with *Successful Farming*'s list of the 30 largest hog producers (www.agriculture.com) to identify and add operations not included in the sample.

2.1.2 Meat Packers and Processors

We used the EFD (USDA, FSIS, 2005) to construct the sampling frames for packers and processors. For packers, we took a census because of the relatively small number of plants. For processors, we took a census of the 50 largest plants and selected a sample from the remaining population (i.e., small establishments).

We used the USDA, Food Safety and Inspection Service (FSIS) Enhanced Facilities Database (EFD) to construct the sampling frames for meat packers and meat processors (USDA, FSIS, 2005). The EFD is a database of federally and state-inspected meat, poultry, and egg products establishments and contains information on volume, annual revenue, number of employees, inspection activities, and contact information.

The sampling unit for meat packers and processors was defined as the establishment because establishment-level data were needed for the analysis. Using the EFD, we constructed separate sampling frames for beef packers, pork packers, lamb packers, and meat processors. We excluded from the sampling frames all state-inspected establishments and establishments that slaughter fewer than 50 head a year. These establishments are very small (the vast majority have fewer than 10 employees), thus the use of alternative marketing arrangements (AMAs) is likely to be limited. Also, for state-inspected establishments, products produced under state inspection are limited to intrastate commerce.

Establishments that slaughter and process were included in the sampling frame for packers. Packers that slaughter multiple species and have a Hazard Analysis and Critical Control Points (HACCP) size designation[5] of “small” or “large” were included in the sampling frame for each species slaughtered. Establishments with a HACCP size designation of “very small” were only included in the sampling frame for one species. Such

[5] Under FSIS’ HACCP rule, large plants have 500 or more employees, small plants have 10 or more employees but fewer than 500, and very small plants have fewer than 10 employees or less than $2.5 million in annual sales.

establishments were assigned to one species by using an algorithm that allocated plants across species based on the relative slaughter volumes and so that the universe size was approximately equal for beef and pork packers.

For packers and processors, we stratified the sample by establishment size (large versus small) using annual slaughter volume as the size criterion for packers and annual revenue as the size criterion for processors. The large sample included the 60 largest beef packers, 60 largest pork packers, 30 largest lamb packers, and 50 largest processors[6] and was the same set of establishments initially selected to provide transactions data.

For packers, the small sample included all remaining plants; thus, we took a complete census of all packers because of the relatively small number of plants. For processors, we took a census of the 50 largest establishments and selected a sample of establishments from the remaining population (i.e., small establishments).

2.1.3 Wholesalers, Retailers, and Food Service Operators

> We used the D&B database to construct the sampling frames for wholesalers, retailers, and food service operators. We took a census of the approximately 50 largest companies and a sample of companies from the remaining population (i.e., small companies).

We used the D&B database to construct the sampling frames for wholesalers, retailers, and food service operators. For these industry segments, the sampling unit was defined as the firm or company (single-location businesses or the headquarters for multilocation businesses) because firm-level data were needed for the analysis. We constructed separate sampling frames for each industry segment on the basis of the company's primary SIC code. Companies without reported revenue or number of employees were excluded from the sampling frame. For each industry segment, we took a census of the approximately 50 largest companies[7] and a sample of companies from the remaining population (i.e., small companies). We used annual revenue as the size criterion. The large wholesalers selected have annual revenues greater than $50 million, large retailers have annual revenues greater than $250 million, and large food

[6] Lamb processing plants (known as breakers) tend to be specialized and relatively small. To ensure adequate representation of lamb processors in the large sample, 10 specialized lamb processing plants were substituted for an equivalent number of nonlamb processing plants to achieve the specified sample size.

[7] Our target sample size for large companies within each industry segment was 50 companies; however, because revenue is reported as categories in the D&B database, it was necessary to select more than 50 companies.

service operators have annual revenues greater than $100 million (includes meat and nonmeat revenues).

After drawing the sample, we compared the large sample with industry lists of the largest companies (e.g., *Progressive Grocer*'s list of top 50 supermarket operations [www.progressivegrocer.com]) to identify and add companies not included in the sample.

2.1.4 Meat Exporters

We used the USMEF membership list to construct the sampling frame for meat exporters. We took a complete census of the 46 exporters.

Because there is not a separate SIC code for meat exporters, we used the 2005 membership list for the U.S. Meat Export Federation (USMEF) to construct the sampling frame for meat exporters. Exporters that also slaughter were excluded from the sampling frame because these establishments were included in the sampling frame for meat packers. The sampling unit for meat exporters was defined as the firm or company (single-location businesses or the headquarters for multilocation businesses) because firm-level data were needed for the analysis. Because the universe size for meat exporters is relatively small, we took a complete census of the 46 exporters.

2.2 SAMPLE SELECTION

Precision of survey results (i.e., reliability of data) is a direct function of sample and universe sizes and the particular design used for selecting the sample. The selected samples for the small strata needed to be large enough to ensure margins of error on estimated proportions to be no larger than ±5% with at least 95% confidence. Sample sizes were calculated to achieve this level of precision for the most variable estimates (i.e., proportions of about 50%). Thus, for each analytic domain of interest, the sample size (*n*) was calculated by

$$n = \frac{Np(1-p)}{(N-1)\frac{\varepsilon^2}{z^2} + p(1-p)} \,, \qquad (2.1)$$

where *N* is the universe, *p* is the estimated proportion, ε is the error bound, and *z* is the 95th percentile of the standard normal distribution.

To ensure that the sample size requirements were met, the required sample sizes were adjusted upward for the anticipated eligibility and response rates. The eligibility rate ranged from

55% to 90%, depending on the source of the sampling frame and the industry segment. A lower eligibility rate was assumed for the D&B database because our experience using this database suggests that some of the selected establishments will not be eligible for the survey (e.g., the establishments are out of business or do not process, distribute, or sell the specified type of livestock or meat). As described in Section 3.3, our data collection procedures included contacting sample establishments by telephone and screening them for eligibility.

Based on our experience with similar surveys, we assumed a response rate of 60% for livestock producers and feeders, wholesalers, retailers, food service operators, and exporters. A response rate of 65% was assumed for packers and processors, assuming that these segments would be more likely than the other industry segments to participate in the survey because GIPSA has direct authority over packers and processors.

For the small strata for industry segments for which a census was not taken, we also selected two reserve samples in case our assumed eligibility and response rates were lower than anticipated. The reserve samples were selected in the same way as the main sample. Reserve sample 2 was approximately 20% of the size of the starting sample, and reserve sample 3 was approximately 10% of the size of the starting sample. Ultimately, we needed to draw additional reserve samples for the beef producer, hog producer, and wholesaler segments during data collection, because the achieved response rates and eligibility rates were lower than anticipated. Table 2-3 shows the final sample design for the industry survey.

Table 2-3. Sample Design for the Industry Survey

Industry Segment	Universe Size	Small[a]				Small-Reserve Sample				Large[b]		Total Sample Released
		Required Sample	Eligibility Rate	Response Rate	Starting Sample	Reserve 2	Reserve 3	Reserve 4	Reserve 5	Starting Sample	Reserve Sample	
Livestock producers and feeders												
Fed cattle feedlot	14,166	111	85%	60%	217	43	22	14	15	25	5	326
Fed cattle ranching/ farming	35,442	271	85%	60%	532	106	53	35	36	25	12	763
Hog	7,384	374	85%	60%	733	146	74	250	100	102	—	1,305
Lamb	1,267	330	85%	60%	647	129	65	—	—	80	—	856
Packers[c]												
Beef	300	Census taken			240	Census taken				60	—	300
Pork	309	Census taken			249	Census taken				60	—	309
Lamb	120	Census taken			90	Census taken				30	—	120
Processors	4,050	351	90%	65%	600	120	60	—	—	50	—	650
Wholesalers	3,562	347	80%	60%	723	144	73	100	50	72	—	1,112
Exporters	46	Census taken										46
Retailers	28,559	379	80%	60%	790	158	79	—	—	91	—	1,039
Food service operators	44,246	380	55%	60%	1,154	212	106	—	—	122	—	1,488

Note: Shading indicates sample released during data collection.
[a] For fed cattle (feedlot and ranching/farming), small includes small and medium operations.
[b] It was not necessary to adjust for eligibility and nonresponse because we took a census of large establishments/companies.
[c] Universe size for packers is adjusted so that plants with a HACCP size of very small are only included in one species.

3 Design and Administration of the Industry Survey

This section describes the development of the survey instruments for the industry survey, our pretest procedures, and our data collection procedures for the industry survey.

3.1 SURVEY INSTRUMENT DESIGN

As shown in Table 3-1, we developed 10 separate self-administered questionnaires for the industry survey. We worked closely with the study teams to develop the questionnaires for each industry segment. Each questionnaire collected information on the following:

- characteristics and volumes of livestock and meat inputs and outputs
- participation in certification programs, branding programs, and alliances
- use of alternative purchasing methods and pricing methods for the purchase of inputs
- terms of purchase methods
- reasons for using the spot market or alternative purchase methods
- use of alternative sales methods and pricing methods for the sale of outputs
- terms of sales methods
- reasons for using the spot market or alternative sales methods
- characteristics of operation (e.g., number of employees, annual sales)

Table 3-1. Questionnaires for the Industry Survey

Industry Segment	Respondents: Livestock Producers and Feeders	Packers	Processors	Wholesalers and Exporters	Retailers	Food Service Operators
Fed cattle and beef	•	•				
Hogs and pork	•	•				
Lambs and lamb meat	•	•				
All species			•	•	•	•

3.2 PRETEST PROCEDURES

Our pretest procedures included a review of the survey instruments using RTI's Question Appraisal System (QAS) and interviews with individuals from the target population. The draft survey instruments were also reviewed by the peer reviewers and GIPSA staff.

3.2.1 Question Appraisal System

We thoroughly tested the 10 different versions of the questionnaire. Our pretest procedures included a review of the survey instruments using RTI's QAS and interviews with individuals from the target population. The draft survey instruments were also reviewed by the peer reviewers and GIPSA staff.

The QAS is a structured, standardized instrument review methodology that evaluates survey questions in relation to the tasks required of the respondents (to understand and respond to the questions) and evaluates the structure and effectiveness of the questionnaire form itself. In part, the QAS is a coding system (i.e., an item taxonomy) that describes the cognitive demands of the questionnaire and documents the question features that are likely to lead to response error. These potential errors include errors related to comprehension, task definition, information retrieval, judgment, and response generation. Two RTI survey methodologists used the QAS methodology to identify revision candidates with regard to item wording, response wording, and questionnaire formats. For example, the survey methodologists reviewed each question to identify any problems related to communicating the intent or meaning of the question to the respondent (e.g., the use of any undefined, unclear, or complex terms; the potential for multiple ways to interpret the question; and the use of complicated syntax). Based on the results of the QAS and comments provided by the peer reviewers and GIPSA staff, we revised the draft questionnaires and then conducted pretest interviews, as described below.

3.2.2 Pretest Interviews

We conducted telephone interviews with 31 individuals from the target population (Table 3-2) to pretest the survey instruments for the industry survey. Plants/companies selected for the pretest interviews completed the draft questionnaire for their type of establishment before the interview. In the pretest interviews, an interviewer went through the questionnaire item by item with the pretest respondent and used probing techniques (e.g., explain what you mean by your response) to evaluate respondent comprehension and interpretation of each question. Through the pretest interviews, we were able to identify unclear terminology, ambiguous phrasing, inappropriate (or missing) multiple choice responses, and words and terms that did not denote their intended meanings and that could be interpreted in different ways by different segments of the target population.

Based on the pretest interview findings, we revised the questionnaires to clarify questions that were confusing to respondents; to clarify the definitions provided for the different types of marketing arrangements, pricing methods, and other terms used in the survey; to add additional response items to multiple choice questions where appropriate; and to reformat certain questions to reduce respondent burden. The final questionnaires are included as Appendix A in Volume 2.

Table 3-2. Number of Pretest Interviews

	Fed Cattle/ Beef	Hogs/ Pork	Lambs/Lamb Meat	All Species	Total
Livestock producers and feeders	4	5	5	—	14
Packers	3	3	3	—	9
Processors	—	—	—	3	3
Wholesalers	—	—	—	1	1
Exporters	—	—	—	1	1
Retailers	—	—	—	1	1
Food service operators	—	—	—	2	2
Total	7	8	8	8	31

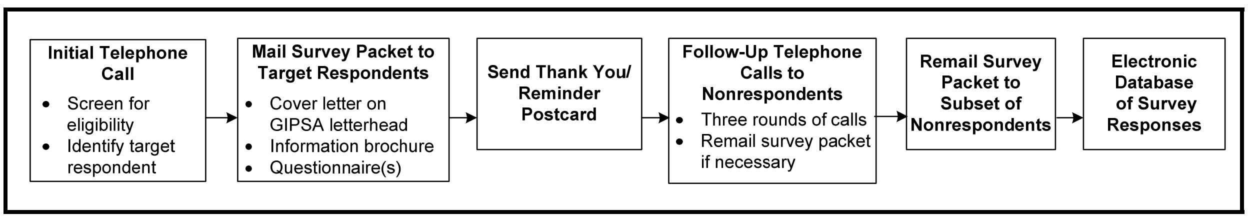
3.3 SURVEY ADMINISTRATION PROCEDURES

We used a multimodal survey approach. We contacted sampled business units by telephone to screen for eligibility and to identify the target respondent, mailed a self-administered questionnaire to target respondents, and made a series of telephone calls to nonrespondents to encourage participation.

We conducted the full-scale data collection for the industry survey from November 2005 to February 2006 (no calls were made between Christmas and New Year's Day). Figure 3-1 illustrates the steps in the data collection process. These procedures included

- contacting sampled business units by telephone to screen for eligibility and to identify the target respondent for the survey,
- mailing the survey packet (cover letter, information brochure, questionnaire(s), and metered [prepaid] envelope) to target respondents,
- making follow-up telephone calls to nonrespondents to encourage participation, and
- remailing the survey packet to a subset of the nonrespondents.

Figure 3-1. Data Collection Procedures for the Industry Survey



RTI's telephone interviewers contacted each sampled business unit by telephone using computer-assisted telephone interviewing (CATI). The purpose of this initial call was to ensure the sampled business unit met inclusion eligibility (Table 3-3) and to identify the appropriate contact person (i.e., target respondent) for the survey. Companies that had more than one packing and/or processing plant in the sample were contacted by RTI project staff. Sampled business units that refused to participate in the survey were contacted by a member of the project team, and a refusal conversion was attempted.

We sent a survey packet to each target respondent via Federal Express. The packet included a cover letter printed on GIPSA

Table 3-3. Inclusion Criteria for the Industry Survey

Industry Segment	Inclusion Criteria[a]
Livestock producers and feeders:	
Fed cattle	• Operation raises, backgrounds, or feeds beef calves or cattle, including fed Holsteins, intended for slaughter as fed cattle (includes cow-calf, stocker, and feeder operations)
Hog	• Operation raises, feeds, or finishes pigs or hogs intended for slaughter as market hogs (includes farrow-to-finish, feeder-to-finish, farrow-to-feeder, feeder-to-finish, and finishing operations) • Operation is <u>not</u> owned by a packer
Lamb	• Operation raises or feeds lambs intended for slaughter (includes lambing and feeder operations)
Packers:	
Beef	• Plant slaughters fed cattle • Plant does <u>not</u> perform only custom slaughter for fed cattle
Pork	• Plant slaughters market hogs • Plant does <u>not</u> perform only custom slaughter for market hogs
Lamb	• Plant slaughters lambs • Plant does <u>not</u> perform only custom slaughter for lambs
Processors	• Plant produces a product that uses beef, pork, or lamb as an input or ingredient (includes all methods of processing, fabricating, cutting, slicing, grinding, cooking, drying, smoking, curing, assembling, and repackaging) • Plant does <u>not</u> conduct any slaughter activities
Wholesalers	• Company operates a meat wholesaler • Company purchases fresh, frozen, or processed products containing at least 50% beef, pork, or lamb by weight
Exporters	• Company operates a meat exporter • Company purchases fresh, frozen, or processed products containing at least 50% beef, pork, or lamb by weight
Retailers	• Company operates a grocery or other retail store • Company purchases fresh, frozen, or processed products containing at least 50% beef, pork, or lamb by weight
Food service operators	• Company operates a food service operation • Company purchases fresh, frozen, or processed products containing at least 50% beef, pork, or lamb by weight

[a] Respondents were asked about their operations during the past year.

letterhead, the appropriate information brochure,[1] the appropriate questionnaire(s), and a metered (prepaid) envelope for returning the completed questionnaire to RTI. The cover letter was signed by the GIPSA deputy administrator for the Packers and Stockyards Program. The letter informed the establishment of its selection in the survey and explained the purpose of the survey, the importance of participation, the benefits of responding, and RTI's pledge of confidentiality. The information brochure introduced the study to the potential respondent, provided information on RTI's confidentiality procedures, and provided contact information for GIPSA and RTI. Appendixes B and C in Volume 2 provide copies of the cover letter and information brochure for packers and processors and downstream market participants, respectively.

Approximately 1 week after mailing the survey packet, we sent sampled business units a postcard. The postcard served as a thank you for those who had returned the completed questionnaire and as a reminder for those who had not. Appendixes B and C in Volume 2 provide a copy of the postcard for packers and processors and downstream market participants, respectively.

Several weeks after mailing the postcard, telephone interviewers began follow-up telephone calls to nonrespondents to remind them to complete and return the questionnaire. These calls were made at three different points during the data collection period. During the follow-up calls, interviewers offered to send a replacement questionnaire as necessary. Also, sampled business units that had not previously completed the initial telephone call were screened for eligibility.

Approximately 2 weeks before the end of the data collection period, we remailed the survey packet (via Federal Express) to nonrespondents in selected industry segments (large producers, small and large packers, small and large processors, and exporters). The cover letter provided a cut-off date for returning the completed questionnaire. We made the final set of follow-up telephone calls approximately 1 week after the remailing.

[1] We developed two versions of the information brochure targeted to each type of market participant: (1) producers/feeders, packers, and processors and (2) wholesalers, exporters, retailers, and food service operators.

During the data collection period, we operated a toll-free survey help line that respondents could call to request assistance when completing the questionnaire. The help line was staffed by members of the project team knowledgeable about the survey and the livestock and meat industries. We also provided an e-mail address that respondents could contact to request assistance when completing the survey.

At each stage of telephone calls (initial and three followups), up to eight call attempts were made for most cases. Sampled business units without a telephone number and those we were unable to contact by telephone were sent the survey packet; in these cases, the packet was addressed to “plant manager,” “operation manager,” or “meat purchasing department,” depending on the industry segment.

4 Response Rates for the Industry Survey

Because the eligibility and response rates were lower than anticipated, we did not achieve the target number of completed surveys, despite our follow-up efforts with nonrespondents. As a result, we are unable to provide results by size category for lamb packers, processors, and the downstream market participants. However, there are sufficient responses to make inferences to the population by size category for the remaining industry segments.

In this section, we describe the calculation of and provide the eligibility and response rates for the survey. Table 4-1 shows the final disposition of the sample and the eligibility and response rates, by industry segment and size. For these calculations, we assigned each sampled business unit or case to one of the following final disposition codes: respondent, nonrespondent, ineligible, duplicate, or unknown eligibility.

Respondents are cases that completed and returned the questionnaire.[1] Nonrespondents are cases that were eligible for the survey but did not complete the questionnaire. Duplicates are cases that were removed from the sample prior to data collection (e.g., for the downstream market participants, multiple locations for a single company).

The ineligibles category includes cases

- that did not meet the inclusion criteria for the survey (see Table 3-3),
- that were out of business,
- for which we were unable to obtain a working phone number and the mail survey questionnaire was undeliverable (assumed out of business), and
- that did not conduct the business activity for which the case was selected (e.g., included in the pork packer sample but the plant does not slaughter market hogs).

[1] For each questionnaire, we identified a set of key questions that had to be answered to be considered a completed survey; if these questions were not answered, the case was classified as a nonrespondent.

Table 4-1. Eligibility and Response Rates for the Industry Survey

	Beef Producers			Pork Producers			Lamb Producers		
	Small	**Large**	**Total**	**Small**	**Large**	**Total**	**Small**	**Large**	**Total**
Respondents	**270**	**23**	**293**	**206**	**23**	**229**	**267**	**35**	**302**
Nonrespondents	162	18	180	158	24	182	104	16	120
Ineligibles	226	10	236	359	35	394	198	17	215
Duplicates	0	0	0	0	1	1	0	0	0
Unknown eligibility	364	16	380	480	19	499	207	12	219
Total Sample	1,022	67	1,089	1,203	102	1,305	776	80	856
Eligibility rate (%)[a]	65.7	80.4	66.7	50.3	57.3	51.1	65.2	75.0	66.2
Unweighted response rate (%)[b]	33.9	40.4	34.4	24.4	34.8	25.2	46.2	55.6	47.1
Weighted response rate (%)[c]	40.2	42.7	40.2	34.0	39.7	34.1	52.8	58.3	53.1

	Beef Packers			Pork Packers			Lamb Packers			Processors		
	Small	**Large**	**Total**	**Small**	**Large**	**Total**	**Small**	**Large**	**Total**	**Small**	**Large**	**Total**
Respondents	**34**	**30**	**64**	**53**	**35**	**88**	**4**	**7**	**11**	**112**	**13**	**125**
Nonrespondents	100	13	113	83	12	95	35	9	44	159	6	165
Ineligibles	66	12	78	69	8	77	32	3	35	50	3	53
Duplicates	0	0	0	0	0	0	0	0	0	0	0	0
Unknown eligibility	40	5	45	44	5	49	19	11	30	279	28	307
Total sample	240	60	300	249	60	309	90	30	120	600	50	650
Eligibility rate (%)[a]	67.0	78.2	69.4	66.3	85.5	70.4	54.9	84.2	61.1	84.4	86.4	84.5
Unweighted response rate (%)[b]	19.5	62.5	28.8	29.4	67.3	37.9	6.9	25.9	12.9	20.4	27.7	20.9
Weighted response rate (%)[c]	21.1	64.0	30.7	32.1	68.3	40.5	8.1	27.7	15.0	22.1	30.1	22.2

(continued)

Table 4-1. Eligibility and Response Rates for the Industry Survey (continued)

	Wholesalers			Exporters	Retailers			Food Service Operators		
	Small	Large	Total		Small	Large	Total	Small	Large	Total
Respondents	**127**	**15**	**142**	**14**	**121**	**15**	**136**	**96**	**12**	**108**
Nonrespondents	279	26	305	21	259	38	297	277	32	309
Ineligibles	214	11	225	6	202	2	204	253	11	264
Duplicates	73	11	84	1	49	4	53	312	9	321
Unknown eligibility	347	9	356	4	317	32	349	428	58	486
Total sample	1,040	72	1,112	46	948	91	1,039	1,366	122	1,488
Eligibility rate (%)[a]	65.5	78.8	66.5	85.4	65.3	96.4	68.0	59.6	80.0	61.2
Unweighted response rate (%)[b]	16.9	30.0	17.7	35.9	17.4	17.7	17.4	12.0	11.8	12.0
Weighted response rate (%)[c]	20.1	31.2	20.3	36.4	20.6	17.9	20.6	15.3	13.3	15.3

[a] Eligibility rate = (Respondents + Nonrespondents) / (Respondents + Nonrespondents + Ineligibles)
[b] Unweighted response rate = Respondents / (Respondents + Nonrespondents + Unknown Eligibility)
[c] The weighted response rate was calculated using the survey weights adjusted for unknown eligibility.

For some cases, the eligibility status could not be determined because

- there was no telephone number available from directory assistance or the telephone number was not in service;
- a telephone number was available, but we were unable to reach an individual to verify eligibility in the initial or follow-up telephone calls; or
- the case refused to participate before being screened for eligibility.

The eligibility rate—the proportion of cases deemed eligible for the survey—was calculated as follows for each industry segment and size strata:

$$\textit{Eligibility Rate} = \frac{\textit{Respondents} + \textit{Nonrespondents}}{\textit{Respondents} + \textit{Nonrespondents} + \textit{Ineligibles}}. \quad (4.1)$$

The observed eligibility rates were much lower than anticipated, particularly for small establishments/companies and industry segments for which we used the D&B database as the sampling frame. Because the eligibility rates were much lower than anticipated, the reserve sample for some industry segments had to be released during data collection.

For producers, an eligibility rate of 85% was assumed; the actual eligibility rates ranged from 50% to 80%, depending on species and size. Most of the producers that were classified as ineligible did not produce the selected livestock species; this could be partly due to misclassification error in the sampling frame. The target eligibility rates for packers and processors were 95% and 90%, respectively. The actual eligibility rates ranged from 55% to 86% for packers, depending on species and size and 85% for processors. For packers, most of the plants that were classified as ineligible only conducted custom slaughter; thus, they were not eligible for the survey. For processors, most of the plants that were classified as ineligible did not conduct meat processing activities; this could be partly due to compilation error. For the downstream market participants (excluding exporters, for which we took a census), an eligibility rate of 80% was assumed. The actual eligibility rates ranged from 60% to 96%, depending on segment and size. For the downstream market participants, most of the companies that were classified as ineligible did not conduct the type of business activity for which the company was selected or did not buy meat (e.g., only purchase poultry or seafood).

Table 4-1 includes unweighted and weighted response rates for each industry segment and size strata. The unweighted response rates were calculated without making adjustments for cases in the sample with unknown eligibility, while the weighted response rates were calculated using the survey weights adjusted for unknown eligibility.

The unweighted response rate was calculated as follows:

$$\textit{Unweighted Response Rate} = \frac{\textit{Respondents}}{\textit{Respondents} + \textit{Nonrespondents} + \textit{Unknown Eligibility}}. \quad (4.2)$$

The weighted response rate provides an estimate of the percentage of cases on the sampling frame (i.e., the population) that are represented by the responding cases. For cases with unknown eligibility, an adjustment factor was calculated equal to the eligibility rate among cases with known eligibility and applied to the initial sampling weight. For cases with known eligibility, the adjustment factor was equal to one.

The actual response rates were much lower than anticipated. We had assumed response rates of 60% for producers, 65% for packers and processors, and 60% for the downstream market participants. For producers, the weighted response rates ranged from 34% to 58%; response was higher among lamb producers than among beef and pork producers. For packers and processors, the weighted response rates ranged from 8% to 68%; response was higher among beef and pork packers than among lamb packers. For the downstream market participants, the weighted response rates ranged from 13% to 36%. For producers, packers, and processors, response was higher among large establishments than among small establishments.

There are a number of possible reasons that the achieved response rates were lower than expected, including the following:

- The survey was administered over the holiday period. This made it difficult to reach respondents and also reduced their time availability for completing the survey.
- The survey instruments were fairly complex because of the nature of the research questions for the study. This complexity may have discouraged many potential respondents from completing the survey.
- Many potential respondents, particularly those from the downstream segments, may have had little incentive to

complete the survey because the issues of concern for the study may not have been of concern to them.

Because the eligibility and response rates were lower than anticipated, it was not possible to achieve the target number of completed surveys. This was in spite of releasing the reserve sample, making additional telephone followups, and remailing the survey to some industry segments. As a result, we are unable to provide results by size category for lamb packers, processors, and the downstream market participants. However, there are sufficient responses to make inferences to the population by size category for the remaining industry segments.

5 Data Set Preparation for the Industry Survey

This section describes the weighting, data editing, data preparation and coding, and data tabulation procedures for the industry survey.

5.1 WEIGHTING PROCEDURES

We prepared separate data sets for each industry segment. Our procedures for preparing the analysis data sets included developing the survey weights, data editing, data preparation, and data coding.

We developed all statistical estimates for the industry survey by applying to the respondent record data appropriate survey weights that reflect the number of eligible business units.[1] We computed a separate set of survey weights for each industry segment according to the following three steps:

1. We computed initial sampling weights by size stratum.
2. We calculated adjustment factors by size stratum to account for unknown eligibility.
3. We calculated poststratification adjustment factors by weighting class to compensate for nonresponse.

We describe each step of our weighting procedures below.

5.1.1 Initial Sampling Weights

We assigned each sampled business unit an initial sampling weight, W_0. The initial sampling weight is equal to the inverse of the selection probability, where the selection probability is equal to the sample size (*n*) divided by the population (*N*).

[1] We considered weighting the survey data by volume of animals or meat, but no reliable external data source was available for each industry segment; thus, we weighted the survey data by the number of eligible business units.

Thus, the initial sampling weight for each stratum was calculated as follows:

$$W_0 = \frac{1}{Selection\ \ Probability} = \frac{1}{\frac{n}{N}} = \frac{N}{n} \qquad (5.1)$$

For industry segments for which we did not release the reserve sample, the selected sample size was first reduced to the used sample size. For strata for which we took a census, the initial sampling weights were set to one. For each industry segment and stratum, the sum of the initial sampling weights across all sampled business units was equal to the population size.

5.1.2 Adjustment for Unknown Eligibility

We calculated adjustment factors within each industry segment and stratum to compensate for sampled business units for which the eligibility status was not determined. For sampled business units with unknown eligibility, this adjustment factor (F_1) was calculated as

$$F_1 = \frac{\sum_{R \cup \bar{R}} W_0}{\sum_{R \cup \bar{R} \cup I} W_0} \ , \qquad (5.2)$$

where R, $\bar{R}$, and I represent the sets of respondents, nonrespondents, and ineligibles, respectively, for the given stratum.[2] For sampled business units with known eligibility, this adjustment factor was equal to one (i.e., $F_1 = 1$).

Consequently, the adjusted weight for each sampled unit in a stratum was calculated by

$$W_1 = W_0 \times F_1 \ . \qquad (5.3)$$

5.1.3 Nonresponse Adjustment

Nonresponse adjustments ensure that, within each weighting class, respondent weights sum to the population counts of eligible sampled units. These adjustments, implemented with the computation and application of adjustment factors in each weighting class, can help reduce nonresponse bias to the extent that weighting classes are homogeneous.

[2] Thus, the adjustment factor for unknown eligibility (F_1) is equal to the sum of the weights for respondents and nonrespondents in the stratum divided by the sum of the weights for respondents, nonrespondents, and ineligibles in the stratum.

For each industry segment, size was used to define weighting classes. The resulting adjustment factors (F_2) within each weighting class were calculated as:

$$F_2 = \frac{\sum_{R \cup \bar{R} \cup U} W_1}{\sum_{R} W_1} \, , \tag{5.4}$$

where U represents the set of cases with unknown eligibility status.[3]

Finally, the adjusted weight for each responding sampled unit in a weighting class was equal to

$$W_2 = W_1 \times F_2. \tag{5.5}$$

We calculated all survey results using the final adjusted weights (W_2). For each industry segment and stratum, the sum of the final adjusted weights across all respondents is equal to the population of eligible sampled units.

5.2 DATA EDITING

RTI's Fulfillment Department Staff edited the questionnaires to resolve any data errors prior to data entry. One of the most common errors made by respondents was not selecting a response option for each question (i.e., item nonresponse). Item nonresponse was initially recorded as a missing value in the survey data set. As described in Section 5.3, we used logical imputation to impute some missing values.

For the meat processor and downstream market participant questionnaires, several questions asked respondents to provide information on percentage of purchases by type of meat in a grid (e.g., Question 1.2 for the exporter questionnaire). Some respondents made errors when completing these questions (e.g., the responses for the row or the entire table summed to 100% instead of the column summing to 100%). In some cases, it was necessary to contact the respondent by telephone to resolve and correct these errors.

[3] Thus, the nonresponse adjustment (F_2) is equal to the sum of the weights for respondents, nonrespondents, and cases with unknown eligibility in the class divided by the sum of the weights for respondents in the class.

The edited questionnaires were keyed into a database using a data entry system developed by RTI. All data were double-keyed (i.e., 100% verification) for quality control purposes.

5.3 DATA PREPARATION AND CODING

Before tabulating the survey responses, we systematically examined all data to isolate and address data inconsistencies, reporting errors, or otherwise erroneous data. Specific data preparation procedures are described below.

Some questions required respondents to enter numeric responses that sum to 100%; however, some respondents had entered values that did not sum to 100%. Respondents' answers were excluded from the analysis data set if the sum of their responses was less than 80% or greater than 120%. If the sum of the responses was between 80% and 120%, then the corresponding responses were normalized to 100% using the initial response distribution and included in the analysis data set.

Some questions had asked the respondent to enter a numeric value (e.g., number of head sold or purchased). For these questions, we reviewed the responses to isolate and address any outliers. We contacted the respondent by telephone to clarify and, if necessary, adjust their erroneous responses.

For some questions, we used logical imputation to assign a value to a missing response item based on responses to other questions in the questionnaire. For example, if a respondent checked "internal transfer" as a purchase method but did not provide a response for type of pricing method for purchases, the missing response was imputed to the type of pricing method for internal transfers (i.e., "internal transfer pricing").

Some questions required respondents to enter a text response if "other" was selected. For such questions, we manually coded the open-ended text responses and created new response options, as appropriate.

To help assess the validity of the survey data, for each beef packer that provided both survey data and transactions data, we compared their survey responses with their aggregated transactions data (i.e., the analysis was conducted at the plant level). This comparison was conducted for the following variables: purchase method, type of pricing method for purchases, formula base (if formula pricing was used for purchases), valuation method for fed cattle purchases, sales method, type of pricing method for sales, and formula base (if formula pricing was used for sales). For the purchase data, we found that, with a few exceptions, the survey data and transactions data were very consistent, and some comparisons were exactly the same. For the sales data, we found that for most respondents, the survey data and transactions data were generally consistent.

5.4 DATA TABULATION

Sections 6 through 9 of this report provide tables with weighted tabulations for each survey question. Additionally, results are provided by size (small versus large) for selected industry segments and questions.

All analyses were conducted using SAS®, a statistical analysis software tool that takes the sample design into consideration when computing the variances (SAS, version 9.1). In addition to the point estimates such as means or proportions, interval estimates were also provided (i.e., the 95% lower and upper confidence intervals). An indication of the precision of survey estimates is the widths of the 95% confidence intervals. For example, if it is reported that the 95% confidence interval for the percentage of beef packing plants that participate in a particular certification program is 30% to 40%, this means that the probability that the true population value lies between 30% and 40% is 0.95. That is, there remains a probability of 0.05 that the true population value lies outside of the given interval. If the estimated lower value of the confidence interval was negative, then we reported it as "<0." If the estimated upper value of the confidence interval for a mean percentage was greater than 100, then we reported it as ">100."

We computed weighted proportions for questions in which respondents could select one or more responses from a list of responses. Respondents who did not answer the question were excluded from the calculation of proportions. The results tables provide the number of respondents (n), the estimated proportion weighted by the number of eligible business units (%), and the corresponding 95% confidence interval (lower and upper) for each response item. For questions for which respondents could select only one response, the sum of the responses equals 100%. In some cases, the sum does not equal 100% because of rounding, as noted by a dagger (†). For questions for which respondents could select more than one response, the total may sum to more than 100%. These questions are noted with an asterisk (*).

We computed weighted means for questions that required a numeric response from respondents. Respondents who did not answer the question were excluded from the calculation of means. The results tables provide the number of respondents used in the mean calculation (n), the estimated mean weighted by the number of eligible business units (mean), and the corresponding 95% confidence interval (lower and upper).

The constructed 95% confidence intervals can be used to make comparisons between survey estimates (e.g., comparisons between small and large operations). That is, overlapping confidence intervals suggest that the difference between the corresponding point estimates is not statistically significant.

To preserve confidentiality of responses and to avoid the possibility of revealing the identity of businesses that completed the survey, we did not report the results if the total number of respondents for a question was fewer than three or if fewer than three respondents provided a particular answer for a question (i.e., response item). Suppressions of results for a response item are noted in the results tables by “D.” For questions answered by fewer than three respondents, all of the results are suppressed, and, in the case of the cross tabulations, results for both small and large entities are suppressed.

6 Survey Results: Livestock Producers and Feeders

This section presents the weighted tabulations for livestock producers and feeders, by species.[1] We provide tables with weighted tabulations for all survey questions, tables with weighted tabulations for selected questions by size, and a brief summary of the key findings from the survey.

For weighted proportions, the tables provide the number of respondents (n), the estimated proportion weighted by the number of eligible operations (%), and the corresponding 95% confidence interval (lower and upper) for each response item. For questions for which respondents could select only one response, the sum of the responses equals 100%. For questions for which respondents could select more than one response, the total may sum to more than 100%. These questions are noted with an asterisk (*).

For weighted means, the tables provide the number of respondents used in the mean calculation (n), the estimated mean weighted by the number of eligible operations (mean), and the corresponding 95% confidence interval (lower and upper).

In reporting the survey findings, we make comparisons between small and large operations and changes in marketing practices between 3 years ago, the past year, and the next 3 years. These comparisons are based on the magnitude of the

[1] In this section, we use “producers” to collectively refer to producers, backgrounders, stockers, feeders, and finishers.

point estimates and not on statistical testing. The confidence intervals provided in the tables can be used to make comparisons between survey estimates. That is, overlapping confidence intervals suggest that the difference between the corresponding point estimates is not statistically significant.

6.1 BEEF PRODUCERS

Table 6-1 provides weighted tabulations for all survey questions for fed cattle producers and feeders (n = 293). Tables 6-2 through 6-7 provide weighted tabulations for selected questions by size (n = 270 for small beef producers and n = 23 for large beef producers).

6.1.1 Characteristics of Beef Producer Operations

Most operations identified themselves as cow-calf producers (88%), with a nearly equal number each from stocker (17%) and feedlot operations (16%). Nationally, beef cow-calf operations represent 78% of all farms with cattle (including dairy farms), and feedlots represent 9% of the U.S. farms with cattle. For operations that reported having cows and heiferettes in inventory on January 1, 2005, 38% had less than 50 head, 24% had 50 to 99 head, 33% had 100 to 499 head, and the remaining 5% had 500 or more head. (See Table 6-1, Questions 1.2 and 8.3e.)

The majority of beef producers can be characterized as independent businesses that do not participate in alliances, marketing agreements, or certification programs.

The majority of beef producers can be characterized as independent businesses that do not participate in alliances, marketing agreements, or certification programs. For example, 80% of producers do not participate in any type of certification program. Of producers that participated in certification programs, Beef Quality Assurance (BQA), an industry-led voluntary food safety and quality program, was the most frequently cited response, followed by branded beef program certification such as Certified Angus Beef (CAB) and other breed affiliation programs. (See Table 6-1, Question 1.3.)

Less than 9% of operations identified themselves as participating in an alliance. Most were only participating in one alliance. These alliances include other producers (seed stock, cow-calf, or feedlots), feed companies, and packers. (See Table 6-1, Question 1.4.)

There are numerous auction markets that sell cattle near producers. Producers identified an average of eight auctions currently operating within a 200-mile radius of their location. The bulk of the auctions closest to the operations have sales at least weekly. (See Table 6-1, Questions 8.4 and 8.5.)

For most operations, the owner completed the questionnaire. Of these, the majority of respondents were over 45 years of age. About 26% have at least a 4-year college degree, and 35% reported some level of post-secondary education. More than 70% of operations reported annual gross cattle sales of less than $100,000, and 92% had gross cattle sales less than $500,000. Approximately 62% of operations reported total gross farm sales of less than $100,000, and 88% reported total farm gross sales of less than $500,000. For operations in which the owner completed the questionnaire, 45% of household income came from off-farm sources. (See Table 6-1, Questions 8.6 through 8.11.)

6.1.2 Methods for Purchasing or Receiving Calves and Cattle by Beef Producers

Relatively few operations reported purchasing calves or feeder cattle during the past year. Operations that purchased calves (< 500 pounds liveweight) bought an average of 1,440 head, and operations that purchased feeder cattle (≥ 500 pounds liveweight) purchased an average of 4,066 head. More than half (65% and 67%, respectively) of these operations purchased fewer than 500 head. The remaining operations purchased between 500 and more than 20,000 head. (See Table 6-1, Question 2.1.)

More than 80% of the calves and feeder cattle received were owned solely by the operation; 13% were not purchased, but delivered to the operation for custom feeding.[2] There were relatively few cattle purchased under shared ownership or joint ventures. For 78% of operations, all of their calves and feeder cattle were owned solely by the operation during the past year. Operations' ownership arrangements were very similar 3 years ago and are not expected to change within the next 3 years. (See Table 6-1, Question 2.2.)

[2] These values were computed as the mean percentage of head weighted by the number of eligible operations. Other reported means were computed similarly (i.e., weighted by the number of eligible operations).

For producers that received calves or feeder cattle, the majority used only spot market transactions for purchases of calves and cattle.

For producers that received calves or feeder cattle, the majority used only spot market transactions for purchases of calves and cattle. For 76% of operations, all of the calves and feeder cattle received were from spot market transactions. During the past year, 51% of purchases were through auctions, 16% through dealers/brokers, and 14% through direct trade. Less than 5% of purchases were through AMAs (i.e., marketing agreement, forward contract, or internal transfer), and 9% were delivered for custom feeding. There appears to be a slight trend toward decreased use of auction barns and increased use of other types of spot market transactions, such as direct trades. (See Table 6-1, Question 2.3.)

For those operations that purchased calves and cattle, several pricing methods were employed. The most frequently cited pricing methods were public auction (80%) and individually negotiated pricing (43%). Less than 2% used formula pricing. For operations using formula pricing, the Chicago Mercantile Exchange (CME), subscription service prices, and other market prices were most often used as the base. (See Table 6-1, Questions 2.4 and 2.5.)

Buyers paid transportation costs in two-thirds of the transactions, which is not surprising given the amount of calves and feeder cattle purchased through auctions. Likewise, there were few cattle purchased using a written contract (8% of transactions). Most agreements were for less than 6 months. Nearly 85% of cattle purchased were scheduled for delivery within 2 weeks, and another 10% were scheduled for delivery 3 to 4 weeks in advance. (See Table 6-1, Questions 3.1 through 3.4.)

Producers that used only spot market transactions were asked to identify the three most important reasons for using the spot market. The most frequently cited reasons emphasized the business philosophy of the manager. More than 61% identified "Allows for independence, complete control, and flexibility of own business" as a reason for using only the spot market. About one-third chose "Can purchase calves and cattle at lower prices," "Allows for adjusting operations quickly in response to changes in market conditions," "Enhances ability to benefit from favorable market conditions," "Does not require managing complex and costly contracts," and "Secures higher quality calves and cattle." (See Table 6-1, Question 4.1.)

Operations using AMAs were asked to identify the three most important reasons for choosing an alternative to the cash market. Few operations used AMAs, but most of the responses focused on predictability and management. Ninety-five percent chose "Secures higher quality calves and cattle"; about one-half chose "Improves week-to-week supply management," "Can purchase calves and cattle at lower prices," "Improves efficiency of operations due to animal uniformity," and "Reduces price variability for calves and cattle." With the exception of the lower purchase price comment, buyers using AMAs identified quality, reduced variability, uniformity, and management as motivations to using AMAs. Interestingly, both the cash-only and AMA buyers identified "Can purchase calves and cattle at lower prices" and "Secures higher quality calves and cattle" as reasons for choosing the buying method used. These two factors are clearly important objectives, but operations choose different methods to achieve them. (See Table 6-1, Question 4.2.)

6.1.3 Methods for Selling or Transferring Calves or Cattle by Beef Producers

During the past year, operations that sold calves (< 500 pounds liveweight) sold an average of 187 head. Operations that sold feeder cattle (≥ 500 pounds liveweight) sold an average of 368 head, and operations that sold fed cattle sold an average of 1,974 head. One-half or more sold fewer than 50 head. More than 65% of the calves and cattle sold were sent through auction markets, and about 25% used some other type of cash transaction (i.e., video/electronic auction, dealer or broker, direct trade). Less than 4% used AMAs (i.e., forward contract, marketing agreement, or packer owned). During the past year, 85% of operations sold all of their calves or cattle through spot market transactions. Compared with 3 years ago, there has been a slight decrease in use of auction barns, with a slight increase in use of other types of spot market transactions. It is anticipated that 3 years from now there will be little change in the use of different types of sales methods. (See Table 6-1, Questions 5.1 and 5.2.)

Most beef producers priced their calves or cattle through public auctions, followed by individual negotiations.

Most beef producers priced their calves or cattle through public auctions (84% of operations), followed by individual negotiations (32%).[3] For cattle priced on a formula using a grid,

[3] Respondents could select multiple responses.

approximately one-half used a base price tied to individual or multiple plant average. USDA, CME, and subscription services also were used as a base for pricing formulas. For operations that sell fed cattle, the most frequently cited valuation method was liveweight (80% of operations), followed by carcass weight (25%) and carcass weight with a grid (15%). Producers expect little change in pricing and valuation methods in the next 3 years. (See Table 6-1, Questions 5.3 through 5.5.)

Producers paid transportation costs in about one-half of transactions. Likewise, producers that purchase calves also reported paying transportation costs. About 13% of calves and cattle were sold under a written agreement. Most agreements were for less than 6 months. Delivery was also scheduled short term: 64% of deliveries were within 7 days and 15% were delivered within 8 to 14 days. (See Table 6-1, Questions 6.1 through 6.4.)

As with purchasing calves and cattle, the most frequently cited reason for using only cash markets to sell cattle was that it "Allows for independence, complete control, and flexibility of own business" (54%). "Can sell calves and cattle at higher prices" was selected by 41% of operations. Interestingly, "Can purchase fed cattle at lower prices" was frequently cited by beef packers as a reason for only purchasing cattle on the spot market. The ability to both buy low and sell high in the spot market is consistent with producers' belief that the cash market "Enhances ability to benefit from favorable market conditions" (selected by 38% of operations). However, believing that spot markets provide both lower buying prices and higher selling prices appears inconsistent because spot markets are a zero-sum game before transactions costs are paid. (See Table 6-1, Question 7.1.)

Operations that used AMAs to sell calves and cattle placed more emphasis on market access, as well as on higher prices.

Operations that used AMAs to sell calves and cattle placed more emphasis on market access, as well as on higher prices. The most frequently cited reasons for using AMAs included the following: (1) "Allows for sale of higher quality calves and cattle" (52%), (2) "Can sell calves and cattle at higher prices" (39%), (3) "Reduces risk exposure" (35%), and (4) "Reduces price variability for calves and cattle" (34%). Note that producers using only the cash market and those using AMAs both identified selling calves at higher prices as a reason for using each method. (See Table 6-1, Question 7.2.)

6.1.4 Beef Producers' Marketing Practices, by Size of Operation

The majority of small beef producers are cow-calf operations (88%); few are backgrounders or feedlots. There is a variety of operation types among large beef producers, including cow-calf (61%), backgrounding or stocking (35%), and feedlot (52%). Large producers were more likely to participate in certification programs and alliances compared with small producers. Fifty percent of large producers participated in BQA, 30% participated in CAB, and 44% participated in one or more alliances. More than 80% of small producers did not participate in any certification programs or alliances.[4]

Purchasing and selling practices for calves and cattle differed by size of operation. Small producers purchased or received an average of 1,198 calves and 2,512 feeder cattle. Large producers purchased or received an average of 37,466 calves and 248,284 feeder cattle. Most small producers solely owned their cattle, while large producers had a variety of ownership arrangements, including partner agreements, shared ownership, joint ventures, and custom feeding. (See Table 6-2, Questions S2.1 and S2.2.)

Small producers were more likely than large producers to rely on spot market transactions to purchase calves and cattle.

Small producers were more likely than large producers to rely on spot market transactions to purchase calves and cattle (86% and 71%, respectively). Relative to small producers, large producers used more types of spot markets. Small producers sold 51% of their cattle through auctions, while large producers sold 66% of their cattle through auctions, dealers, and direct trade. With the emphasis on spot market transactions, there was relatively little use of AMAs for sale of calves and cattle. However, forward contracting and custom feeding were more common in large operations. Small producers primarily used public auction pricing for cattle sold (80%). Individual negotiation (100%) and public auction pricing (88%) were the most frequently cited pricing methods among large producers. (See Table 6-2, Questions S2.3 and S2.4.)

Large producers paid to transport more of their calves and cattle compared with small producers (79% versus 66% of transactions). Large producers used written contracts more often than small producers (26% versus 8% of transactions). For cattle purchased under contract, most used an agreement

[4] We do not present results by size for these questions in the tables.

of less than 6 months (14% small and 36% large). Large producers scheduled 66% of purchased cattle to be delivered in less than 2 weeks, while small producers scheduled 85% to be delivered in less than 2 weeks. Large producers scheduled 13% of purchased cattle to be delivered more than a month in advance compared with 5% of small producers. (See Table 6-3.)

The three most cited reasons by small producers for using only spot market transactions to purchase calves and cattle were that (1) the spot market "Allows for independence, complete control, and flexibility of own business," (2) producers "Can purchase calves and cattle at lower prices," and (3) the spot market "Allows for adjusting operations quickly in response to changes in market conditions." There were few large producers that used only spot markets. Similarly, we cannot evaluate producers' reasons for using AMAs by size of operation because of the small number of respondents. (See Table 6-4.)

Large producers sold more cattle by direct trade and AMAs than did small producers. Keep in mind that small producers were likely selling a higher percentage of feeder cattle than slaughter cattle, while large producers were selling a higher percentage of cattle for slaughter. Small producers sold nearly two-thirds of their cattle through auction markets and 16% by direct trade. Eight-five percent of small producers sold their cattle exclusively in the spot market. Large operations sold cattle using AMAs (44%) and direct trade (30%). About one-fourth of large producers used only spot market transactions to sell their cattle. (See Table 6-5, Question S5.2.)

Small producers were more likely than large producers to use public auctions to price calves and cattle. Individual negotiation and formula pricing were the most frequently cited pricing methods among large producers.

Small producers (84%) were more likely than large producers (35%) to use public auctions to price calves and cattle. Individual negotiation (74%) and formula pricing (57%) were the most frequently cited pricing methods among large producers. Given the small number of responses, relatively little difference was observed between small and large producers for cattle priced on a grid. An individual or multiple-plant average was the most cited base price. Few large producers reported selling cattle and calves on a formula without a grid. Small producers that did so most often used a plant or multiple-plant average price, retail price, or CME price as the base for their formula. (See Table 6-5, Questions 5.3 and 5.4.)

For producers that sell fed cattle, 80% of small producers sold fed cattle by liveweight, 25% by carcass weight, and 15% by carcass weight with a grid. Similarly, 73% of large producers sold by liveweight, but 60% also sold cattle based on carcass weight with a grid and 33% sold cattle by carcass weight. (See Table 6-5, Question S5.5.)

Small producers paid to transport more of their calves and cattle compared with large producers (53% versus 38%). Small producers were less likely than large producers to have a written contract (12% versus 57%). For large producers, most contracts were for less than 6 months or for more than 10 years or evergreen (an agreement that continues indefinitely until either party decides to terminate). As with purchases, large producers scheduled sales farther in advance than did small producers; 64% of small producers scheduled delivery less than 7 days in advance. This is because small producers were also more frequent users of spot markets, and particularly of auction markets. About one-third of large producers scheduled delivery within 7 days, 23% within 8 to 14 days, and 22% 1 to 2 months in advance. (See Table 6-6.)

Because of the small number of respondents, we cannot compare by size of operation producers' reasons for only using the cash market for selling calves and cattle. There were relatively few operations using AMAs to sell cattle, but the three most frequently cited reasons given by small producers were as follows: (1) "Allows for sale of higher quality calves and cattle," (2) "Can sell calves and cattle at higher prices," and (3) "Reduces price variability for calves and cattle." The three most frequently cited reasons provided by large producers were (1) "Can sell calves and cattle at higher prices," (2) "Reduces risk exposure," and (3) "Facilitates or increases market access." Both large and small producers identified "higher prices" and "less risk" as additional reasons to use AMAs. (See Table 6-7, Questions S7.1 and S7.2.)

6.1.5 Beef Producer Survey Summary

Respondents to the cattle producer survey reflected relatively well the U.S. cattle production sector, with a large number of cow-calf producers and fewer backgrounder and feedlot operations. As such, the results are heavily weighted on feeder cattle marketing practices compared with fed cattle. Most producers were independent businesses that did not belong to an alliance or certification program and that valued independence in their marketing choices. Eighty-five percent of producers sold exclusively on the spot market, with the largest

> Operations often cited the same motivation for using the cash market or AMAs for buying or selling calves and cattle. Either way, respondents identified getting the best price (higher or lower) as a major reason for choosing the marketing method used.

share of cattle sold through auctions. Relatively few producers reported using AMAs, having written contracts, or using advanced scheduling of cattle deliveries. Operations often cited the same motivation for using the cash market or AMAs for buying or selling calves and cattle. Either way, getting the best price was a major reason for choosing the marketing method used.

Large producers marketed relatively more fed cattle than feeder cattle, while small producers sold relatively more feeder cattle than fed cattle. As a result, the responses reflect marketing practices for feeder cattle (mostly auction trade) and fed cattle (direct trade to packers). Large producers were more frequent users of AMAs than were small producers. Large producers tended to schedule sales and purchases farther in advance and used auction markets less. Both large and small producers generally believed that their marketing method provides them higher selling prices. Beyond price, motivation for small producers to use auctions and other spot market transactions was based on management independence. At the same time, large producers stated that they used AMAs to reduce risk and market higher quality cattle.

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293)

	n	%	Lower	Upper
1.2* Which of the following describes your operation during the past year?				
1. Cow-calf	248	88.2	84.4	92.1
2. Backgrounder or stocker	56	17.2	12.6	21.8
3. Feedlot	62	16.3	11.9	20.7
4. Other	11	3.8	1.5	6.2
1.3* What types of certification programs did your operation participate in during the past year?				
1. None	202	80.3	75.3	85.3
2. Kosher certification	D	0.4	0.0	1.2
3. Halal certification	0	0.0	NA	NA
4. Organic certification	4	0.6	0.0	1.5
5. Animal welfare certification	D	0.5	0.0	1.4
6. Beef Quality Assurance (BQA) certification	38	11.1	7.1	15.1
7. Certified Angus Beef	21	4.4	2.1	6.7
8. Other third-party certification of breed or livestock quality (not including Certified Angus Beef)	9	2.0	0.3	3.6
9. Own-company certification of breed or livestock quality	4	1.5	0.0	2.9
10. Buyer certification of breed or livestock quality	7	2.4	0.4	4.3
11. Other	8	1.2	0.0	2.5
1.4a What types of alliances did your operation participate in during the past year for the receipt and/or sale of calves and cattle?				
– Operations participating in an alliance	33	8.6	5.1	12.0
– Respondents with one alliance	26	83.1	66.7	99.6
– Respondents with two alliances	7	16.9	0.4	33.3

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

A description of the notation used in the table headers is provided below.
n = number of respondents
% = estimated proportion weighted by the number of eligible operations
Mean = estimated mean weighted by the number of eligible operations
Lower = lower bound of the 95% confidence interval for the weighted proportion or mean
Upper = upper bound of the 95% confidence interval for the weighted proportion or mean

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

		n	%	Lower	Upper
1.4b	For producers that participated in alliances, what types of alliances did your operation participate in during the past year for the receipt and/or sale of calves and cattle?				
	1. Seed stock supplier only	3	3.8	0.0	9.3
	2. Feed company only	4	13.5	0.0	26.9
	3. Cow-calf operation only	5	21.0	3.9	38.1
	4. Feedlot only	5	17.8	2.4	33.2
	5. Packer/processor only	3	4.5	0.0	13.3
	6. Other only	5	19.3	2.9	35.7
	7. Feed company and seed stock supplier	D	4.4	0.0	13.1
	8. Other and cow-calf operation	D	0.1	0.0	0.2
	9. Packer/processor and feedlot	3	0.2	0.0	0.5
	10. Cow-calf operation, feedlot, and retailer	D	0.1	0.0	0.2
	11. Cow-calf operation, feedlot, and packer/processor	5	10.8	0.0	23.3
	12. Cow-calf operation, feedlot, packer/processor, and retailer	D	0.1	0.0	0.3
	13. Seed stock supplier, cow-calf operation, feedlot, and packer/processor	D	4.4	0.0	13.2
	Total		100.0		

		n	Mean	Lower	Upper
2.1a	How many calves (less than 500 pounds liveweight) did your operation receive or purchase during the past year?	51	1,439.8	499.4	2,380.2
		n	**%**	**Lower**	**Upper**
	1–99	13	39.2	22.3	56.1
	100–499	10	26.2	11.3	41.1
	500–1,999	13	22.1	8.1	36.1
	2,000–19,999	10	10.8	1.7	20.0
	20,000 or more	5	1.7	0.0	4.6
	Total		100.0		

		n	Mean	Lower	Upper
2.1b	How many feeder cattle (500 pounds liveweight or more) did your operation receive or purchase during the past year?	58	4,065.8	2,061.2	6,070.4
		n	**%**	**Lower**	**Upper**
	1–99	15	38.2	22.7	53.8
	100–499	13	29.2	14.5	43.8
	500–1,999	7	14.0	3.5	24.5
	2,000–19,999	11	15.6	5.1	26.0
	20,000 or more	12	3.0	0.0	6.7
	Total		100.0		

D = Results suppressed.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

	3 Years Ago (n = 81)				During Past Year (n = 86)				Expected in 3 Years (n = 81)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
2.2 For all calves and feeder cattle received or purchased by your operation, what were the ownership arrangements (% of head)?												
a. Sole ownership by your operation		81.2	72.4	90.0		81.0	72.0	90.0		81.5	72.3	90.8
b. Partner arrangement		1.3	0.0	2.5		1.3	<0	2.8		1.4	<0	3.2
c. Shared ownership		2.0	<0	4.6		1.0	<0	2.7		1.0	<0	3.0
d. Joint venture		0.0	0.0	0.1		0.1	<0	0.4		0.0	0.0	0.1
e. Delivered for custom feeding/backgrounding		11.4	4.6	18.1		12.7	5.3	20.0		11.7	4.4	19.1
f. Other		4.2	<0	9.2		3.9	<0	8.6		4.2	<0	9.4
Total		100.1†				100.0				99.8†		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Operations for which 100% are sole ownership	53	74.8	64.0	85.5	57	77.7	67.8	87.6	53	77.8	67.6	88.0

† Total does not sum to 100% because of rounding.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

		3 Years Ago (n = 74)				During Past Year (n = 78)				Expected in 3 Years (n = 73)		
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
2.3 What methods are used by your operation for receiving or purchasing calves and feeder cattle (% of head)?												
a. Auction barns		57.1	45.5	68.7		51.1	40.1	62.0		46.7	35.3	58.0
b. Video/electronic auctions		2.4	<0	5.9		3.9	<0	8.0		5.4	0.8	10.1
c. Dealers or brokers		16.3	7.2	25.3		16.1	7.5	24.8		15.9	6.6	25.2
d. Direct trade		13.4	6.3	20.4		14.4	7.2	21.6		16.1	7.9	24.3
e. Forward contract		1.2	<0	3.0		1.2	<0	3.0		2.5	<0	5.3
f. Marketing agreement		0.9	<0	2.7		0.9	<0	2.6		0.9	<0	2.8
g. Internal transfer		0.4	<0	1.1		2.0	<0	4.4		2.2	<0	5.4
h. Delivered for custom feeding/backgrounding		7.1	1.5	12.8		9.2	2.3	16.2		9.0	1.7	16.2
i. Other		1.3	<0	3.8		1.2	<0	3.6		1.3	<0	3.9
Total		100.1†				100.0				100.0		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Operations for which 100% are cash or spot market purchases	49	79.8	69.7	89.9	50	75.6	64.8	86.3	47	76.0	64.8	87.2

† Total does not sum to 100% because of rounding.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
2.4* What types of pricing methods are used by your operation for purchasing calves and feeder cattle?								
1. Individually negotiated pricing	47	43.1	30.6	55.6	50	51.7	38.8	64.7
2. Public auction	68	80.0	69.8	90.1	64	75.3	64.1	86.6
3. Sealed bid	D	0.1	0.0	0.1	D	0.1	0.0	0.2
4. Formula pricing (using another price as the base)	8	1.8	0.0	4.2	6	1.0	0.0	2.7
5. Internal transfer	4	4.8	0.0	10.1	3	3.3	0.0	7.9
6. Delivered for custom feeding/backgrounding	24	19.3	9.7	28.8	21	16.3	7.2	25.4
7. Other	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

		n	%	Lower	Upper
2.5*	For calves and feeder cattle purchased by your operation during the past year using formula pricing, what was the base price of the formula?				
	1. USDA live quote	D	16.7	0.0	51.4
	2. Chicago Mercantile Exchange (CME) cattle futures	5	18.0	0.0	45.7
	3. Subscription service price (for example, Cattle Fax, Urner Barry)	3	36.4	0.0	81.3
	4. Cost of production	D	39.4	0.0	85.4
	5. Other market price	5	34.4	0.0	72.2
	6. Other	0	0.0	NA	NA
		n	**Mean**	**Lower**	**Upper**
2.6a	For calves purchased using a slide during the past year, what were the most common terms of the slide?				
	a. Minimum target weight (hundred weight)	6	4.8	4.6	5.0
	b. Maximum target weight (hundred weight)	12	5.6	5.1	6.2
	c. First slide premium below target weight (cents per pound)	6	8.1	7.5	8.6
	d. First slide discount above target weight (cents per pound)	12	8.3	6.6	10.1
2.6b	For steers purchased using a slide during the past year, what were the most common terms of the slide?				
	a. Minimum target weight (hundred weight)	3	7.8	6.5	9.2
	b. Maximum target weight (hundred weight)	9	8.2	6.9	9.4
	c. First slide premium below target weight (cents per pound)	3	2.1	2.1	2.1
	d. First slide discount above target weight (cents per pound)	9	5.3	2.6	8.0
2.6c	For heifers purchased using a slide during the past year, what were the most common terms of the slide?				
	a. Minimum target weight (hundred weight)	3	6.9	5.6	8.2
	b. Maximum target weight (hundred weight)	9	6.8	5.2	8.3
	c. First slide premium below target weight (cents per pound)	3	2.1	2.1	2.1
	d. First slide discount above target weight (cents per pound)	9	4.5	1.4	7.6

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

		n	Mean	Lower	Upper
3.1	For what percentage of calves and feeder cattle purchased during the past year did the buyer (your operation) pay for transportation?	70	65.9	52.9	78.9
3.2	What percentage of calves and feeder cattle purchased during the past year were under a written agreement (versus oral)?	69	8.4	2.1	14.7

		Mean (n = 57)	Lower	Upper
3.3	For calves and feeder cattle purchased during the past year, what was the length of the agreement or contract (oral or written) (% of head)?			
	a. Purchases not under agreement or contract	82.6	71.3	94.0
	b. Less than 6 months	14.1	4.0	24.2
	c. 6 to 11 months	0.3	<0	0.6
	d. 1 to 2 years	0.0	0.0	0.0
	e. 3 to 5 years	0.0	0.0	0.0
	f. 6 to 10 years	0.0	0.0	0.0
	g. More than 10 years or evergreen	3.0	<0	9.0
	Total	100.0		

		Mean (n = 70)	Lower	Upper
3.4	For calves and feeder cattle purchased during the past year, how far in advance of delivery was the delivery scheduled (% of head)?			
	a. Less than 2 weeks	84.6	75.5	93.7
	b. 3 to 4 weeks	10.1	2.4	17.9
	c. 5 to 8 weeks	1.2	0.1	2.4
	d. 9 to 12 weeks	2.8	<0	6.9
	e. 13 to 16 weeks	0.1	<0	0.3
	f. More than 16 weeks	1.1	<0	2.5
	Total	99.9†		

† Total does not sum to 100% because of rounding.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

		n	%	Lower	Upper
4.1*	What are the three most important reasons why your operation only uses the cash or spot market for purchasing calves and feeder cattle?				
	1. Can purchase calves and cattle at lower prices	17	36.4	20.9	51.8
	2. Reduces risk exposure	6	11.3	1.3	21.3
	3. Reduces costs of activities for buying calves and cattle	7	18.3	5.6	31.0
	4. Reduces price variability for calves and cattle	D	3.9	0.0	9.9
	5. Reduces potential liability and litigation concerns	D	0.0	0.0	0.1
	6. Increases supply chain information	D	5.0	0.0	12.1
	7. Secures higher quality calves and cattle	14	28.8	14.5	43.1
	8. Facilitates or increases market access	D	3.9	0.0	9.9
	9. Allows for adjusting operations quickly in response to changes in market conditions	19	33.8	18.8	48.9
	10. Does not require identifying and recruiting long-term contracting partners	4	10.5	0.4	20.7
	11. Does not require managing complex and costly contracts	12	30.7	15.8	45.6
	12. Eliminates possible negative public perceptions about use of contracts	0	0.0	NA	NA
	13. Allows for independence, complete control, and flexibility of own business	30	61.3	45.7	76.9
	14. Enhances ability to benefit from favorable market conditions	19	32.9	18.2	47.6
	15. Other	D	2.8	0.0	8.3

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

		n	%	Lower	Upper
4.2*	What are the three most important reasons why your operation uses alternative purchase methods for purchasing calves and feeder cattle?				
	1. Can purchase calves and cattle at lower prices	4	48.8	0.0	100.0
	2. Reduces risk exposure	D	1.7	0.0	5.7
	3. Reduces costs of activities for buying calves and cattle	3	5.0	0.0	10.7
	4. Reduces price variability for calves and cattle	D	45.4	0.0	100.0
	5. Reduces potential liability and litigation concerns	0	0.0	NA	NA
	6. Increases supply chain information	D	1.7	0.0	5.7
	7. Secures higher quality calves and cattle	6	95.0	89.3	100.0
	8. Facilitates or increases market access	D	1.7	0.0	5.7
	9. Allows for food safety and biosecurity assurances	0	0.0	NA	NA
	10. Allows for product traceability	D	3.4	0.0	8.5
	11. Improves week-to-week supply management	5	51.2	0.0	100.0
	12. Improves efficiency of operations due to animal uniformity	D	46.2	0.0	100.0
	13. Reduces investment requirements for facilities and equipment	0	0.0	NA	NA
	14. Reduces operating capital requirements	0	0.0	NA	NA
	15. Enhances access to credit	0	0.0	NA	NA
	16. Other	0	0.0	NA	NA
		n	**Mean**	**Lower**	**Upper**
5.1a	How many calves (less than 500 pounds liveweight) did your operation sell or ship during the past year?	95	186.5	<0	449.1
		n	**%**	**Lower**	**Upper**
	1–49	66	77.0	67.9	86.1
	50–99	11	12.0	4.9	19.1
	100–499	9	9.2	2.9	15.4
	500–1,999	4	1.2	0.0	3.3
	2,000–49,999	5	0.7	0.0	1.8
	50,000 or more	0	0.0	NA	NA
	Total		100.1†		

D = Results suppressed.
NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.
* Respondents could select multiple responses.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

		n	Mean	Lower	Upper
5.1b	How many feeder cattle (500 pounds liveweight or more) did your operation sell or ship during the past year?	189	367.5	76.1	658.9
		n	**%**	**Lower**	**Upper**
	1–49	87	49.9	42.3	57.4
	50–99	30	17.9	12.0	23.8
	100–499	44	24.0	17.6	30.5
	500–1,999	13	5.8	2.4	9.1
	2,000 or more	15	2.4	0.5	4.2
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
5.1c	How many fed cattle (steers and heifers) did your operation sell or ship during the past year?	93	1,973.8	999.2	2,948.4
		n	**%**	**Lower**	**Upper**
	1–49	37	54.4	42.7	66.1
	50–99	10	13.3	5.2	21.3
	100–499	16	18.5	9.6	27.5
	500–1,999	7	6.2	0.9	11.6
	2,000–9,999	5	2.9	0.0	6.3
	10,000–19,999	5	2.9	0.0	6.3
	20,000–49,999	3	1.5	0.0	3.5
	50,000 or more	10	0.3	0.2	0.4
	Total		100.0		

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

	3 Years Ago (n = 251)				During Past Year (n = 261)				Expected in 3 Years (n = 245)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
5.2 What methods for selling or shipping calves and cattle are used by your operation (% of head)?												
a. Auction barns		70.4	64.8	76.0		65.4	59.7	71.2		64.5	58.6	70.5
b. Video/electronic auctions		3.9	1.5	6.2		4.4	1.8	7.0		5.6	2.8	8.5
c. Dealers or brokers		4.8	2.1	7.5		5.5	2.7	8.3		5.4	2.7	8.0
d. Direct trade		12.9	8.9	17.0		15.7	11.4	20.0		14.8	10.5	19.1
e. Forward contract		2.1	0.6	3.7		3.0	1.2	4.9		2.7	1.0	4.3
f. Marketing agreement		0.4	<0	1.1		0.6	<0	1.3		1.3	0.3	2.3
g. Packer fed/owned		0.1	0.0	0.1		0.1	0.0	0.1		0.1	0.0	0.1
h. Internal transfer		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
i. Custom fed/ backgrounded, not marketed by your operation		2.9	0.9	4.8		3.5	1.3	5.8		3.4	1.1	5.6
j. Custom slaughtered for your operation		2.6	0.7	4.4		1.5	0.1	2.9		2.0	0.3	3.7
k. Other		0.0	0.0	0.0		0.2	<0	0.7		0.3	<0	0.8
Total		100.1†				99.9†				100.1†		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Operations for which 100% are cash or spot market sales	199	85.5	80.9	90.1	205	84.9	80.4	89.4	185	82.0	77.0	87.0

† Total does not sum to 100% because of rounding.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
5.3* What types of pricing methods are used by your operation for selling calves and cattle?								
1. Individually negotiated pricing	107	31.8	26.0	37.6	101	33.1	27.0	39.2
2. Public auction	221	83.5	78.9	88.0	207	84.2	79.5	88.9
3. Sealed bid	D	0.5	0.0	1.3	D	0.7	0.0	1.8
4. Formula pricing (using another price as the base)	32	5.8	3.1	8.5	30	5.6	2.9	8.3
5. Internal transfer	4	0.2	0.0	0.6	3	0.0	0.0	0.1
6. Custom fed/backgrounded, not marketed by your operation	21	5.8	2.9	8.6	16	5.3	2.4	8.2
7. Custom slaughtered for your operation	16	5.4	2.6	8.2	17	6.4	3.2	9.5
8. Other	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

	With Grid				Without Grid			
	n	%	Lower	Upper	n	%	Lower	Upper
5.4* For calves and cattle sold by your operation during the past year using formula pricing, what was the base price of the formula?								
1. Individual or multiple packing plant average price	15	50.7	20.7	80.7	8	27.9	7.7	48.1
2. USDA live quote	8	15.4	0.0	32.9	D	5.7	0.0	17.1
3. USDA dressed or carcass quote	5	33.0	5.3	60.7	3	10.5	0.0	23.7
4. USDA boxed beef price	D	5.0	0.0	15.3	0	0.0	NA	NA
5. Chicago Mercantile Exchange (CME) cattle futures	D	16.0	0.0	39.5	4	15.1	0.0	30.9
6. Subscription service price (for example, Cattle Fax, Urner Barry)	3	19.0	0.0	41.5	4	7.3	0.0	18.1
7. Cost of production	D	4.8	0.0	15.1	D	0.1	0.0	0.3
8. Retail price	D	9.3	0.0	28.0	6	31.7	9.6	53.7
9. Other market price	D	0.2	0.0	0.6	0	0.0	NA	NA
10. Other	0	0.0	NA	NA	0	0.0	NA	NA
11. Auction price *(write-in response)*	0	0.0	NA	NA	3	13.6	0.0	29.7

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
5.5* What types of valuation methods are used by your operation for selling fed cattle?								
1. Liveweight	55	79.9	69.1	90.7	50	77.7	66.0	89.4
2. Carcass weight not dependent on grid value	23	25.2	13.8	36.6	21	25.5	13.4	37.5
3. Carcass weight dependent on grid value	20	14.8	5.9	23.8	18	15.7	5.9	25.6
4. Other	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

		n	Mean	Lower	Upper
5.6a	For calves sold using a slide during the past year, what were the most common terms of the slide?				
	a. Minimum target weight (hundred weight)	D	3.0	NA	NA
	b. Maximum target weight (hundred weight)	7	6.6	4.9	8.2
	c. First slide premium below target weight (cents per pound)	D	10.0	NA	NA
	d. First slide discount above target weight (cents per pound)	7	5.8	2.5	9.2
5.6b	For steers sold using a slide during the past year, what were the most common terms of the slide?				
	a. Minimum target weight (hundred weight)	D	6.0	NA	NA
	b. Maximum target weight (hundred weight)	10	8.2	6.9	9.5
	c. First slide premium below target weight (cents per pound)	D	5.0	NA	NA
	d. First slide discount above target weight (cents per pound)	10	4.0	2.6	5.3
5.6c	For heifers sold using a slide during the past year, what were the most common terms of the slide?				
	a. Minimum target weight (hundred weight)	D	6.0	NA	NA
	b. Maximum target weight (hundred weight)	9	7.9	6.9	9.0
	c. First slide premium below target weight (cents per pound)	D	5.0	NA	NA
	d. First slide discount above target weight (cents per pound)	9	4.0	2.6	5.3
6.1	For what percentage of calves and cattle sold during the past year did the seller (your operation) pay for transportation?	219	53.1	46.2	59.9
6.2	What percentage of calves and cattle sold during the past year were under a written agreement (versus oral)?	218	12.5	8.1	17.0

D = Results suppressed.
NA = Confidence interval not calculable.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

		Mean (n = 193)	**Lower**	**Upper**
6.3	For calves and cattle sold during the past year, what was the length of the agreement or contract (oral or written) (% of head)?			
	a. Sales not under agreement or contract	79.4	73.5	85.2
	b. Less than 6 months	14.8	9.8	19.9
	c. 6 to 11 months	5.0	1.7	8.2
	d. 1 to 2 years	0.0	0.0	0.1
	e. 3 to 5 years	0.0	0.0	0.0
	f. 6 to 10 years	0.0	0.0	0.1
	g. More than 10 years or evergreen	0.8	<0	1.9
	Total	100.0		
		Mean (n = 205)	**Lower**	**Upper**
6.4	For calves and cattle sold during the past year, how far in advance of delivery was the delivery scheduled (% of head)?			
	a. Less than 7 days	63.6	56.7	70.6
	b. 8 to 14 days	14.8	9.9	19.7
	c. 15 to 21 days	5.6	2.3	8.8
	d. 22 to 30 days	6.1	2.6	9.6
	e. 1 to 2 months	4.6	1.7	7.6
	f. More than 2 months	5.2	2.0	8.5
	Total	99.9†		

† Total does not sum to 100% because of rounding.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

	n	%	Lower	Upper
7.1* What are the three most important reasons why your operation only uses the cash or spot market for selling calves and cattle?				
1. Can sell calves and cattle at higher prices	78	40.9	33.6	48.2
2. Reduces risk exposure	22	11.8	7.0	16.7
3. Reduces costs of activities for selling calves and cattle	42	22.8	16.5	29.1
4. Reduces price variability for calves and cattle	16	8.4	4.3	12.5
5. Reduces potential liability and litigation concerns	7	4.0	1.1	7.0
6. Increases supply chain information	D	0.8	0.0	1.9
7. Allows for sale of higher quality calves and cattle	29	16.3	10.7	21.8
8. Facilitates or increases market access	22	11.6	6.8	16.4
9. Allows for adjusting operations quickly in response to changes in market conditions	44	23.1	16.8	29.3
10. Does not require identifying and recruiting long-term contracting partners	37	19.9	14.0	25.9
11. Does not require managing complex and costly contracts	45	24.8	18.4	31.3
12. Eliminates possible negative public perceptions about use of contracts	5	2.8	0.3	5.2
13. Allows for independence, complete control, and flexibility of own business	101	54.1	46.7	61.5
14. Enhances ability to benefit from favorable market conditions	72	37.5	30.3	44.8
15. Other	D	1.2	0.0	3.0
16. No other choice *(write-in response)*	D	0.8	0.0	1.9
17. Can easily sell small number of animals *(write-in response)*	8	4.2	1.2	7.1
18. Convenience *(write-in response)*	5	3.0	0.4	5.6

D = Results suppressed.

* Respondents could select multiple responses.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

		n	%	Lower	Upper
7.2*	What are the three most important reasons why your operation uses alternative sales methods for selling calves and cattle?				
	1. Can sell calves and cattle at higher prices	14	38.5	10.8	66.2
	2. Reduces risk exposure	11	34.5	7.5	61.4
	3. Reduces costs of activities for selling calves and cattle	3	12.8	0.0	31.4
	4. Reduces price variability for calves and cattle	6	33.8	7.7	59.9
	5. Reduces potential liability and litigation concerns	D	8.3	0.0	25.0
	6. Increases supply chain information	D	4.5	0.0	13.6
	7. Allows for sale of higher quality calves and cattle	10	51.6	23.2	80.0
	8. Facilitates or increases market access	9	19.7	0.0	42.1
	9. Increases flexibility in responding to consumer demand	D	10.0	0.0	29.7
	10. Allows for product branding in retail sales	3	4.7	0.0	14.0
	11. Allows for food safety and biosecurity assurances	D	0.2	0.0	0.5
	12. Allows for product traceability	D	0.2	0.0	0.5
	13. Improves week-to-week production management	6	9.4	0.0	22.5
	14. Secures a buyer for calves and cattle	10	26.5	3.4	49.6
	15. Provides detailed carcass data	4	20.3	0.0	46.1
	16. Enhances access to credit	D	8.3	0.0	25.0
	17. Other	D	0.3	0.0	0.8
		n	**Mean**	**Lower**	**Upper**
8.1	Approximately how many people (including yourself and family members) were employed for livestock production at your operation during the past year?				
	a. Full time	207	2.3	2.0	2.6
	b. Part time	114	1.9	1.6	2.1
	c. Seasonal	59	2.7	2.0	3.3
8.2	What is the total acreage of your operation used for livestock production?	281	3,347.5	2,276.1	4,418.9

D = Results suppressed.
* Respondents could select multiple responses.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

		n	Mean	Lower	Upper
8.3a	How many beef calves (less than 500 pounds liveweight), including fed Holsteins, were on this operation on January 1, 2005?	158	197.7	50.1	345.3
		n	**%**	**Lower**	**Upper**
	1–49	91	65.3	57.3	73.3
	50–99	18	13.6	7.6	19.5
	100–499	30	17.6	11.3	23.9
	500–1,999	7	2.3	0.1	4.4
	2,000–19,999	9	1.3	0.0	3.0
	20,000 or more	3	0.0	0.0	0.1
	Total		100.1†		
		n	**Mean**	**Lower**	**Upper**
8.3b	How many steers, including fed Holsteins, were on this operation on January 1, 2005?	165	347.1	205.9	488.3
		n	**%**	**Lower**	**Upper**
	1–49	87	65.6	57.7	73.4
	50–99	14	9.6	4.6	14.5
	100–499	28	15.8	9.7	21.9
	500–1,999	15	6.0	2.5	9.5
	2,000–19,999	10	2.9	0.5	5.3
	20,000 or more	11	0.2	0.1	0.2
	Total		100.1†		
		n	**Mean**	**Lower**	**Upper**
8.3c	How many heifers, including fed Holsteins, were on this operation on January 1, 2005?	192	219.4	135.7	303.0
		n	**%**	**Lower**	**Upper**
	1–49	112	70.2	63.2	77.1
	50–99	17	10.9	5.9	15.9
	100–499	30	14.3	9.1	19.6
	500–1,999	12	3.2	0.9	5.5
	2,000–19,999	12	1.3	0.1	2.6
	20,000–49,999	3	0.0	0.0	0.1
	50,000 or more	6	0.1	0.0	0.1
	Total		100.0		

NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

		n	Mean	Lower	Upper
8.3d	How many bulls, stags, and bullocks, including fed Holsteins, were on this operation on January 1, 2005?	207	10.3	4.9	15.6
		n	**%**	**Lower**	**Upper**
	1–49	188	97.3	95.4	99.1
	50–99	6	1.9	0.3	3.5
	100–499	7	0.6	0.0	1.3
	500–1,999	6	0.3	0.0	0.8
	2,000 or more	0	0.0	NA	NA
	Total		100.1†		
		n	**Mean**	**Lower**	**Upper**
8.3e	How many cows and heiferettes, including fed Holsteins, were on this operation on January 1, 2005?	232	143.8	118	169.5
		n	**%**	**Lower**	**Upper**
	1–49	81	37.6	31.0	44.3
	50–99	50	24.4	18.4	30.3
	100–499	73	33.4	26.9	39.8
	500–1,999	14	4.0	1.7	6.4
	2,000–9,999	10	0.5	0.0	1.2
	10,000–49,999	4	0.0	0.0	0.1
	50,000 or more	0	0.0	NA	NA
	Total		99.9†		
		n	**Mean**	**Lower**	**Upper**
8.4	How many auctions operate for selling cattle within 200 miles of your operation?				
	a. Number of auctions operating 3 years ago	255	8.7	7.6	9.9
	b. Number of auctions currently operating	256	8.4	7.2	9.5

NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

	3 Years Ago				Currently			
	n	%	Lower	Upper	n	%	Lower	Upper
8.5* For the auction located closest to your operation, how often does it operate for selling cattle?								
1. Monthly	0	0.0	NA	NA	D	0.4	0.0	1.3
2. Every 2 weeks	3	1.0	0.0	2.3	4	1.3	0.0	2.7
3. Weekly	209	89.1	84.9	93.4	213	88.1	83.8	92.4
4. 2 times per week	17	6.7	3.3	10.2	19	6.9	3.5	10.2
5. 3 to 5 times per week	8	3.6	1.1	6.0	7	2.7	0.6	4.8
6. Daily	3	1.4	0.0	3.1	D	1.0	0.0	2.3
7. Other	D	0.5	0.0	1.6	D	0.5	0.0	1.6
8. Less than monthly *(write-in response)*	5	2.0	0.0	3.9	5	1.9	0.0	3.8

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

		n	%	Lower	Upper
8.6	What were your operation's approximate total gross sales for calves and cattle during the past year?				
	1. Under $99,999	176	71.6	66.1	77.1
	2. $100,000 to $499,999	55	20.4	15.4	25.5
	3. $500,000 to $999,999	6	1.9	0.3	3.5
	4. $1,000,000 to $2,499,999	8	2.0	0.5	3.5
	5. $2,500,000 to $4,999,999	6	0.6	0.0	1.5
	6. $5,000,000 to $9,999,999	6	0.9	0.0	2.2
	7. $10,000,000 to $19,999,999	4	0.6	0.0	1.4
	8. $20,000,000 to $99,999,999	8	1.0	0.1	1.9
	9. $100,000,000 to $499,999,999	8	0.4	0.0	1.0
	10. $500,000,000 or more	3	0.5	0.0	1.4
	Total		99.9†		
8.7	What were your operation's approximate total gross sales for all farm outputs during the past year?				
	1. Under $99,999	149	61.8	55.7	67.9
	2. $100,000 to $499,999	67	26.4	20.8	32.0
	3. $500,000 to $999,999	14	4.6	2.1	7.1
	4. $1,000,000 to $2,499,999	13	3.2	1.4	5.1
	5. $2,500,000 to $4,999,999	5	1.0	0.0	2.1
	6. $5,000,000 to $9,999,999	5	0.5	0.0	1.4
	7. $10,000,000 to $19,999,999	5	0.8	0.0	1.7
	8. $20,000,000 to $99,999,999	7	0.8	0.0	1.6
	9. $100,000,000 to $499,999,999	7	0.2	0.0	0.6
	10. $500,000,000 or more	3	0.7	0.0	1.7
	Total		100.0		
8.8	Which of the following best describes your position with this operation?				
	1. Owner	242	91.5	88.2	94.8
	2. Manager	31	4.9	2.4	7.4
	3. Family member (not owner or manager)	4	1.5	0.0	2.9
	4. Other hired employee	4	0.0	0.0	0.1
	5. Other	D	0.8	0.0	1.9
	6. Partner or co-owner *(write-in response)*	4	1.3	0.0	2.6
	Total		100.0		

D = Results suppressed.

† Total does not sum to 100% because of rounding.

(continued)

Table 6-1. Weighted Responses for the Beef Producer Survey (n = 293) (continued)

		n	%	Lower	Upper
8.9	If owner, what is your age?				
	1. Less than 25	0	0.0	NA	NA
	2. 26 to 35	4	1.9	0.0	3.7
	3. 36 to 45	14	5.7	2.7	8.8
	4. 46 to 55	78	31.0	24.9	37.0
	5. 56 to 65	67	27.6	21.7	33.5
	6. Older than 65	79	33.9	27.6	40.1
	Total		100.1†		
8.10	If owner, what is your education level?				
	1. Less than high school graduate	18	7.8	4.2	11.3
	2. High school graduate/GED	74	31.0	25.0	37.1
	3. Some college or technical school, no degree	80	35.2	28.9	41.6
	4. College graduate	49	19.1	14.0	24.2
	5. Post-graduate	19	6.8	3.6	10.1
	Total		99.9†		
		n	**Mean**	**Lower**	**Upper**
8.11	If owner, what percentage of your total annual household income comes from off-farm sources?	240	44.8	40.3	49.4

NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.

Table 6-2. Use of Purchase Methods for Beef Producers, by Size (Small = 270, Large = 23)

		Small				Large				All Operations			
		n	Mean	Lower	Upper	n	Mean	Lower	Upper	n	Mean	Lower	Upper
S2.1a	How many calves (less than 500 pounds liveweight) did your operation receive or purchase during the past year?	39	1,198.4	292.6	2,104.2	12	37,466.2	<0	81,152.4	51	1,439.8	499.4	2,380.2
S2.1b	How many feeder cattle (500 pounds liveweight or more) did your operation receive or purchase during the past year?	45	2,511.9	762.6	4,261.2	13	248,284.4	98,147.4	398,421.4	58	4,065.8	2,061.2	6,070.4

(continued)

Table 6-2. Use of Purchase Methods for Beef Producers, by Size (Small = 270, Large = 23) (continued)

	Small (n = 70)				Large (n = 16)				All Operations (n = 86)			
		Mean	Lower	Upper		Mean	Lower	Upper		Mean	Lower	Upper
S2.2 For all calves and feeder cattle received or purchased by your operation during the past year, what were the ownership arrangements (% of head)?												
a. Sole ownership by your operation		81.1	72.0	90.1		59.2	37.8	80.6		81.0	72.0	90.0
b. Partner arrangement		1.3	<0	2.8		5.0	0.2	9.8		1.3	<0	2.8
c. Shared ownership		0.9	<0	2.7		7.5	<0	16.1		1.0	<0	2.7
d. Joint venture		0.1	<0	0.4		5.8	<0	13.7		0.1	<0	0.4
e. Delivered for custom feeding/ backgrounding		12.6	5.2	20.1		21.6	4.8	38.4		12.7	5.3	20
f. Other		3.9	<0	8.7		0.9	<0	2.9		3.9	<0	8.6
Total		99.9†				100.0				100.0		
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
Operations for which 100% are sole ownership	52	78.0	68.0	87.9	5	31.3	5.7	56.8	57	77.7	67.8	87.6

† Total does not sum to 100% because of rounding.

(continued)

Table 6-2. Use of Purchase Methods for Beef Producers, by Size (Small = 270, Large = 23) (continued)

		Small (n = 64)				Large (n = 14)				All Operations (n = 78)		
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
S2.3 What methods were used by your operation during the past year for receiving or purchasing calves and feeder cattle (% of head)?												
a. Auction barns		51.2	40.1	62.2		23.4	9.3	37.4		51.1	40.1	62.0
b. Video/electronic auctions		3.9	<0	8.1		4.9	0.3	9.6		3.9	<0	8.0
c. Dealers or brokers		16.1	7.4	24.8		21.1	3.2	39.1		16.1	7.5	24.8
d. Direct trade		14.3	7.1	21.6		21.2	4.6	37.9		14.4	7.2	21.6
e. Forward contract		1.2	<0	3.0		8.6	<0	19.9		1.2	<0	3.0
f. Marketing agreement		0.9	<0	2.6		0.0	0.0	0.0		0.9	<0	2.6
g. Internal transfer		2.0	<0	4.4		1.8	<0	5.6		2.0	<0	4.4
h. Delivered for custom feeding/ backgrounding		9.2	2.2	16.2		19.0	4.5	33.5		9.2	2.3	16.2
i. Other		1.2	<0	3.6		0.0	0.0	0.0		1.2	<0	3.6
Total		100.0				100.0				100.0		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Operations for which 100% are cash or spot market purchases	46	75.8	64.9	86.6	4	28.6	1.5	55.6	50	75.6	64.8	86.3

(continued)

Table 6-2. Use of Purchase Methods for Beef Producers, by Size (Small = 270, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S2.4* What types of pricing methods were used by your operation during the past year for purchasing calves and feeder cattle?												
1. Individually negotiated pricing	31	42.8	30.3	55.4	16	100.0	100.0	100.0	47	43.1	30.6	55.6
2. Public auction	54	79.9	69.7	90.2	14	87.5	69.3	100.0	68	80.0	69.8	90.1
3. Sealed bid	0	0.0	NA	NA	D	12.5	0.0	30.7	D	0.1	0.0	0.1
4. Formula pricing (using another price as the base)	D	1.7	0.0	4.0	D	37.5	10.9	64.1	8	1.8	0.0	4.2
5. Internal transfer	D	4.8	0.0	10.2	D	6.3	0.0	19.6	4	4.8	0.0	10.1
6. Delivered for custom feeding/backgrounding	15	19.1	9.4	28.7	9	56.3	28.9	83.6	24	19.3	9.7	28.8
7. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-2. Use of Purchase Methods for Beef Producers, by Size (Small = 270, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S2.5* For calves and feeder cattle purchased by your operation during the past year using formula pricing, what was the base price of the formula?												
1. USDA live quote	D	16.6	0.0	54.5	D	20.0	0.0	75.5	D	16.7	0.0	51.4
2. Chicago Mercantile Exchange (CME) cattle futures	D	17.3	0.0	47.4	D	60.0	0.0	100.0	5	18.0	0.0	45.7
3. Subscription service price (for example, Cattle Fax, Urner Barry)	D	36.7	0.0	85.7	D	20.0	0.0	75.5	3	36.4	0.0	81.3
4. Cost of production	D	40.0	0.0	90.1	0	0.0	NA	NA	D	39.4	0.0	85.4
5. Other market price	D	34.7	0.0	75.9	D	20.0	0.0	75.5	5	34.4	0.0	72.2
6. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 6-3. Terms of Purchase Methods for Beef Producers, by Size (Small = 270, Large = 23)

	Small				Large				All Operations			
	n	Mean	Lower	Upper	n	Mean	Lower	Upper	n	Mean	Lower	Upper
S3.1 For what percentage of calves and feeder cattle purchased during the past year did the buyer (your operation) pay for transportation?	55	65.8	52.7	79.0	15	79.2	58.6	99.8	70	65.9	52.9	78.9
S3.2 What percentage of calves and feeder cattle purchased during the past year were under a written agreement (versus oral)?	54	8.3	1.9	14.7	15	25.7	8.1	43.3	69	8.4	2.1	14.7
	Small (n = 44)				Large (n = 13)				All Operations (n = 57)			
		Mean	Lower	Upper		Mean	Lower	Upper		Mean	Lower	Upper
S3.3 For calves and feeder cattle purchased during the past year, what was the length of the agreement or contract (oral or written) (% of head)?												
a. Purchases not under agreement or contract		82.8	71.3	94.3		60.7	34.8	86.6		82.6	71.3	94.0
b. Less than 6 months		14.0	3.7	24.2		35.8	11.3	60.3		14.1	4.0	24.2
c. 6 to 11 months		0.3	<0	0.6		1.9	<0	5.3		0.3	<0	0.6
d. 1 to 2 years		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
e. 3 to 5 years		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
f. 6 to 10 years		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
g. More than 10 years or evergreen		3.0	<0	9.1		1.5	<0	3.8		3.0	<0	9.0
Total		100.1†				99.9†				100.0		

† Total does not sum to 100% because of rounding.

(continued)

Table 6-3. Terms of Purchase Methods for Beef Producers, by Size (Small = 270, Large = 23) (continued)

	Small (n = 55)			Large (n = 15)			All Operations (n = 70)		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
S3.4 For calves and feeder cattle purchased during the past year, how far in advance of delivery was the delivery scheduled (% of head)?									
a. Less than 2 weeks	84.7	75.6	93.9	65.8	44.9	86.7	84.6	75.5	93.7
b. 3 to 4 weeks	10.1	2.2	17.9	21.3	2.7	39.9	10.1	2.4	17.9
c. 5 to 8 weeks	1.2	0.0	2.4	4.4	0.8	8.0	1.2	0.1	2.4
d. 9 to 12 weeks	2.9	<0	6.9	2.2	0.2	4.2	2.8	<0	6.9
e. 13 to 16 weeks	0.1	<0	0.3	2.5	0.2	4.7	0.1	<0	0.3
f. More than 16 weeks	1.1	<0	2.5	3.8	<0	10.9	1.1	<0	2.5
Total	100.1†			100.0			99.9†		

† Total does not sum to 100% because of rounding.

Table 6-4. Reasons for Using Purchase Methods for Beef Producers, by Size (Small = 270, Large = 23)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S4.1* What are the three most important reasons why your operation only uses the cash or spot market for purchasing calves and feeder cattle?												
1. Can purchase calves and cattle at lower prices	D	36.4	20.8	51.9	D	40.0	0.0	100.0	17	36.4	20.9	51.8
2. Reduces risk exposure	D	11.3	1.3	21.3	D	20.0	0.0	75.5	6	11.3	1.3	21.3
3. Reduces costs of activities for buying calves and cattle	7	18.4	5.6	31.1	0	0.0	NA	NA	7	18.3	5.6	31.0
4. Reduces price variability for calves and cattle	D	4.0	0.0	10.0	0	0.0	NA	NA	D	3.9	0.0	9.9
5. Reduces potential liability and litigation concerns	0	0.0	NA	NA	D	20.0	0.0	75.5	D	0.0	0.0	0.1
6. Increases supply chain information	D	5.0	0.0	12.2	0	0.0	NA	NA	D	5.0	0.0	12.1
7. Secures higher quality calves and cattle	D	28.8	14.5	43.2	D	20.0	0.0	75.5	14	28.8	14.5	43.1
8. Facilitates or increases market access	D	4.0	0.0	10.0	0	0.0	NA	NA	D	3.9	0.0	9.9
9. Allows for adjusting operations quickly in response to changes in market conditions	15	33.7	18.6	48.8	4	80.0	24.5	100.0	19	33.8	18.8	48.9
10. Does not require identifying and recruiting long-term contracting partners	4	10.6	0.4	20.8	0	0.0	NA	NA	4	10.5	0.4	20.7
11. Does not require managing complex and costly contracts	12	30.8	15.8	45.8	0	0.0	NA	NA	12	30.7	15.8	45.6
12. Eliminates possible negative public perceptions about use of contracts	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
13. Allows for independence, complete control, and flexibility of own business	27	61.3	45.7	77.0	3	60.0	0.0	100.0	30	61.3	45.7	76.9
14. Enhances ability to benefit from favorable market conditions	16	32.9	18.1	47.7	3	60.0	0.0	100.0	19	32.9	18.2	47.6
15. Other	D	2.8	0.0	8.3	0	0.0	0.0	0.0	D	2.8	0.0	8.3

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-4. Reasons for Using Purchase Methods for Beef Producers, by Size (Small = 270, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S4.2* What are the three most important reasons why your operation uses alternative purchase methods for purchasing calves and feeder cattle?	(results suppressed)				(results suppressed)							
1. Can purchase calves and cattle at lower prices									4	48.8	0.0	100.0
2. Reduces risk exposure									D	1.7	0.0	5.7
3. Reduces costs of activities for buying calves and cattle									3	5.0	0.0	10.7
4. Reduces price variability for calves and cattle									D	45.4	0.0	100.0
5. Reduces potential liability and litigation concerns									0	0.0	NA	NA
6. Increases supply chain information									D	1.7	0.0	5.7
7. Secures higher quality calves and cattle									6	95.0	89.3	100.0
8. Facilitates or increases market access									D	1.7	0.0	5.7
9. Allows for food safety and biosecurity assurances									0	0.0	NA	NA
10. Allows for product traceability									D	3.4	0.0	8.5
11. Improves week-to-week supply management									5	51.2	0.0	100.0
12. Improves efficiency of operations due to animal uniformity									D	46.2	0.0	100.0
13. Reduces investment requirements for facilities and equipment									0	0.0	NA	NA
14. Reduces operating capital requirements									0	0.0	NA	NA
15. Enhances access to credit									0	0.0	NA	NA
16. Other									0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 6-5. Use of Sales Methods for Beef Producers, by Size (Small = 270, Large = 23)

		Small				Large				All Operations			
		n	Mean	Lower	Upper	n	Mean	Lower	Upper	n	Mean	Lower	Upper
S5.1a	How many calves (less than 500 pounds liveweight) did your operation sell or ship during the past year?	87	176.3	<0	439.3	8	5,978.0	<0	13,686.2	95	186.5	<0	449.1
S5.1b	How many feeder cattle (500 pounds liveweight or more) did your operation sell or ship during the past year?	180	363.2	71.5	655.0	9	4,844.1	1,210.6	8,477.6	189	367.5	76.1	658.9
S5.1c	How many fed cattle (steers and heifers) did your operation sell or ship during the past year?	77	1,024.6	270.3	1,778.8	16	216,302.3	73,292.1	359,312.4	93	1,973.8	999.2	2,948.4

(continued)

Table 6-5. Use of Sales Methods for Beef Producers, by Size (Small = 270, Large = 23) (continued)

	Small (n = 240)				Large (n = 21)				All Operations (n = 261)			
		Mean	Lower	Upper		Mean	Lower	Upper		Mean	Lower	Upper
S5.2 What methods for selling or shipping calves and cattle were used by your operation during the past year (% of head)?												
a. Auction barns		65.5	59.8	71.3		4.4	<0	9.6		65.4	59.7	71.2
b. Video/electronic auctions		4.4	1.8	7.0		5.3	0.0	10.6		4.4	1.8	7.0
c. Dealers or brokers		5.5	2.7	8.3		7.6	<0	17.4		5.5	2.7	8.3
d. Direct trade		15.7	11.4	20.0		30.0	11.8	48.3		15.7	11.4	20.0
e. Forward contract		3.0	1.1	4.8		17.3	3.5	31.2		3.0	1.2	4.9
f. Marketing agreement		0.5	<0	1.2		15.0	1.2	28.7		0.6	<0	1.3
g. Packer fed/owned		0.0	0.0	0.1		9.5	<0	23.2		0.1	0.0	0.1
h. Internal transfer		0.0	0.0	0.0		2.0	<0	5.0		0.0	0.0	0.0
i. Custom fed/ backgrounded, not marketed by your operation		3.5	1.3	5.8		6.3	<0	16.4		3.5	1.3	5.8
j. Custom slaughtered for your operation		1.5	0.1	2.9		2.4	<0	7.3		1.5	0.1	2.9
k. Other		0.2	<0	0.7		0.0	0.0	0.0		0.2	<0	0.7
Total		99.8†				99.8†				99.9†		
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
Operations for which 100% are cash or spot market sales	200	85.0	80.5	89.5	5	23.8	3.9	43.7	205	84.9	80.4	89.4

† Total does not sum to 100% because of rounding.

(continued)

Table 6-5. Use of Sales Methods for Beef Producers, by Size (Small = 270, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S5.3* What types of pricing methods were used by your operation for selling calves and cattle during the past year?												
1. Individually negotiated pricing	90	31.7	25.9	37.5	17	73.9	54.5	93.3	107	31.8	26.0	37.6
2. Public auction	213	83.6	79.0	88.1	8	34.8	13.7	55.8	221	83.5	78.9	88.0
3. Sealed bid	D	0.5	0.0	1.3	0	0.0	NA	NA	D	0.5	0.0	1.3
4. Formula pricing (using another price as the base)	19	5.7	3.0	8.4	13	56.5	34.6	78.4	32	5.8	3.1	8.5
5. Internal transfer	D	0.2	0.0	0.6	D	13.0	0.0	27.9	4	0.2	0.0	0.6
6. Custom fed/ backgrounded, not marketed by your operation	17	5.7	2.9	8.6	4	17.4	0.6	34.2	21	5.8	2.9	8.6
7. Custom slaughtered for your operation	D	5.4	2.6	8.2	D	4.3	0.0	13.4	16	5.4	2.6	8.2
8. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-5. Use of Sales Methods for Beef Producers, by Size (Small = 270, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S5.4a* For calves and cattle sold by your operation during the past year using formula pricing with a grid, what was the base price of the formula?												
1. Individual or multiple packing plant average price	8	50.4	18.5	82.4	7	63.6	29.7	97.5	15	50.7	20.7	80.7
2. USDA live quote	3	14.8	0.0	33.4	5	45.5	10.4	80.5	8	15.4	0.0	32.9
3. USDA dressed or carcass quote	5	33.7	4.1	63.2	0	0.0	NA	NA	5	33.0	5.3	60.7
4. USDA boxed beef price	D	4.9	0.0	15.9	D	9.1	0.0	29.3	D	5.0	0.0	15.3
5. Chicago Mercantile Exchange (CME) cattle futures	D	16.3	0.0	41.4	0	0.0	NA	NA	D	16.0	0.0	39.5
6. Subscription service price (for example, Cattle Fax, Urner Barry)	3	19.4	0.0	43.5	0	0.0	NA	NA	3	19.0	0.0	41.5
7. Cost of production	D	4.9	0.0	15.9	0	0.0	NA	NA	D	4.8	0.0	15.1
8. Retail price	D	9.4	0.0	29.5	0	0.0	NA	NA	D	9.3	0.0	28.0
9. Other market price	0	0.0	NA	NA	D	9.1	0.0	29.3	D	0.2	0.0	0.6
10. Other	0	0.0	NA	NA	0	0.0	0.0	0.0	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-5. Use of Sales Methods for Beef Producers, by Size (Small = 270, Large = 23) (continued)

		Small				Large				All Operations			
		n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S5.4b*	For calves and cattle sold by your operation during the past year using formula pricing without a grid, what was the base price of the formula?												
	1. Individual or multiple packing plant average price	D	27.9	7.5	48.3	D	25.0	0.0	100.0	8	27.9	7.7	48.1
	2. USDA live quote	D	5.6	0.0	17.1	D	25.0	0.0	100.0	D	5.7	0.0	17.1
	3. USDA dressed or carcass quote	3	10.5	0.0	23.9	0	0.0	NA	NA	3	10.5	0.0	23.7
	4. USDA boxed beef price	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
	5. Chicago Mercantile Exchange (CME) cattle futures	4	15.2	0.0	31.1	0	0.0	NA	NA	4	15.1	0.0	30.9
	6. Subscription service price (for example, Cattle Fax, Urner Barry)	D	7.1	0.0	18.0	D	50.0	0.0	100.0	4	7.3	0.0	18.1
	7. Cost of production	0	0.0	NA	NA	D	25.0	0.0	100.0	D	0.1	0.0	0.3
	8. Retail price	6	31.8	9.5	54.1	0	0.0	NA	NA	6	31.7	9.6	53.7
	9. Other market price	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
	10. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
	11. Auction *(write-in response)*	3	13.7	0.0	30.0	0	0.0	NA	NA	3	13.6	0.0	29.7

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-5. Use of Sales Methods for Beef Producers, by Size (Small = 270, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S5.5* What types of valuation methods are used by your operation for selling fed cattle?												
1. Liveweight	44	79.9	69.0	90.8	11	73.3	48.0	98.7	55	79.9	69.1	90.7
2. Carcass weight not dependent on grid value	18	25.1	13.6	36.6	5	33.3	6.3	60.4	23	25.2	13.8	36.6
3. Carcass weight dependent on grid value	11	14.6	5.5	23.6	9	60.0	31.9	88.1	20	14.8	5.9	23.8
4. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 6-6. Terms of Sales Methods for Beef Producers, by Size (Small = 270, Large = 23)

	Small				Large				All Operations			
	n	**Mean**	**Lower**	**Upper**	**n**	**Mean**	**Lower**	**Upper**	**n**	**Mean**	**Lower**	**Upper**
S6.1 For what percentage of calves and cattle sold during the past year did the seller (your operation) pay for transportation?	201	53.1	46.3	59.9	18	38.1	17.4	58.8	219	53.1	46.2	59.9
S6.2 What percentage of calves and cattle sold during the past year were under a written agreement (versus oral)?	199	12.4	8.0	16.9	19	56.7	36.7	76.6	218	12.5	8.1	17.0
	Small (n = 175)				**Large** (n = 18)				**All Operations** (n = 193)			
S6.3 For calves and cattle sold during the past year, what was the length of the agreement or contract (oral or written) (% of head)?												
a. Sales not under agreement or contract		79.4	73.6	85.3		31.0	10.5	51.5		79.4	73.5	85.2
b. Less than 6 months		14.8	9.7	19.9		31.9	10.1	53.8		14.8	9.8	19.9
c. 6 to 11 months		5.0	1.7	8.2		5.1	<0	12.4		5.0	1.7	8.2
d. 1 to 2 years		0.0	0.0	0.1		6.1	<0	16.8		0.0	0.0	0.1
e. 3 to 5 years		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
f. 6 to 10 years		0.0	0.0	0.1		0.0	0.0	0.0		0.0	0.0	0.1
g. More than 10 years or evergreen		0.7	<0	1.9		25.8	4.2	47.5		0.8	<0	1.9
Total		99.9†				99.9†				100.0		

† Total does not sum to 100% because of rounding.

(continued)

Table 6-6. Terms of Sales Methods for Beef Producers, by Size (Small = 270, Large = 23) (continued)

	Small (n = 185)			Large (n = 20)			All Operations (n = 205)		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
S6.4 For calves and cattle sold during the past year, how far in advance of delivery was the delivery scheduled (% of head)?									
a. Less than 7 days	63.7	56.8	70.7	30.5	12.7	48.3	63.6	56.7	70.6
b. 8 to 14 days	14.8	9.8	19.7	23.3	4.6	41.9	14.8	9.9	19.7
c. 15 to 21 days	5.6	2.3	8.9	1.3	<0	3.4	5.6	2.3	8.8
d. 22 to 30 days	6.1	2.6	9.6	11.7	1.2	22.1	6.1	2.6	9.6
e. 1 to 2 months	4.6	1.6	7.5	21.5	4.7	38.3	4.6	1.7	7.6
f. More than 2 months	5.2	2.0	8.4	11.9	<0	25.1	5.2	2.0	8.5
Total	100.0			100.2†			99.9†		

† Total does not sum to 100% because of rounding.

Table 6-7. Reasons for Using Sales Methods for Beef Producers, by Size (Small = 270, Large = 23)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S7.1* What are the three most important reasons why your operation only uses the cash or spot market for selling calves and cattle?	(results suppressed)				(results suppressed)							
1. Can sell calves and cattle at higher prices									78	40.9	33.6	48.2
2. Reduces risk exposure									22	11.8	7.0	16.7
3. Reduces costs of activities for selling calves and cattle									42	22.8	16.5	29.1
4. Reduces price variability for calves and cattle									16	8.4	4.3	12.5
5. Reduces potential liability and litigation concerns									7	4.0	1.1	7.0
6. Increases supply chain information									D	0.8	0.0	1.9
7. Allows for sale of higher quality calves and cattle									29	16.3	10.7	21.8
8. Facilitates or increases market access									22	11.6	6.8	16.4
9. Allows for adjusting operations quickly in response to changes in market conditions									44	23.1	16.8	29.3
10. Does not require identifying and recruiting long-term contracting partners									37	19.9	14.0	25.9
11. Does not require managing complex and costly contracts									45	24.8	18.4	31.3
12. Eliminates possible negative public perceptions about use of contracts									5	2.8	0.3	5.2
13. Allows for independence, complete control, and flexibility of own business									101	54.1	46.7	61.5

D = Results suppressed.
* Respondents could select multiple responses.

(continued)

Table 6-7. Reasons for Using Sales Methods for Beef Producers, by Size (Small = 270, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S7.1* (continued)	(results suppressed)				(results suppressed)							
14. Enhances ability to benefit from favorable market conditions									72	37.5	30.3	44.8
15. Other									D	1.2	0.0	3.0
16. No other choice *(write-in response)*									D	0.8	0.0	1.9
17. Can easily sell small number of animals *(write-in response)*									8	4.2	1.2	7.1
18. Convenience *(write-in response)*									5	3.0	0.4	5.6
S7.2* What are the three most important reasons why your operation uses alternative sales methods for selling calves and cattle?												
1. Can sell calves and cattle at higher prices	6	38.1	8.4	67.7	8	57.1	27.5	86.8	14	38.5	10.8	66.2
2. Reduces risk exposure	5	34.3	5.4	63.1	6	42.9	13.2	72.5	11	34.5	7.5	61.4
3. Reduces costs of activities for selling calves and cattle	D	12.9	0.0	32.8	D	7.1	0.0	22.6	3	12.8	0.0	31.4
4. Reduces price variability for calves and cattle	6	34.6	6.6	62.6	0	0.0	NA	NA	6	33.8	7.7	59.9
5. Reduces potential liability and litigation concerns	D	8.5	0.0	26.4	0	0.0	NA	NA	D	8.3	0.0	25.0
6. Increases supply chain information	D	4.4	0.0	14.2	D	7.1	0.0	22.6	D	4.5	0.0	13.6
7. Allows for sale of higher quality calves and cattle	7	52.3	22.0	82.7	3	21.4	0.0	46.0	10	51.6	23.2	80.0
8. Facilitates or increases market access	3	19.1	0.0	43.1	6	42.9	13.2	72.5	9	19.7	0.0	42.1
9. Increases flexibility in responding to consumer demand	D	10.2	0.0	31.4	0	0.0	NA	NA	D	10.0	0.0	29.7

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-7. Reasons for Using Sales Methods for Beef Producers, by Size (Small = 270, Large = 23) (continued)

	Small				Large				All Operations			
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
S7.2* (continued)												
10. Allows for product branding in retail sales	D	4.5	0.0	14.4	D	14.3	0.0	35.3	3	4.7	0.0	14.0
11. Allows for food safety and biosecurity assurances	0	0.0	NA	NA	D	7.1	0.0	22.6	D	0.2	0.0	0.5
12. Allows for product traceability	0	0.0	NA	NA	D	7.1	0.0	22.6	D	0.2	0.0	0.5
13. Improves week-to-week production management	D	9.0	0.0	22.9	D	28.6	1.5	55.6	6	9.4	0.0	22.5
14. Secures a buyer for calves and cattle	5	26.3	1.6	51.0	5	35.7	7.0	64.4	10	26.5	3.4	49.6
15. Provides detailed carcass data	D	20.4	0.0	48.0	D	14.3	0.0	35.3	4	20.3	0.0	46.1
16. Enhances access to credit	D	8.5	0.0	26.4	0	0.0	NA	NA	D	8.3	0.0	25.0
17. Other	0	0.0	NA	NA	D	14.3	0.0	35.3	D	0.3	0.0	0.8

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

6.2 PORK PRODUCERS

Table 6-8 provides weighted tabulations for all survey questions for pork producers (n = 229).[5] Tables 6-9 through 6-15 provide weighted tabulations for selected questions by size (n = 206 for small pork producers and n = 23 for large pork producers).

6.2.1 Characteristics of Pork Producer Operations

Most operations identified themselves as independent growers (82%); the remaining were contract growers or producers with production contracts (17%) or swine integrators with production facilities (7%). Almost 86% of operations conducted feeder-to-finish operations, 67% conducted wean-to-feeder operations, and 63% also conducted farrow-to-wean operations. Although not asked directly, some operations have multiple production segments, such as farrow-to-finish operations. (See Table 6-8, Questions 1.2 and 1.3.)

Operations reported having, on average, 528 nursery pigs, 696 weaned pigs, 925 feeder pigs, and 1,997 finishing hogs in their owned inventory on January 1, 2005. However, these mean values can be misleading because some operations are specialized and only have one category of hogs, while other operations may have some hogs in each category. Few producers had pigs or hogs at their operations that were owned by another operation or owned jointly with another operation. Although few operations owned pigs or hogs on contract farms operated by a different owner, of those that did own pigs or hogs on contract farms, the number of pigs or hogs was quite large. Specifically, for operations that owned finishing hogs on contract farms operated by a different owner, the average number of hogs was nearly 6,600. (See Table 6-8, Questions 9.3 and 9.4.)

More than three-fourths of pork producers participated in some type of certification program last year.

More than three-fourths of pork producers participated in some type of certification program last year. Seventy-four percent of operations participated in the Pork Quality Assurance (PQA) certification program, and 10% participated in an animal welfare certification program. (See Table 6-8, Question 1.4.)

[5] The survey results presented in this volume are weighted using the survey weighting procedures described in Section 5.1 of this volume. In contrast, some of the survey results presented in Volume 4 are recalculated using weights that are benchmarked to external counts obtained from the Pork Check-off Program.

Producers identified an average of three hog auctions and five buying stations operating within a 200-mile radius of their location. Most auctions and buying stations operate on a daily or weekly basis. (See Table 6-8, Questions 9.5 and 9.6.)

For most operations, the owner completed the questionnaire. Of these, 80% of respondents were over 45 years of age. Specifically, 41% were 46 to 55 years of age, and 38% were 56 or older. More than 40% of owner respondents have a college degree, and another 26% have some college or technical school training. About 35% of operations reported that total gross sales for pigs and hogs were less than $100,000, and an additional 35% had total gross sales of $100,000 to $500,000. Approximately 18% of operations reported total gross farm sales of less than $100,000, and 43% reported total gross farm sales between $100,000 and $500,000. For operations in which the owner completed the questionnaire, on average, 28% of household income came from off-farm sources. (See Table 6-8, Questions 9.7 through 9.12.)

6.2.2 Methods for Procuring Pigs by Pork Producers

Respondents included operations that produce pigs from sows, procure weaned pigs, and/or procure feeder pigs. For operations that procured weaned pigs from U.S. sources (including iso-weaned and nursery pigs), 55% procured less than 5,000 weaned pigs during the past year, 21% procured 5,000 to 9,999 pigs, and 24% procured 10,000 or more weaned pigs. For operations that procured feeder pigs from U.S sources, 53% procured less than 2,000 feeder pigs during the past year, 21% procured 2,000 to 4,999 pigs, and 26% procured 5,000 or more pigs. Few operations reported procuring weaner or feeder pigs or hogs from outside the United States. (See Table 6-8, Question 2.1.)

The most common ownership arrangement for pigs arriving on the farm was sole ownership. During the past year, 65% of pigs were owned solely by the operation, 26% were owned by an integrator or packer, and 8% were owned through partnership or other arrangements.[6] For 63% of the operations that received pigs, all of their pigs were owned solely by the

[6] These values were computed as the mean percentage of head weighted by the number of eligible operations. The other means were computed similarly (i.e., weighted by the number of eligible operations).

operation during the past year. Operations' ownership arrangements were similar 3 years ago and are not expected to change within the next 3 years. (See Table 6-8, Question 2.2.)

> Pork producers used a variety of purchase and pricing methods to procure pigs, including procurement or marketing contracts, production contracts, and marketing agreements. Spot market transactions were used to a lesser extent.

Pork producers used a variety of methods to receive or purchase pigs. During the past year, 27% of pigs were purchased using spot market transactions, 14% were purchased using procurement or marketing contracts, 35% were obtained using production contracts, 11% were purchased using marketing agreements, 9% were transferred internally, and 4% were procured using other methods. For 26% of operations, 100% of the pigs procured were from spot market transactions. In general, operations' purchase methods were very similar 3 years ago and are not expected to change within the next 3 years. (See Table 6-8, Question 2.3.)

Pork producers used a variety of methods for pricing pigs. Nearly 47% of operations used formula pricing, 31% used individually negotiated pricing, 27% used production contract terms, 11% used internal transfer pricing, and 9% used public auctions. The use of production contracts to price pigs is expected to increase some in the next 3 years (32% versus 27%), and negotiated pricing is expected to decline slightly. For producers using formula pricing, 60% used CME lean hog futures as the base price of the formula. To a much lesser extent, formulas were based on the USDA-quoted price and cost of production. (See Table 6-8, Questions 2.4 and 2.5.)

On average, 37% of all pigs were purchased using a slide. Buyers paid transportation costs in 43% of all transactions. Almost 32% of pigs were purchased under a written agreement. (See Table 6-8, Questions 2.6 through 2.8.)

Eleven respondents reported using procurement or marketing contracts to procure pigs during the past year. Because of the small number of respondents, we cannot characterize producers' use of procurement or marketing contracts. (See Table 6-8, Questions 3.1 through 3.3.)

Thirty-seven respondents reported using production contracts during the past year. For operations using production contracts, 58% had feeder-to-finish contracts, 25% had wean-to-finish contracts, 11% had farrow-to-wean contracts, and 7% had contracts for other stages of production. With the exception of feeder-to-finish contracts, we cannot characterize producers' use of production contracts because of the small number of respondents. Feeder-to-finish production contracts varied in contract length, with 36% of operations having contracts that were 3 to 5 years in length and 28% of operations having contracts that were 6 years or longer. However, 31% of operations had contracts that were for only one batch of pigs at a time.[7] Most specified payment per square foot of housing for each specified time period and/or payment per pig or hog delivered as the compensation formula. For contracts with efficiency adjustments, most specified a feed conversion efficiency and many specified a survivability premium to reduce death loss. Contracts specified a variety of terms; however, the most common term was to offer a minimum guaranteed payment for each batch of pigs. This minimum guarantee reduces the risk to the grower. While not specified, it is likely that the multiyear contracts are more recent and match the length of the loan for the contract building. Matching contract and loan lengths has been a common requirement of lenders since the early to mid-1990s. (See Table 6-8, Questions 4.1 through 4.5.)

For producers that only used spot market transactions to procure pigs, the two most frequently cited reasons for doing so were (1) "Allows for independence, complete control, and flexibility of own business" (71%) and (2) "Can purchase pigs at lower prices" (46%). One-third of producers reported "Allows for adjusting operations quickly in response to changes in market conditions" and "Enhances ability to benefit from favorable market conditions" as important reasons for only buying on the spot market. For producers that used AMAs to procure pigs, the three most frequently cited reasons for doing so were (1) "Reduces risk exposure" (62%), (2) "Reduces price variability for pigs" (53%), and "Secures higher quality pigs" (44%). Thus, these producers value AMAs because they help mitigate risk in procurement transactions. (See Table 6-8, Questions 5.1 and 5.2.)

[7] Respondents could select multiple responses.

6.2.3 Methods for Selling or Transferring Pigs and Hogs by Pork Producers

Most pork producers responding to the survey sell or ship market hogs; fewer respondents sell or ship weaned and feeder pigs. Most producers are small operations and sell or ship fewer than 2,000 pigs or hogs each year. For operations that sell or ship weaned pigs, 44% sold or shipped fewer than 2,000 pigs during the past year, 37% sold or shipped 2,000 to 19,999 pigs, and 19% sold or shipped 20,000 or more pigs. For operations that sell or ship feeder pigs, 68% sold or shipped fewer than 2,000 pigs during the past year, 21% sold or shipped 2,000 to 19,999 pigs, and 11% sold or shipped 20,000 or more pigs. For operations that sell or ship market hogs, 54% sold or shipped fewer than 2,000 hogs during the past year, 40% sold or shipped 2,000 to 19,999 hogs, and 6% sold or shipped 20,000 or more hogs. (See Table 6-8, Question 6.1.)

More pork producers (but with fewer hogs) relied on the spot market to sell pigs and hogs, but some producers (with more hogs) used AMAs such as marketing agreements, procurement or marketing contracts, and production contracts.

Pork producers used a variety of methods to sell or transfer pigs and hogs. During the past year, 61% of pigs and hogs were sold using spot market transactions, 16% were sold using marketing agreements, 9% were sold using procurement or marketing contracts, 7% were sold using production contracts, and 7% were sold using other methods. For 57% of producers, all pig and hog sales were through spot market transactions. Sales methods were very similar 3 years ago; however, spot market transactions are expected to decline slightly in the next 3 years, as is the number of producers that use only spot markets. (See Table 6-8, Question 6.2.)

Likewise, a variety of pricing methods were employed to sell pigs and hogs. About 53% of operations used formula pricing, 49% used individually negotiated pricing, 14% used public auctions, and 2% used production contracts to price pigs and hogs. The use of production contract terms is expected to increase slightly in the next 3 years. Because of the small number of respondents, we cannot characterize the base used to price weaned and feeder pigs sold using formula pricing. For operations that sell market hogs using formula pricing, 50% used individual or multiple-plant average price as the base and 30% used USDA dressed or carcass quote as the base. For operations that sell market hogs, 70% used carcass weight dependent on merit as the valuation method, and 36% used liveweight. (See Table 6-8, Questions 6.3 through 6.5.)

On average, 30% of all pigs and hogs were sold using a slide. Sellers paid transportation costs in 67% of all transactions. Almost 18% of pigs and hogs were sold under a written agreement. (See Table 6-8, Questions 6.6 through 6.8.)

Eighteen respondents reported using procurement or marketing contracts to sell pigs and hogs during the past year. Operations with procurement or marketing contracts most often had only one contract, but some reported selling pigs and hogs under two contracts. Most pigs and hogs were sold under contracts with a length of 1 to 2 years, but 22% were in 3- to 5-year contracts, and more than 18% were in contracts longer than 10 years in length. Producers specified a variety of terms in their procurement or marketing contracts. The most common terms specified the number of pigs or hogs to be delivered during each period and required the producer to be PQA certified. Other contract terms addressed quality of hogs and changes to carcass pricing grid, without producer's consent. (See Table 6-8, Questions 7.1 through 7.3.)

For producers that used only spot market transactions, the three most frequently cited reasons for doing so were as follows: (1) "Allows for independence, complete control, and flexibility of own business" (80%), (2) "Enhances ability to benefit from favorable market conditions" (41%), and (3) "Can sell pigs and hogs at higher prices" (35%). These producers value the independence and flexibility offered by spot market transactions. For producers that used AMAs, the three most frequently cited reasons for doing so were (1) "Reduces risk exposure" (76%), (2) "Reduces price variability for pigs and hogs" (44%), and (3) "Secures a buyer for pigs and hogs" (39%). These producers value AMAs because they help mitigate risk in sales transactions. (See Table 6-8, Questions 8.1 and 8.2.)

6.2.4 Pork Producers' Marketing Practices, by Size of Operation

Of the 89 respondents that provided information on their marketing practices for procuring pigs, fewer than 10 respondents were large operations. Because of the small number of large operations, we cannot compare differences in pig procurement practices by size of operation. (See Tables 6-9 through 6-12.) However, we can compare differences in pig and hog sales practices, as described below.

Large producers were more likely than small producers to use AMAs to sell pigs and hogs.

During the past year, small producers sold an average of 10,800 weaned pigs, 4,400 feeder pigs, and 4,300 market hogs. Large producers sold an average of 62,800 weaned pigs, 45,400 feeder pigs, and 171,100 market hogs. Large producers were more likely than small producers to use AMAs to sell pigs and hogs. During the past year, large producers sold 77% of their pigs and hogs using AMAs, and small producers sold 36% of their pigs and hogs using AMAs. For large producers, the most common types of AMAs included marketing agreements and production contracts. Only 17% of large producers sold all of their pigs or hogs using spot market transactions compared with 58% of small producers. (See Table 6-13, Questions S6.1 and S6.2.)

Both large and small producers used a variety of methods to price pigs and hogs. The majority used formula pricing for selling pigs and hogs (73% of large producers and 53% of small producers). About 40% of large producers and 49% of small producers used individually negotiated pricing. Almost 27% of large producers and less than 2% of small producers used production contract terms, and 7% of large producers and 14% of small producers used public auctions to sell pigs and hogs. Similar valuation methods were employed by small and large producers for selling market hogs, with carcass weight dependent on merit being the most frequently cited valuation method. (See Table 6-13, Questions S6.3 and 6.5.)

Large producers tended to use slides to sell pigs and hogs more often compared with small producers (56% versus 28% of total head sold). Small producers paid to transport more of their pigs and hogs compared with large producers (68% versus 46% of total head sold). Large producers were more likely than small producers to use written contracts (61% versus 17% of total head sold). (See Table 6-13, Questions 6.6 through 6.8.)

Because of the small number of respondents, we cannot compare the terms of procurement or marketing contracts by size of operation. Likewise, we cannot compare producers' reasons for using the spot market or AMAs by size of operation because of the small number of respondents. (See Tables 6-14 and 6-15.)

6.2.5 Pork Producer Survey Summary

> The majority of pork producers used AMAs in addition to or instead of the cash market for purchasing pigs. Conversely, the majority of pork producers relied primarily on spot market transactions for selling pigs and hogs.

The majority of pork producers used AMAs in addition to or instead of the cash market for purchasing pigs. Producers used production contracts, procurement or marketing contracts, and marketing agreements to purchase pigs. Producers used AMAs to reduce risk exposure, reduce price variability, and secure higher quality pigs. A variety of pricing methods were employed to purchase pigs and hogs, including formula pricing, individually negotiated pricing, and public auctions. Nearly one-third of pigs were purchased under written agreements.

Conversely, the majority of pork producers relied primarily on spot market transactions for selling pigs and hogs because they believe they get higher prices and because the cash market allows for greater independence and enhances the ability to benefit from favorable market conditions. Compared with small producers, large producers were more likely to use AMAs to sell pigs and hogs. For producers using AMAs, the most common type of arrangement was a marketing agreement. A variety of pricing methods were employed to sell pigs and hogs, including formula pricing, individually negotiated pricing, and public auctions. Less than 20% of pigs and hogs were sold under a written agreement.

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229)

		n	%	Lower	Upper
1.2*	Which of the following describes your operation during the past year?				
	1. Independent grower	175	81.9	76.6	87.1
	2. Contract grower (producer with production contract)	39	17.2	12.0	22.4
	3. Swine integrator with production facilities	21	7.0	3.6	10.4
	4. Swine integrator without production facilities	0	0.0	NA	NA
	5. Packer-owned farm	0	0.0	NA	NA
	6. Other	0	0.0	NA	NA
1.3*	What types of activities were conducted at this location during the past year?				
	1. Farrow to wean	146	62.6	56.0	69.2
	2. Wean to feeder	154	67.3	60.9	73.7
	3. Feeder to finish	192	85.6	80.8	90.4
1.4*	What types of certification programs did your operation participate in during the past year?				
	4. None	50	24.4	18.4	30.4
	5. Organic certification	0	0.0	NA	NA
	6. Animal welfare certification	24	10.4	6.1	14.6
	7. Pork Quality Assurance (PQA) certification	164	73.6	67.5	79.8
	8. Third-party certification of breed or livestock quality (for example, Berkshire Gold)	9	3.2	0.8	5.7
	9. Own-company certification of breed or livestock quality	4	1.2	0.0	2.6
	10. Buyer certification of breed or livestock quality	6	2.6	0.4	4.8
	11. Other	D	0.6	0.0	1.6
	12. Trucker quality assurance *(write-in response)*	3	1.5	0.0	3.2

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

A description of the notation used in the table headers is provided below.
n = number of respondents
% = estimated proportion weighted by the number of eligible operations
Mean = estimated mean weighted by the number of eligible operations
Lower = lower bound of the 95% confidence interval for the weighted proportion or mean
Upper = upper bound of the 95% confidence interval for the weighted proportion or mean

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

		U.S. Sources				Outside the United States			
		n	Mean	Lower	Upper	n	Mean	Lower	Upper
2.1a	How many weaned pigs (including iso-weaned and nursery pigs) did your operation receive or purchase during the past year?	43	9,384.7	5,020.6	13,748.8	D	(results suppressed)		
		n	%	Lower	Upper	n	%	Lower	Upper
	1–1,999	9	23.3	9.4	37.1		(results suppressed)		
	2,000–4,999	13	31.4	16.2	46.5				
	5,000–9,999	8	20.7	7.4	34.0				
	10,000–19,999	4	10.3	0.3	20.3				
	20,000 or more	9	14.4	3.3	25.4				
	Total		100.1						
		n	Mean	Lower	Upper	n	Mean	Lower	Upper
2.1b	How many feeder pigs did your operation receive or purchase during the past year?	56	4,447.5	1,913.2	6,981.8	5	5,792.0	2,199.2	9,384.8
		n	%	Lower	Upper	n	%	Lower	Upper
	1–499	16	29.3	16.5	42.0		(results suppressed)		
	500–1,999	13	23.5	11.6	35.4				
	2,000–4,999	11	21.3	9.8	32.8				
	5,000–9,999	9	17.4	6.7	28.1				
	10,000 or more	7	8.6	1.0	16.1				
	Total		100.1†						

D = Results suppressed.
NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

	3 Years Ago (n = 86)				During Past Year (n = 89)				Expected in 3 Years (n = 86)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
2.2 For all pigs received or purchased by your operation, what were the ownership arrangements (% of head)?												
a. Sole ownership by your operation		66.5	56.1	76.9		65.2	55.0	75.5		64.9	54.5	75.3
b. Partner arrangement		5.5	0.6	10.5		7.4	2.0	12.8		7.7	2.0	13.3
c. Shared ownership		1.3	<0	3.8		0.6	<0	1.8		0.6	<0	1.9
d. Joint venture		0.0	0.0	0.0		0.3	<0	0.9		0.6	<0	1.9
e. Owned by integrator or packer (other than your operation)		26.7	16.9	36.5		26.5	16.9	36.0		26.2	16.5	35.9
f. Other		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Total		100.0				100.0				100.0		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Operations for which 100% are sole ownership	55	65.2	54.5	75.8	56	63.3	52.8	73.9	54	63.2	52.5	73.9

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

	3 Years Ago (n = 77)			During Past Year (n = 85)			Expected in 3 Years (n = 78)		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
2.3 What methods are used by your operation for receiving or purchasing pigs (% of head)?									
a. Auction barns	4.4	<0	8.9	4.9	0.3	9.5	3.8	<0	8.2
b. Video/electronic auctions	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
c. Dealers or brokers	8.6	1.9	15.3	8.7	2.4	15.0	7.0	1.0	13.1
d. Direct trade	12.7	5.0	20.4	12.6	5.3	19.9	11.0	3.8	18.1
e. Procurement or marketing contract	10.9	3.7	18.1	13.6	6.0	21.2	14.9	6.7	23.2
f. Production contract with packer or integrator	17.5	8.5	26.5	17.0	8.6	25.4	18.7	9.5	27.9
g. Production contract with weaner or feeder pig producer	17.3	8.3	26.3	18.1	9.4	26.8	19.9	10.4	29.3
h. Forward contract	0.0	0.0	0.0	1.3	<0	3.8	1.4	<0	4.2
i. Marketing agreement	11.4	3.8	19.0	10.9	4.0	17.8	10.5	3.4	17.7
j. Internal transfer	13.0	5.1	20.8	9.1	2.8	15.4	10.0	3.0	16.9
k. Other	2.9	<0	6.8	2.6	<0	6.1	1.4	<0	4.2
l. Receive through co-op *(write-in response)*	1.4	<0	4.3	1.3	<0	3.8	1.4	<0	4.2
Total	100.1†			100.1†			100.0		

	3 Years Ago				During Past Year				Expected in 3 Years			
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Operations for which 100% are cash or spot market purchases	18	25.7	15.2	36.1	20	25.6	15.7	35.5	15	21.1	11.4	30.8

† Total does not sum to 100% because of rounding.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
2.4* What types of pricing methods are used by your operation for purchasing pigs?								
1. Individually negotiated pricing	23	30.5	19.3	41.7	18	27.2	15.7	38.7
2. Public auction	6	9.0	2.0	16.0	4	6.7	0.2	13.2
3. Sealed bid	0	0.0	NA	NA	0	0.0	NA	NA
4. Formula pricing (using another price as the base)	34	46.9	34.7	59.1	30	47.3	34.3	60.2
5. Internal transfer	10	11.1	3.6	18.6	10	12.4	4.0	20.8
6. Production contract terms	19	27.1	16.2	37.9	20	32.0	19.9	44.1
7. Other	0	0.0	NA	NA	0	0.0	NA	NA
8. Co-op shares *(write-in response)*	D	3.0	0.0	7.2	D	1.7	0.0	5.0

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

		n	%	Lower	Upper
2.5*	For pigs purchased by your operation during the past year using formula pricing, what was the base price of the formula?				
	1. USDA live quote	5	16.4	2.5	30.4
	2. Chicago Mercantile Exchange (CME) lean hog futures	20	60.1	41.8	78.4
	3. Subscription service price (for example, Urner Barry)	0	0.0	NA	NA
	4. Cost of production	7	17.4	3.4	31.3
	5. Other market price	D	6.6	0.0	15.9
	6. Other	D	3.3	0.0	10.0
		n	**Mean**	**Lower**	**Upper**
2.6	What percentage of pigs purchased during the past year were purchased using a slide?	62	36.7	24.3	49.1
2.7	What percentage of pigs purchased during the past year did the buyer (your operation) pay for transportation?	62	43.1	30.6	55.7
2.8	What percentage of pigs purchased during the past year were under a written agreement (versus oral)?	62	31.6	19.5	43.6
		n	**%**	**Lower**	**Upper**
3.1	With how many pork producers did your operation maintain procurement or marketing contracts for purchasing pigs during the past year?				
	1. One	11	90.3	68.6	100.0
	2. Two	D	9.7	0.0	31.4
	3. Three to five	0	0.0	NA	NA
	4. Six to ten	0	0.0	NA	NA
	5. More than ten	0	0.0	NA	NA
	Total		100.0		
			Mean (n = 11)	**Lower**	**Upper**
3.2	For pigs purchased under a procurement or marketing contract during the past year, what was the length of the contract (% of head)?				
	a. Less than 6 months		21.5	<0	53.8
	b. 6 to 11 months		0.0	0.0	0.0
	c. 1 to 2 years		0.0	0.0	0.0
	d. 3 to 5 years		12.3	<0	36.9
	e. 6 to 10 years		12.3	<0	36.9
	f. More than 10 years or evergreen		53.9	15.3	92.4
	Total		100.0		

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

		n	%	Lower	Upper
3.3*	Which of the following terms were specified in the procurement or marketing contracts used by your operation during the past year?				
	1. Number of pigs to be delivered each specified time period	9	70.8	37.7	100.0
	2. Average weight of pigs	7	51.4	15.3	87.5
	3. Quality of pigs	10	80.5	51.7	100.0
	4. Producer must sell 100 percent of production to your operation	D	9.7	0.0	31.4
	5. Minimum guaranteed price for pigs	4	38.9	3.5	74.3
	6. Includes a ledger account	0	0.0	NA	NA
	7. Includes a price window	D	19.5	0.0	48.3
	8. Specifications for production facilities	D	9.7	0.0	31.4
	9. Breeding/genetics used by producer	6	50.0	13.8	86.2
	10. Feeding programs used by producer	4	38.9	3.5	74.3
	11. Producer must be Pork Quality Assurance (PQA) certified	6	50.0	13.8	86.2
	12. Allows your operation to inspect and monitor production facilities	4	30.5	0.0	63.8
	13. Includes definition of viable or acceptable pig	8	61.1	25.7	96.5
	14. Price adjustment for single or multiple source pigs	0	0.0	NA	NA
	15. None of the above	D	9.7	0.0	31.4

		Mean (n = 37)	Lower	Upper
4.1	What types of contracts did your operation have during the past year for the production of pigs or hogs (% of head)?			
	a. Farrow to wean	10.8	0.3	21.2
	b. Farrow to feeder	0.0	0.0	0.0
	c. Farrow to finish	1.5	<0	4.5
	d. Wean to feeder	5.6	<0	12.5
	e. Wean to finish	24.6	9.6	39.7
	f. Feeder to finish	57.5	40.7	74.2
	g. Other	0.0	0.0	0.0
	Total	100.0		

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

	Farrow to Wean				Farrow to Feeder				Farrow to Finish			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
4.2* What was the length of the production contracts used by your operation during the past year?												
1. One batch of pigs or hogs at a time	0	0.0	NA	NA	(n = 0)				(results suppressed)			
2. Less than 1 year	0	0.0	NA	NA								
3. 1 to 2 years	5	74.2	15.5	100.0								
4. 3 to 5 years	0	0.0	NA	NA								
5. 6 to 10 years	D	25.8	0.0	84.5								
6. More than 10 years	D	22.6	0.0	80.7								
	Wean to Feeder				**Wean to Finish**				**Feeder to Finish**			
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
1. One batch of pigs or hogs at a time	D	22.6	0.0	80.7	0	0.0	NA	NA	8	31.3	11.1	51.4
2. Less than 1 year	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
3. 1 to 2 years	D	25.8	0.0	84.5	0	0.0	NA	NA	3	9.4	0.0	21.9
4. 3 to 5 years	4	51.6	0.0	100.0	6	61.0	21.5	100.0	9	35.6	14.8	56.4
5. 6 to 10 years	0	0.0	NA	NA	3	25.4	0.0	60.8	7	23.1	4.9	41.3
6. More than 10 years	0	0.0	NA	NA	D	13.5	0.0	40.7	D	5.0	0.0	14.1

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

	Farrow to Wean				Farrow to Feeder				Farrow to Finish			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
4.3* What was the compensation formula for production contracts used by your operation during the past year?												
1. Payment per square foot of housing for each specified time period	D	2.6	0.0	9.0	(n = 0)				(results suppressed)			
2. Payment per pig or hog delivered	7	81.6	36.5	100.0								
3. Payment per pound of weight gain	0	0.0	NA	NA								
4. Other	D	18.4	0.0	63.5								
	Wean to Feeder				**Wean to Finish**				**Feeder to Finish**			
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
1. Payment per square foot of housing for each specified time period	5	74.2	15.5	100.0	6	68.2	18.9	100.0	11	38.8	17.1	60.6
2. Payment per pig or hog delivered	D	25.8	0.0	84.5	D	31.8	0.0	81.1	11	46.7	24.4	69.1
3. Payment per pound of weight gain	0	0.0	NA	NA	0	0.0	NA	NA	7	28.3	8.1	48.5
4. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

	Farrow to Wean				Farrow to Feeder				Farrow to Finish			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
4.4* What type of efficiency adjustments were used as part of the compensation formula for production contracts used by your operation during the past year?												
1. Feed conversion efficiency	D	30.5	0.0	100.0	(n = 0)				(results suppressed)			
2. Livability/survivability	D	30.5	0.0	100.0								
3. Preferred weight category	0	0.0	NA	NA								
4. Comparison between your operation's performance and other growers' performance	0	0.0	NA	NA								
5. Comparison between your operation's performance and a fixed standard	0	0.0	NA	NA								
6. Pigs weaned per sow	5	100.0	100.0	100.0								
7. Back fat measurement within target range	0	0.0	NA	NA								
8. Quality defects (for example, abscesses or injuries)	D	4.3	0.0	18.0								
9. Other	0	0.0	NA	NA								

Note: Question 4.4 only applies to respondents that use efficiency adjustments.
D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

	Wean to Feeder				Wean to Finish				Feeder to Finish			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
4.4* (continued)												
1. Feed conversion efficiency	D	50.0	0.0	100.0	3	41.6	0.0	100.0	12	76.6	51.2	100.0
2. Livability/survivability	4	100.0	100.0	100.0	4	61.1	0.0	100.0	8	46.8	16.8	76.8
3. Preferred weight category	0	0.0	NA	NA	D	38.9	0.0	100.0	5	37.2	8.1	66.4
4. Comparison between your operation’s performance and other growers’ performance	0	0.0	NA	NA	D	19.5	0.0	73.5	4	29.8	2.1	57.5
5. Comparison between your operation’s performance and a fixed standard	0	0.0	NA	NA	0	0.0	NA	NA	D	8.5	0.0	24.6
6. Pigs weaned per sow	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
7. Back fat measurement within target range	0	0.0	NA	NA	0	0.0	NA	NA	D	14.9	0.0	36.5
8. Quality defects (for example, abscesses or injuries)	D	6.2	0.0	32.8	D	19.5	0.0	73.5	D	7.4	0.0	23.4
9. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

Note: Question 4.4 only applies to respondents that use efficiency adjustments.
D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

	Farrow to Wean				Farrow to Feeder				Farrow to Finish			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
4.5* Which of the following terms were specified in the production contracts used by your operation during the past year?												
1. Specifies minimum number of batches of pigs or hogs for each specified time period	D	18.9	0.0	67.6	(n = 0)				(results suppressed)			
2. Specifies genetics of pigs or hogs	D	21.6	0.0	70.7								
3. Offers minimum guaranteed payment for each batch	D	21.6	0.0	70.7								
4. Specifies that insurance premiums for pig or hog mortality are paid by grower	0	0.0	NA	NA								
5. Requires mandatory facilities/equipment upgrades	0	0.0	NA	NA								
6. Offers payment incentives for facilities/equipment upgrades	0	0.0	NA	NA								
7. Offers subsidized financing for facilities/equipment upgrades	0	0.0	NA	NA								
8. Requires mandatory arbitration for conflict resolution	D	21.6	0.0	70.7								
9. Allows contractor to change compensation formula without grower's consent	D	2.7	0.0	9.6								
10. Includes provision for dead on arrival, condemned, lightweight, or culled pigs or hogs	3	56.8	0.0	100.0								
11. Includes definition of viable or acceptable pig	3	40.5	0.0	100.0								
12. Other	0	0	NA	NA								

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

	Wean to Feeder				Wean to Finish				Feeder to Finish			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
4.5* Which of the following terms were specified in the production contracts used by your operation during the past year?												
1. Specifies minimum number of batches of pigs or hogs for each specified time period	D	41.3	0.0	100.0	D	24.1	0.0	100.0	4	25.7	1.7	49.7
2. Specifies genetics of pigs or hogs	0	0.0	NA	NA	D	24.1	0.0	100.0	D	12.8	0.0	31.3
3. Offers minimum guaranteed payment for each batch	3	52.9	0.0	100.0	3	51.7	0.0	100.0	12	60.5	33.9	87.2
4. Specifies that insurance premiums for pig or hog mortality are paid by grower	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
5. Requires mandatory facilities/equipment upgrades	0	0.0	NA	NA	0	0.0	NA	NA	D	6.4	0.0	20.0
6. Offers payment incentives for facilities/equipment upgrades	0	0.0	NA	NA	0	0.0	NA	NA	D	0.9	0.0	2.8
7. Offers subsidized financing for facilities/equipment upgrades	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
8. Requires mandatory arbitration for conflict resolution	D	5.8	0.0	24.4	0	0.0	NA	NA	D	7.3	0.0	21.0
9. Allows contractor to change compensation formula without grower's consent	D	5.8	0.0	24.4	0	0.0	NA	NA	D	7.3	0.0	21.0
10. Includes provision for dead on arrival, condemned, lightweight, or culled pigs or hogs	D	47.1	0.0	100.0	D	48.3	0.0	100.0	8	40.4	13.7	67.1
11. Includes definition of viable or acceptable pig	3	52.9	0.0	100.0	D	24.1	0.0	100.0	4	14.7	0.0	33.3
12. Other	0	0.0	NA	NA	0	0.0	NA	NA	D	0.9	0.0	2.8

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

		n	%	Lower	Upper
5.1*	What are the three most important reasons why your operation only uses the cash or spot market for purchasing pigs?				
	1. Can purchase pigs at lower prices	11	45.6	24.2	66.9
	2. Reduces risk exposure	6	21.3	3.9	38.7
	3. Reduces costs of activities for buying pigs	4	16.6	0.6	32.6
	4. Reduces price variability for pigs	D	8.3	0.0	20.1
	5. Reduces potential liability and litigation concerns	0	0.0	NA	NA
	6. Increases supply chain information	0	0.0	NA	NA
	7. Secures higher quality pigs	5	17.2	1.2	33.1
	8. Facilitates or increases market access	D	4.1	0.0	12.7
	9. Allows for adjusting operations quickly in response to changes in market conditions	8	33.1	12.9	53.4
	10. Does not require identifying and recruiting long-term contracting partners	D	4.1	0.0	12.7
	11. Does not require managing complex and costly contracts	3	12.4	0.0	26.6
	12. Eliminates possible negative public perceptions about use of contracts	0	0.0	NA	NA
	13. Allows for independence, complete control, and flexibility of own business	18	71.0	51.5	90.5
	14. Enhances ability to benefit from favorable market conditions	8	33.1	12.9	53.4
	15. Other	D	4.1	0.0	12.7
5.2*	What are the three most important reasons why your operation uses alternative purchase methods for purchasing pigs?				
	1. Can purchase pigs at lower prices	3	15.2	0.0	32.4
	2. Reduces risk exposure	13	61.6	38.8	84.4
	3. Reduces costs of activities for buying pigs	4	15.9	0.0	33.2
	4. Reduces price variability for pigs	13	52.9	29.3	76.5
	5. Reduces potential liability and litigation concerns	0	0.0	NA	NA
	6. Increases supply chain information	0	0.0	NA	NA
	7. Secures higher quality pigs	12	43.5	20.1	66.8
	8. Facilitates or increases market access	0	0.0	NA	NA
	9. Allows for food safety and biosecurity assurances	D	0.7	0.0	2.2
	10. Allows for product traceability	0	0.0	NA	NA
	11. Improves week-to-week supply management	4	11.6	0.0	26.2
	12. Improves efficiency of operations due to animal uniformity	10	42.0	18.7	65.4
	13. Reduces investment requirements for facilities and equipment	3	15.2	0.0	32.4
	14. Reduces operating capital requirements	4	15.9	0.0	33.2
	15. Enhances access to credit	0	0.0	NA	NA
	16. Other	3	15.2	0.0	32.4

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

		n	Mean	Lower	Upper
6.1a	How many weaned pigs did your operation sell or ship during the past year?	25	13,543.7	6,529.7	20,557.6
		n	**%**	**Lower**	**Upper**
	1–1,999	11	44.4	20.6	68.1
	2,000–9,999	3	15.8	0.0	33.5
	10,000–19,999	4	21.1	1.3	40.8
	20,000–49,999	3	11.3	0.0	26.3
	50,000 or more	4	7.5	0.0	18.6
	Total		100.1†		
		n	**Mean**	**Lower**	**Upper**
6.1b	How many feeder pigs did your operation sell or ship during the past year?	37	5,705.7	1,806.3	9,605.1
		n	**%**	**Lower**	**Upper**
	1–499	13	42.0	23.9	60.0
	500–1,999	9	26.3	10.1	42.4
	2,000–4,999	6	11.0	0.0	22.1
	5,000–19,999	4	10.1	0.0	21.1
	20,000 or more	5	10.6	0.0	21.6
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
6.1c	How many market hogs did your operation sell or ship during the past year?	198	6,299.8	4,468.1	8,131.4
		n	**%**	**Lower**	**Upper**
	1–499	36	19.5	13.8	25.3
	500–1,999	64	34.7	27.8	41.6
	2,000–4,999	36	19.5	13.8	25.3
	5,000–9,999	23	12.0	7.3	16.7
	10,000-19,999	16	8.2	4.2	12.2
	20,000–49,999	14	5.3	2.1	8.4
	50,000 or more	9	0.7	0.4	1.0
	Total		99.9†		

† Total does not sum to 100% because of rounding.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

	3 Years Ago (n = 207)				During Past Year (n = 212)				Expected in 3 Years (n = 199)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
6.2 What methods for selling or shipping pigs and hogs are used by your operation (% of head)?												
a. Auction barns		4.9	2.2	7.7		4.6	1.9	7.3		4.6	1.8	7.4
b. Video/electronic auctions		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
c. Dealers or brokers		9.1	5.1	13.2		9.0	5.1	13.0		7.8	4.0	11.6
d. Direct trade		46.3	39.5	53.1		47.5	40.7	54.2		42.2	35.5	49.0
e. Procurement or marketing contract		8.3	4.5	12.0		8.9	5.0	12.7		8.9	5.0	12.8
f. Production contract		9.3	5.2	13.4		7.4	3.8	11.0		8.6	4.7	12.6
g. Forward contract		1.7	0.3	3.1		2.6	1.0	4.2		4.6	2.3	7.0
h. Marketing agreement		17.9	12.5	23.2		15.6	10.7	20.6		18.4	13.0	23.7
i. Internal transfer		1.2	<0	2.7		2.0	0.1	3.8		2.2	0.2	4.3
j. Other		0.9	<0	2.2		0.9	<0	2.1		0.9	<0	2.3
k. Sold through co-op *(write-in response)*		0.5	<0	1.6		1.6	<0	3.3		1.7	<0	3.5
Total		100.1†				100.1†				99.9†		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are cash or spot market sales	110	57.3	50.3	64.3	113	57.0	50.0	64.0	90	48.8	41.5	56.1

† Total does not sum to 100% because of rounding.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
6.3* What types of pricing methods are used by your operation for selling pigs and hogs?								
1. Individually negotiated pricing	81	48.6	40.7	56.5	69	46.3	38.0	54.5
2. Public auction	22	13.5	8.1	18.9	21	14.2	8.4	20.0
3. Sealed bid	0	0.0	NA	NA	0	0.0	NA	NA
4. Formula pricing (using another price as the base)	92	52.9	45.0	60.7	82	53.0	44.7	61.3
5. Internal transfer	D	0.6	0.0	1.9	D	0.7	0.0	2.1
6. Production contract terms	7	2.3	0.1	4.5	13	6.8	2.7	10.8
7. Other	D	0.6	0.0	1.9	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

	Weaned Pigs				Feeder Pigs				Market Hogs			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
6.4* For pigs and hogs sold by your operation during the past year using formula pricing, what was the base price of the formula?												
1. Individual or multiple packing plant average price	D	17.7	0.0	43.9	0	0.0	NA	NA	49	50.0	39.7	60.3
2. USDA live quote	D	8.9	0.0	28.4	5	32.4	6.4	58.4	20	17.8	10.0	25.7
3. USDA dressed or carcass quote	0	0.0	NA	NA	D	13.0	0.0	31.7	33	30.0	20.6	39.4
4. Auction prices	4	35.5	2.8	68.1	9	58.4	31.4	85.3	6	6.5	1.4	11.5
5. Chicago Mercantile Exchange (CME) lean hog futures	6	38.0	5.3	70.6	D	1.8	0.0	3.8	13	12.2	5.5	18.8
6. Subscription service price (for example, Urner Barry)	0	0.0	NA	NA	0	0.0	NA	NA	D	1.1	0.0	3.2
7. Corn or soybean meal futures	D	8.9	0.0	28.4	D	6.5	0.0	20.2	D	2.2	0.0	5.2
8. Cost of production	0	0.0	NA	NA	0	0.0	NA	NA	5	3.5	0.0	7.2
9. Retail price	0	0.0	NA	NA	D	7.4	0.0	21.3	3	2.3	0.0	5.3
10. Other market price	0	0.0	NA	NA	0	0.0	NA	NA	D	2.2	0.0	5.2
11. Other	D	8.9	0.0	28.4	D	6.5	0.0	20.2	D	1.1	0.0	3.2

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
6.5* What types of valuation methods are used by your operation for selling market hogs?								
1. Liveweight	56	35.6	27.8	43.3	48	32.6	24.7	40.5
2. Carcass weight not dependent on merit	8	4.8	1.4	8.3	9	6.0	2.0	9.9
3. Carcass weight dependent on merit	114	70.1	62.7	77.6	109	72.2	64.6	79.8
4. Other	0	0.0	NA	NA	0	0.0	NA	NA

NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

		n	Mean	Lower	Upper
6.6	What percentage of pigs and hogs sold during the past year were sold using a slide?	169	27.9	21.1	34.8
6.7	For what percentage of pigs and hogs sold during the past year did the seller (your operation) pay for transportation?	170	67.3	60.1	74.5
6.8	What percentage of pigs and hogs sold during the past year were under a written agreement (versus oral)?	170	17.5	11.9	23.1
		n	**%**	**Lower**	**Upper**
7.1	With how many buyers did your operation maintain procurement or marketing contracts during the past year?				
	1. One	14	73.4	49.3	97.5
	2. Two	3	19.3	0.0	41.0
	3. Three to five	D	7.3	0.0	21.0
	4. Six to ten	0	0.0	NA	NA
	5. More than ten	0	0.0	NA	NA
	Total		100.0		
			Mean (n = 18)	**Lower**	**Upper**
7.2	For pigs and hogs sold under a procurement or marketing contract during the past year, what was the length of the contract (% of head)?				
	a. Less than 6 months		9.1	<0	24.1
	b. 6 to 11 months		2.0	<0	4.3
	c. 1 to 2 years		42.2	14.1	70.2
	d. 3 to 5 years		21.5	<0	44.7
	e. 6 to 10 years		6.9	<0	21.4
	f. More than 10 years or evergreen		18.3	<0	39.4
	Total		100.0		

D = Results suppressed.
NA = Confidence interval not calculable.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

		n	%	Lower	Upper
7.3*	Which of the following terms were specified in the procurement or marketing contracts used by your operation during the past year?				
	1. Number of pigs or hogs to be delivered each specified time period	16	86.3	66.5	100.0
	2. Average weight of pigs or hogs	8	43.1	15.1	71.2
	3. Quality of pigs or hogs	9	50.0	21.6	78.4
	4. Yield percentage of market hogs	4	21.6	0.0	44.8
	5. Producer must sell 100 percent of production to your operation	3	20.6	0.0	43.8
	6. Minimum guaranteed price for pigs or hogs	6	35.3	8.1	62.5
	7. Includes a ledger account	D	6.9	0.0	21.4
	8. Includes a price window	4	21.6	0.0	44.8
	9. Specifications for production facilities	0	0.0	NA	NA
	10. Breeding/genetics used by producer	D	13.7	0.0	33.5
	11. Feeding programs used by producer	D	6.9	0.0	21.4
	12. PSE requirements	0	0.0	NA	NA
	13. Producer must be Pork Quality Assurance (PQA) certified	14	72.5	47.0	98.1
	14. Allows packer to inspect and monitor production facilities	3	14.7	0.0	34.6
	15. Allows producer to visit and monitor packing facilities	D	7.8	0.0	22.5
	16. Allows packer to change carcass pricing grid without producer's consent	9	50.0	21.6	78.4
	17. Includes definition of viable or acceptable pig or hog	10	51.0	22.6	79.3
	18. Price adjustment for single or multiple sources of pigs or hogs	0	0.0	NA	NA
	19. None of the above	D	6.9	0.0	21.4

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

		n	%	Lower	Upper
8.1*	What are the three most important reasons why your operation only uses the cash or spot market for selling pigs and hogs?				
	1. Can sell pigs and hogs at higher prices	37	35.3	25.7	45.0
	2. Reduces risk exposure	12	11.4	5.0	17.8
	3. Reduces costs of activities for selling pigs and hogs	20	20.5	12.4	28.7
	4. Reduces price variability for pigs and hogs	3	3.1	0.0	6.6
	5. Reduces potential liability and litigation concerns	3	3.1	0.0	6.6
	6. Increases supply chain information	D	0.1	0.0	0.4
	7. Allows for sale of higher quality pigs	11	9.5	3.7	15.4
	8. Facilitates or increases market access	14	14.4	7.3	21.5
	9. Allows for adjusting operations quickly in response to changes in market conditions	20	19.6	11.6	27.7
	10. Does not require identifying and recruiting long-term contracting partners	17	16.6	9.1	24.1
	11. Does not require managing complex and costly contracts	24	24.6	15.9	33.3
	12. Eliminates possible negative public perceptions about use of contracts	D	2.1	0.0	4.9
	13. Allows for independence, complete control, and flexibility of own business	78	80.1	72.1	88.1
	14. Enhances ability to benefit from favorable market conditions	40	41.1	31.1	51.0
	15. Other	0	0.0	NA	NA
	16. No other choice *(write-in response)*	D	1.0	0.0	3.1
	17. Can easily sell small number of animals *(write-in response)*	7	7.2	2.0	12.4
	18. Convenience *(write-in response)*	3	3.1	0.0	6.6

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

		n	%	Lower	Upper
8.2*	What are the three most important reasons why your operation uses alternative sales methods for selling pigs and hogs?				
	1. Can sell pigs and hogs at higher prices	4	21.4	1.2	41.6
	2. Reduces risk exposure	16	76.4	56.1	96.6
	3. Reduces costs of activities for selling pigs and hogs	6	22.9	2.6	43.2
	4. Reduces price variability for pigs and hogs	10	44.3	20.1	68.5
	5. Reduces potential liability and litigation concerns	0	0.0	NA	NA
	6. Increases supply chain information	D	6.1	0.0	17.3
	7. Allows for sale of higher quality pigs	D	10.7	0.0	25.9
	8. Facilitates or increases market access	6	18.3	0.1	36.5
	9. Increases flexibility in responding to consumer demand	0	0.0	NA	NA
	10. Allows for product branding in retail sales	0	0.0	NA	NA
	11. Allows for food safety and biosecurity assurances	0	0.0	NA	NA
	12. Allows for product traceability	0	0.0	NA	NA
	13. Improves week-to-week production management	4	16.8	0.0	34.9
	14. Secures a buyer for pigs and hogs	9	38.9	15.2	62.7
	15. Provides detailed carcass data	4	16.8	0.0	34.9
	16. Enhances access to credit	3	11.4	0.0	26.8
	17. Other	0	0.0	NA	NA
		n	**Mean**	**Lower**	**Upper**
9.1	Approximately how many people (including yourself and family members) were employed for livestock production at your operation during the past year?				
	a. Full time	192	2.9	2.4	3.4
	b. Part time	125	1.8	1.6	2.0
	c. Seasonal	24	2.1	1.1	3.0
9.2	What is the total acreage of your operation used for livestock production?	212	463.7	391.3	536.0

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

	Owned by Your Operation				Owned by Another Operation				Owned Jointly with Another Operation			
	n	**Mean**	**Lower**	**Upper**	**n**	**Mean**	**Lower**	**Upper**	**n**	**Mean**	**Lower**	**Upper**
9.3 How many pigs and hogs were on your operation on January 1, 2005?												
a. Nursing pigs	121	528.3	356.3	700.3	4	2,967.7	<0	7,631.0	0	—	—	—
b. Weaned pigs	119	696.3	495.7	897.0	10	6,990.1	<0	16,548.3	D	(results suppressed)		
c. Feeder pigs	117	924.5	563.0	1,286.0	7	1,308.7	542.6	2,074.8	3	2,166.7	<0	6,528.7
d. Finishing hogs	161	1,997.4	1,153.5	2,841.2	19	4,592.3	115.5	9,069.1	3	1,633.3	<0	4,121.6
e. Sows	137	464.7	312.2	617.3	5	2,260.5	721.0	3,800.0	0	—	—	—
f. Boars	133	7.2	6.1	8.3	5	5.2	2.9	7.4	0	—	—	—
	n	**Mean**	**Lower**	**Upper**								
9.4 How many pigs and hogs owned by your operation were on contract farms operated by a different owner on January 1, 2005?												
a. Nursing pigs	D	(results suppressed)										
b. Weaned pigs	10	2,918.7	1,029.9	4,807.6								
c. Feeder pigs	10	4,122.1	569.6	7,674.6								
d. Finishing hogs	25	6,577.3	2,891.3	10,263.3								
e. Sows	4	7,912.5	<0	25,135.8								
f. Boars	3	11.3	<0	31.4								
	3 Years Ago				**Currently**							
	n	**Mean**	**Lower**	**Upper**	**n**	**Mean**	**Lower**	**Upper**				
9.5 How many auctions and buying stations operate for selling pigs and hogs within 200 miles of your operation?												
a. Hog auctions	115	3.3	2.7	3.9	122	2.6	2.1	3.1				
b. Buying stations	136	6.3	4.4	8.2	140	4.9	3.2	6.6				

D = Results suppressed.
NA = Confidence interval not calculable.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

	3 Years Ago				Currently			
	n	%	Lower	Upper	n	%	Lower	Upper
9.6* For the auction or buying station located closest to your operation, how often does it operate for selling pigs and hogs?								
1. Monthly	3	1.9	0.0	4.4	D	1.7	0.0	4.0
2. Every 2 weeks	3	1.9	0.0	4.4	6	5.0	1.0	8.9
3. Weekly	46	38.3	29.3	47.4	52	40.4	31.6	49.3
4. 2 times per week	D	1.8	0.0	4.2	11	9.2	3.9	14.4
5. 3 to 5 times per week	20	16.9	9.9	23.9	23	18.4	11.4	25.4
6. Daily	53	43.8	34.5	53.0	48	37.1	28.4	45.8
7. Other	D	0.9	0.0	2.6	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

		n	%	Lower	Upper
9.7	What were your operation's approximate total gross sales for pigs and hogs during the past year?				
	1. Under $99,999	71	35.2	28.6	41.9
	2. $100,000 to $499,999	71	35.2	28.6	41.9
	3. $500,000 to $999,999	20	10.0	5.8	14.3
	4. $1,000,000 to $2,499,999	18	6.9	3.4	10.4
	5. $2,500,000 to $4,999,999	14	4.9	2.0	7.8
	6. $5,000,000 to $19,999,999	6	0.9	0.0	1.9
	7. $20,000,000 to $49,999,999	4	0.7	0.0	1.7
	8. $50,000,000 to $99,999,999	4	1.6	0.0	3.3
	9. $100,000,000 to $499,999,999	7	3.1	0.7	5.5
	10. $500,000,000 or more	3	1.5	0.0	3.2
	Total		100.0		
9.8	What were your operation's approximate total gross sales for all farm outputs during the past year?				
	1. Under $99,999	38	18.0	12.6	23.3
	2. $100,000 to $499,999	87	43.0	36.2	49.9
	3. $500,000 to $999,999	33	16.3	11.2	21.5
	4. $1,000,000 to $2,499,999	22	9.6	5.6	13.7
	5. $2,500,000 to $9,999,999	21	7.4	3.9	11.0
	6. $10,000,000 to $19,999,999	5	0.3	0.1	0.6
	7. $20,000,000 to $49,999,999	4	0.7	0.0	1.7
	8. $50,000,000 to $99,999,999	0	0.0	NA	NA
	9. $100,000,000 to $499,999,999	6	2.1	0.2	4.1
	10. $500,000,000 or more	5	2.5	0.3	4.6
	Total		99.9†		
9.9	Which of the following best describes your position with this operation?				
	1. Owner	194	89.1	85.0	93.3
	2. Manager	19	6.3	3.1	9.5
	3. Family member (not owner or manager)	5	2.0	0.1	3.9
	4. Other hired employee	4	0.7	0.0	1.7
	5. Other	0	0.0	NA	NA
	6. Partner or co-owner *(write-in response)*	4	1.9	0.0	3.8
	Total		100.0		
9.10	If owner, what is your age?				
	1. Less than 25	0	0.0	NA	NA
	2. 26 to 35	7	3.8	1.0	6.6
	3. 36 to 45	31	16.5	11.1	21.9
	4. 46 to 55	79	41.4	34.2	48.6
	5. 56 to 65	52	26.6	20.2	33.0
	6. Older than 65	23	11.7	7.0	16.3
	Total		100.0		

NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.

(continued)

Table 6-8. Weighted Responses for the Pork Producer Survey (n = 229) (continued)

		n	%	Lower	Upper
9.11	If owner, what is your education level?				
	1. Less than high school graduate	D	1.1	0.0	2.6
	2. High school graduate/GED	55	29.7	23.0	36.3
	3. Some college or technical school, no degree	51	26.1	19.7	32.5
	4. College graduate	77	40.3	33.1	47.5
	5. Post-graduate	7	2.9	0.5	5.3
	Total		100.1†		
		n	**Mean**	**Lower**	**Upper**
9.12	If owner, what percentage of your total annual household income comes from off-farm sources?	192	28.3	23.9	32.7

D = Results suppressed.
† Total does not sum to 100% because of rounding.

Table 6-9. Use of Purchase Methods for Pork Producers, by Size (Small = 206, Large = 23)

		Small				Large				All Operations			
		n	Mean	Lower	Upper	n	Mean	Lower	Upper	n	Mean	Lower	Upper
S2.1a1	How many weaned pigs (including iso-weaned and nursery pigs) did your operation receive or purchase from U.S. sources during the past year?	38	7,054.9	4,452.1	9,657.7	5	134,680.0	<0	401,560.7	43	9,384.7	5,020.6	13,748.8
S2.1a2	How many weaned pigs (including iso-weaned and nursery pigs) did your operation receive or purchase from sources outside the U.S. during the past year?	(results suppressed)				(results suppressed)				(results suppressed)			
S2.1b1	How many feeder pigs did your operation receive or purchase from U.S. sources during the past year?	51	3,211.7	2,146.5	4,276.9	5	93,644.0	<0	327,442.9	56	4,447.5	1,913.2	6,981.8
S2.1b2	How many feeder pigs did your operation receive or purchase from sources outside the U.S. during the past year?	5	5,792.0	2,199.2	9,384.8	0	—	—	—	5	5,792.0	2,199.2	9,384.8

(continued)

Table 6-9. Use of Purchase Methods for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small (n = 82)				Large (n = 7)				All Operations (n = 89)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
S2.2 For all pigs received or purchased by your operation during the past year, what were the ownership arrangements (% of head)?												
a. Sole ownership by your operation		65.3	55.0	75.7		57.1	7.7	>100		65.2	55.0	75.5
b. Partner arrangement		7.3	1.8	12.8		14.3	<0	49.2		7.4	2.0	12.8
c. Shared ownership		0.6	<0	1.8		0.0	0.0	0.0		0.6	<0	1.8
d. Joint venture		0.3	<0	0.9		0.0	0.0	0.0		0.3	<0	0.9
e. Owned by integrator or packer (other than your operation)		26.4	16.7	36.1		28.6	<0	73.7		26.5	16.9	36.0
f. Other		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Total		99.9†				100.0				100.0		
	n	**%**	**Low**	**High**	**n**	**%**	**Low**	**High**	**n**	**%**	**Low**	**High**
Establishments for which 100% are sole ownership	52	63.4	52.8	74.1	4	57.1	7.7	100.0	56	63.3	52.8	73.9

† Total does not sum to 100% because of rounding.

(continued)

Table 6-9. Use of Purchase Methods for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small (n = 77)				Large (n = 8)				All Operations (n = 85)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
S2.3 What methods are used by your operation for receiving or purchasing pigs (% of head)?												
a. Auction barns		5.0	0.3	9.7		0.0	0.0	0.0		4.9	0.3	9.5
b. Video/electronic auctions		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
c. Dealers or brokers		8.8	2.4	15.2		0.0	0.0	0.0		8.7	2.4	15.0
d. Direct trade		12.8	5.4	20.2		0.0	0.0	0.0		12.6	5.3	19.9
e. Procurement or marketing contract		13.2	5.6	20.9		37.1	<0	80.0		13.6	6.0	21.2
f. Production contract with packer or integrator		16.9	8.3	25.4		25.0	<0	63.7		17.0	8.6	25.4
g. Production contract with weaner or feeder pig producer		18.2	9.4	27.0		12.5	<0	42.1		18.1	9.4	26.8
h. Forward contract		1.3	<0	3.9		0.4	<0	1.3		1.3	<0	3.8
i. Marketing agreement		11.0	4.0	18.1		0.0	0.0	0.0		10.9	4.0	17.8
j. Internal transfer		8.8	2.4	15.2		25.0	<0	63.7		9.1	2.8	15.4
k. Other		2.6	<0	6.2		0.0	0.0	0.0		2.6	<0	6.1
l. Receive through co-op *(write-in response)*		1.3	<0	3.9		0.0	0.0	0.0		1.3	<0	3.8
Total		99.9†				100.0				100.1†		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are cash or spot market purchases	20	25.6	15.7	35.5	0	—	—	—	20	25.6	15.7	35.5

† Total does not sum to 100% because of rounding.

(continued)

Table 6-9. Use of Purchase Methods for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S2.4* During the past year, what types of pricing methods were used by your operation for purchasing pigs?												
1. Individually negotiated pricing	20	30.3	18.9	41.7	3	42.9	0.0	92.3	23	30.5	19.3	41.7
2. Public auction	6	9.1	2.0	16.2	0	0.0	NA	NA	6	9.0	2.0	16.0
3. Sealed bid	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
4. Formula pricing (using another price as the base)	31	47.0	34.6	59.3	3	42.9	0.0	92.3	34	46.9	34.7	59.1
5. Internal transfer	7	10.6	3.0	18.2	3	42.9	0.0	92.3	10	11.1	3.6	18.6
6. Production contract terms	D	27.3	16.2	38.3	D	14.3	0.0	49.2	19	27.1	16.2	37.9
7. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
8. Co-op shares *(write-in response)*	D	3.0	0.0	7.3	0	0.0	NA	NA	D	3.0	0.0	7.2

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-9. Use of Purchase Methods for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S2.5* For pigs purchased by your operation during the past year using formula pricing, what was the base price of the formula?												
1. USDA live quote	5	16.7	2.5	30.8	0	0.0	NA	NA	5	16.4	2.5	30.4
2. Chicago Mercantile Exchange (CME) lean hog futures	D	60.0	41.4	78.6	D	66.7	0.0	100.0	20	60.1	41.8	78.4
3. Subscription service price (for example, Urner Barry)	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
4. Cost of production	D	16.7	2.5	30.8	D	66.7	0.0	100.0	7	17.4	3.4	31.3
5. Other market price	D	6.7	0.0	16.1	0	0.0	NA	NA	D	6.6	0.0	15.9
6. Other	D	3.3	0.0	10.2	0	0.0	NA	NA	D	3.3	0.0	10.0

	Small				Large				All Operations			
	n	Mean	Lower	Upper	n	Mean	Lower	Upper	n	Mean	Lower	Upper
S2.6* What percentage of pigs purchased during the past year were purchased using a slide?	57	37.0	24.4	49.6	5	10.0	<0	37.8	62	36.7	24.3	49.1
S2.7 For what percentage of pigs purchased during the past year did the buyer (your operation) pay for transportation?	57	43.4	30.7	56.1	5	20.0	<0	75.5	62	43.1	30.6	55.7
S2.8 What percentage of pigs purchased during the past year were under a written agreement (versus oral)?	57	30.7	18.5	42.9	5	100.0	100.0	100.0	62	31.6	19.5	43.6

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 6-10. Terms of Procurement or Marketing Contracts for Pork Producers, by Size (Small = 206, Large = 23)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S3.1 With how many pork producers did your operation maintain procurement or marketing contracts for purchasing pigs during the past year?												
1. One	(results suppressed)				(results suppressed)				11	90.3	68.6	100.0
2. Two									D	9.7	0.0	31.4
3. Three to five									0	0.0	NA	NA
4. Six to ten									0	0.0	NA	NA
5. More than ten									0	0.0	NA	NA
Total										100.0		

	Small (n = 9)			Large (n = 2)			All Operations (n = 11)		
	Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
S3.2 For pigs purchased under a procurement or marketing contract during the past year, what was the length of the contract (% of head)?									
a. Less than 6 months	(results suppressed)			(results suppressed)			21.5	<0	53.8
b. 6 to 11 months							0.0	0.0	0.0
c. 1 to 2 years							0.0	0.0	0.0
d. 3 to 5 years							12.3	<0	36.9
e. 6 to 10 years							12.3	<0	36.9
f. More than 10 years or evergreen							53.9	15.3	92.4
Total							100.0		

D = Results suppressed.
NA = Confidence interval not calculable.

(continued)

Table 6-10. Terms of Procurement or Marketing Contracts for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S3.3* Which of the following terms were specified in the procurement or marketing contracts used by your operation during the past year?												
1. Number of pigs to be delivered each specified time period	(results suppressed)				(results suppressed)				9	70.8	37.7	100.0
2. Average weight of pigs									7	51.4	15.3	87.5
3. Quality of pigs									10	80.5	51.7	100.0
4. Producer must sell 100 percent of production to your operation									D	9.7	0.0	31.4
5. Minimum guaranteed price for pigs									4	38.9	3.5	74.3
6. Includes a ledger account									0	0.0	NA	NA
7. Includes a price window									D	19.5	0.0	48.3
8. Specifications for production facilities									D	9.7	0.0	31.4
9. Breeding/genetics used by producer									6	50.0	13.8	86.2
10. Feeding programs used by producer									4	38.9	3.5	74.3
11. Producer must be Pork Quality Assurance (PQA) certified									6	50.0	13.8	86.2
12. Allows your operation to inspect and monitor production facilities									4	30.5	0.0	63.8
13. Includes definition of viable or acceptable pig									8	61.1	25.7	96.5
14. Price adjustment for single or multiple source pigs									0	0.0	NA	NA
15. None of the above									D	9.7	0.0	31.4

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 6-11. Terms of Production Contracts for Pork Producers, by Size (Small = 206, Large = 23)

	Small (n = 33)				Large (n = 4)				All Operations (n = 37)			
		Mean	Lower	Upper		Mean	Lower	Upper		Mean	Lower	Upper
S4.1 What types of contracts did your operation have during the past year for the production of pigs or hogs?												
a. Farrow to wean		10.6	0.0	21.2		21.0	<0	77.7		10.8	0.3	21.2
b. Farrow to feeder		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
c. Farrow to finish		1.5	<0	4.6		0.0	0.0	0.0		1.5	<0	4.5
d. Wean to feeder		5.6	<0	12.6		9.0	<0	25.7		5.6	<0	12.5
e. Wean to finish		25.0	9.6	40.4		2.5	<0	10.5		24.6	9.6	39.7
f. Feeder to finish		57.3	40.2	74.4		67.5	3.4	<0		57.5	40.7	74.2
g. Other		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Total		100.0				100.0				100.0		
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S4.2[a] What was the length of the feeder-to-finish production contracts used by your operation during the past year?												
1. One batch of pigs or hogs at a time	D	31.8	10.7	53.0	D	16.7	0.0	59.5	8	31.3	11.1	51.4
2. Less than 1 year	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
3. 1 to 2 years	D	9.1	0.0	22.1	D	16.7	0.0	59.5	3	9.4	0.0	21.9
4. 3 to 5 years	D	36.4	14.5	58.2	D	16.7	0.0	59.5	9	35.6	14.8	56.4
5. 6 to 10 years	D	22.7	3.7	41.7	D	33.3	0.0	87.5	7	23.1	4.9	41.3
6. More than 10 years	D	4.5	0.0	14.0	D	16.7	0.0	59.5	D	5.0	0.0	14.1

D = Results suppressed.
NA = Confidence interval not calculable.
[a] Results suppressed for all segments except feeder to finish.

(continued)

Table 6-11. Terms of Production Contracts for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small				Large				All Operations			
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
S4.3[a] What was the compensation formula for feeder-to-finish production contracts used by your operation during the past year?												
1. Payment per square foot of housing for each specified time period	8	38.1	15.4	60.7	3	60.0	0.0	100.0	11	38.8	17.1	60.6
2. Payment per pig or hog delivered	D	47.6	24.3	70.9	D	20.0	0.0	75.5	11	46.7	24.4	69.1
3. Payment per pound of weight gain	D	28.6	7.5	49.6	D	20.0	0.0	75.5	7	28.3	8.1	48.5
4. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
S4.4[a] What type of efficiency adjustments were used as part of the compensation formula for feeder-to-finish production contracts used by your operation during the past year?												
1. Feed conversion efficiency	D	76.9	50.4	100.0	D	66.7	0.0	100.0	12	76.6	51.2	100.0
2. Livability/survivability	D	46.2	14.8	77.5	D	66.7	0.0	100.0	8	46.8	16.8	76.8
3. Preferred weight category	5	38.5	7.9	69.1	0	0.0	NA	NA	5	37.2	8.1	66.4
4. Comparison between your operation's performance and other growers' performance	4	30.8	1.7	59.8	0	0.0	NA	NA	4	29.8	2.1	57.5
5. Comparison between your operation's performance and a fixed standard	D	7.7	0.0	24.5	D	33.3	0.0	100.0	D	8.5	0.0	24.6
6. Pigs weaned per sow	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
7. Back fat measurement within target range	D	15.4	0.0	38.1	0	0.0	NA	NA	D	14.9	0.0	36.5
8. Quality defects (for example, abscesses or injuries)	D	7.7	0.0	24.5	0	0.0	NA	NA	D	7.4	0.0	23.4
9. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

Note: Question 4.4 only applies to respondents that use efficiency adjustments.
D = Results suppressed.
NA = Confidence interval not calculable.
[a] Results suppressed for all segments except feeder to finish.

(continued)

Table 6-11. Terms of Production Contracts for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S4.5[a] Which of the following terms were specified in the feeder-to-finish production contracts used by your operation during the past year?												
1. Specifies minimum number of batches of pigs or hogs for each specified time period	4	26.7	1.3	52.0	0	0.0	NA	NA	4	25.7	1.7	49.7
2. Specifies genetics of pigs or hogs	D	13.3	0.0	32.8	0	0.0	NA	NA	D	12.8	0.0	31.3
3. Offers minimum guaranteed payment for each batch	9	60.0	31.9	88.1	3	75.0	0.0	100.0	12	60.5	33.9	87.2
4. Specifies that insurance premiums for pig or hog mortality are paid by grower	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
5. Requires mandatory facilities/equipment upgrades	D	6.7	0.0	21.0	0	0.0	NA	NA	D	6.4	0.0	20.0
6. Offers payment incentives for facilities/equipment upgrades	0	0.0	NA	NA	D	25.0	0.0	100.0	D	0.9	0.0	2.8
7. Offers subsidized financing for facilities/equipment upgrades	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
8. Requires mandatory arbitration for conflict resolution	D	6.7	0.0	21.0	D	25.0	0.0	100.0	D	7.3	0.0	21.0
9. Allows contractor to change compensation formula without grower's consent	D	6.7	0.0	21.0	D	25.0	0.0	100.0	D	7.3	0.0	21.0
10. Includes provision for dead on arrival, condemned, lightweight, or culled pigs or hogs	D	40.0	11.9	68.1	D	50.0	0.0	100.0	8	40.4	13.7	67.1
11. Includes definition of viable or acceptable pig	D	13.3	0.0	32.8	D	50.0	0.0	100.0	4	14.7	0.0	33.3
12. Other	0	0.0	NA	NA	D	25.0	0.0	100.0	D	0.9	0.0	2.8

D = Results suppressed.
NA = Confidence interval not calculable.
[a] Results suppressed for all segments except feeder to finish.

Table 6-12. Reasons for Using Purchase Methods for Pork Producers, by Size (Small = 206, Large = 23)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S5.1* What are the three most important reasons why your operation only uses the cash or spot market for purchasing pigs?	(results suppressed)				(results suppressed)							
1. Can purchase pigs at lower prices									11	45.6	24.2	66.9
2. Reduces risk exposure									6	21.3	3.9	38.7
3. Reduces costs of activities for buying pigs									4	16.6	0.6	32.6
4. Reduces price variability for pigs									D	8.3	0.0	20.1
5. Reduces potential liability and litigation concerns									0	0.0	NA	NA
6. Increases supply chain information									0	0.0	NA	NA
7. Secures higher quality pigs									5	17.2	1.2	33.1
8. Facilitates or increases market access									D	4.1	0.0	12.7
9. Allows for adjusting operations quickly in response to changes in market conditions									8	33.1	12.9	53.4
10. Does not require identifying and recruiting long-term contracting partners									D	4.1	0.0	12.7
11. Does not require managing complex and costly contracts									3	12.4	0.0	26.6
12. Eliminates possible negative public perceptions about use of contracts									0	0.0	NA	NA
13. Allows for independence, complete control, and flexibility of own business									18	71.0	51.5	90.5
14. Enhances ability to benefit from favorable market conditions									8	33.1	12.9	53.4
15. Other									D	4.1	0.0	12.7

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-12. Reasons for Using Purchase Methods for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S5.2* What are the three most important reasons why your operation uses alternative purchase methods for purchasing pigs?												
1. Can purchase pigs at lower prices	3	15.8	0.0	33.8	0	0.0	NA	NA	3	15.2	0.0	32.4
2. Reduces risk exposure	D	63.2	39.3	87.0	D	20.0	0.0	75.5	13	61.6	38.8	84.4
3. Reduces costs of activities for buying pigs	D	15.8	0.0	33.8	D	20.0	0.0	75.5	4	15.9	0.0	33.2
4. Reduces price variability for pigs	10	52.6	27.9	77.4	3	60.0	0.0	100.0	13	52.9	29.3	76.5
5. Reduces potential liability and litigation concerns	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
6. Increases supply chain information	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
7. Secures higher quality pigs	8	42.1	17.7	66.6	4	80.0	24.5	100.0	12	43.5	20.1	66.8
8. Facilitates or increases market access	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
9. Allows for food safety and biosecurity assurances	0	0.0	NA	NA	D	20.0	0.0	75.5	D	0.7	0.0	2.2
10. Allows for product traceability	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
11. Improves week-to-week supply management	D	10.5	0.0	25.7	D	40.0	0.0	100.0	4	11.6	0.0	26.2
12. Improves efficiency of operations due to animal uniformity	D	42.1	17.7	66.6	D	40.0	0.0	100.0	10	42.0	18.7	65.4
13. Reduces investment requirements for facilities and equipment	3	15.8	0.0	33.8	0	0.0	NA	NA	3	15.2	0.0	32.4
14. Reduces operating capital requirements	D	15.8	0.0	33.8	D	20.0	0.0	75.5	4	15.9	0.0	33.2
15. Enhances access to credit	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
16. Other	3	15.8	0.0	33.8	0	0.0	NA	NA	3	15.2	0.0	32.4

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 6-13. Use of Sales Methods for Pork Producers, by Size (Small = 206, Large = 23)

		Small				Large				All Operations			
		n	Mean	Lower	Upper	n	Mean	Lower	Upper	n	Mean	Lower	Upper
S6.1a	How many weaned pigs did your operation sell or ship during the past year?	18	10,835.9	4,057.2	17,614.7	7	62,812.7	<0	132,801.7	25	13,543.7	6,529.7	20,557.6
S6.1b	How many feeder pigs did your operation sell or ship during the past year?	30	4,397.4	1,187.7	7,607.1	7	45,382.1	<0	135,467.8	37	5,705.7	1,806.3	9,605.1
S6.1c	How many market hogs did your operation sell or ship during the past year?	182	4,252.2	3,274.2	5,230.2	16	171,109.5	34,014.2	308,204.8	198	6,299.8	4,468.1	8,131.4

(continued)

Table 6-13. Use of Sales Methods for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small (n = 189)				Large (n = 23)				All Operations (n = 212)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
S6.2 What methods for selling or shipping pigs and hogs were used by your operation during the last year (% of head)?												
a. Auction barns		4.7	1.9	7.4		0.2	<0	0.7		4.6	1.9	7.3
b. Video/electronic auctions		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
c. Dealers or brokers		9.0	5.0	13.0		10.0	<0	22.4		9.0	5.1	13.0
d. Direct trade		48.1	41.2	54.9		12.7	1.0	24.3		47.5	40.7	54.2
e. Procurement or marketing contract		8.8	4.8	12.7		17.0	2.2	31.7		8.9	5.0	12.7
f. Production contract		7.1	3.5	10.8		21.7	3.5	40.0		7.4	3.8	11.0
g. Forward contract		2.5	0.9	4.1		4.3	<0	13.4		2.6	1.0	4.2
h. Marketing agreement		15.4	10.3	20.5		29.7	10.5	49.0		15.6	10.7	20.6
i. Internal transfer		1.9	0.1	3.8		4.3	<0	13.4		2.0	0.1	3.8
j. Other		0.9	<0	2.2		0.0	0.0	0.0		0.9	<0	2.1
k. Sold through co-op *(write-in response)*		1.6	<0	3.4		0.0	0.0	0.0		1.6	<0	3.3
Total		100.0				99.9†				100.1†		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are cash or spot market sales	109	57.7	50.6	64.8	4	17.4	0.6	34.2	113	57.0	50.0	64.0

† Total does not sum to 100% because of rounding.

(continued)

Table 6-13. Use of Sales Methods for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S6.3* What types of pricing methods were used by your operation for selling pigs and hogs during the last year?												
1. Individually negotiated pricing	75	48.7	40.7	56.7	6	40.0	11.9	68.1	81	48.6	40.7	56.5
2. Public auction	D	13.6	8.2	19.1	D	6.7	0.0	21.0	22	13.5	8.1	18.9
3. Sealed bid	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
4. Formula pricing (using another price as the base)	81	52.6	44.6	60.6	11	73.3	48.0	98.7	92	52.9	45.0	60.7
5. Internal transfer	D	0.6	0.0	1.9	0	0.0	NA	NA	D	0.6	0.0	1.9
6. Production contract terms	3	1.9	0.0	4.2	4	26.7	1.3	52.0	7	2.3	0.1	4.5
7. Other	D	0.6	0.0	1.9	0	0.0	NA	NA	D	0.6	0.0	1.9

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-13. Use of Sales Methods for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S6.4a* For weaned pigs sold by your operation during the past year using formula pricing, what was the base price of the formula?	(results suppressed)				(results suppressed)							
1. Individual or multiple packing plant average price									D	17.7	0.0	43.9
2. USDA live quote									D	8.9	0.0	28.4
3. USDA dressed or carcass quote									0	0.0	NA	NA
4. Auction prices									4	35.5	2.8	68.1
5. Chicago Mercantile Exchange (CME) lean hog futures									6	38.0	5.3	70.6
6. Subscription service price (for example, Urner Barry)									0	0.0	NA	NA
7. Corn or soybean meal futures									D	8.9	0.0	28.4
8. Cost of production									0	0.0	NA	NA
9. Retail price									0	0.0	NA	NA
10. Other market price									0	0.0	NA	NA
11. Other									D	8.9	0.0	28.4

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-13. Use of Sales Methods for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S6.4b* For feeder pigs sold by your operation during the past year using formula pricing, what was the base price of the formula?	(results suppressed)				(results suppressed)							
1. Individual or multiple packing plant average price									0	0.0	NA	NA
2. USDA live quote									5	32.4	6.4	58.4
3. USDA dressed or carcass quote									D	13.0	0.0	31.7
4. Auction prices									9	58.4	31.4	85.3
5. Chicago Mercantile Exchange (CME) lean hog futures									D	1.8	0.0	3.8
6. Subscription service price (for example, Urner Barry)									0	0.0	NA	NA
7. Corn or soybean meal futures									D	6.5	0.0	20.2
8. Cost of production									0	0.0	NA	NA
9. Retail price									D	7.4	0.0	21.3
10. Other market price									0	0.0	NA	NA
11. Other									D	6.5	0.0	20.2

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-13. Use of Sales Methods for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S6.4c* For market hogs sold by your operation during the past year using formula pricing, what was the base price of the formula?												
1. Individual or multiple packing plant average price	46	50.5	40.1	61.0	3	23.1	0.0	49.6	49	50.0	39.7	60.3
2. USDA live quote	16	17.6	9.6	25.6	4	30.8	1.7	59.8	20	17.8	10.0	25.7
3. USDA dressed or carcass quote	27	29.7	20.1	39.2	6	46.2	14.8	77.5	33	30.0	20.6	39.4
4. Auction prices	6	6.6	1.4	11.8	0	0.0	NA	NA	6	6.5	1.4	11.5
5. Chicago Mercantile Exchange (CME) lean hog futures	D	12.1	5.3	18.9	D	15.4	0.0	38.1	13	12.2	5.5	18.8
6. Subscription service price (for example, Urner Barry)	D	1.1	0.0	3.3	0	0.0	NA	NA	D	1.1	0.0	3.2
7. Corn or soybean meal futures	D	2.2	0.0	5.3	0	0.0	NA	NA	D	2.2	0.0	5.2
8. Cost of production	D	3.3	0.0	7.0	D	15.4	0.0	38.1	5	3.5	0.0	7.2
9. Retail price	D	2.2	0.0	5.3	D	7.7	0.0	24.5	3	2.3	0.0	5.3
10. Other market price	D	2.2	0.0	5.3	0	0.0	NA	NA	D	2.2	0.0	5.2
11. Other	D	1.1	0.0	3.3	0	0.0	NA	NA	D	1.1	0.0	3.2

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-13. Use of Sales Methods for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S6.5* What types of valuation methods were used by your operation for selling market hogs during the last year?												
1. Liveweight	52	35.6	27.8	43.5	4	30.8	1.7	59.8	56	35.6	27.8	43.3
2. Carcass weight not dependent on merit	D	4.8	1.3	8.3	D	7.7	0.0	24.5	8	4.8	1.4	8.3
3. Carcass weight dependent on merit	102	69.9	62.3	77.4	12	92.3	75.5	100.0	114	70.1	62.7	77.6
4. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

	Small				Large				All Operations			
	n	Mean	Lower	Upper	n	Mean	Lower	Upper	n	Mean	Lower	Upper
S6.6 What percentage of pigs and hogs sold during the past year were sold using a slide?	153	27.5	20.5	34.5	16	55.9	28.8	83.1	169	27.9	21.1	34.8
S6.7 For what percentage of pigs and hogs sold during the past year did the seller (your operation) pay for transportation?	154	67.6	60.3	74.9	16	45.9	19.5	72.4	170	67.3	60.1	74.5
S6.8 What percentage of pigs and hogs sold during the past year were under a written agreement (versus oral)?	154	16.8	11.2	22.5	16	61.2	37.2	85.2	170	17.5	11.9	23.1

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 6-14. Terms of Procurement or Marketing Contracts for Pork Producers, by Size (Small = 206, Large = 23)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S7.1 With how many buyers did your operation maintain procurement or marketing contracts during the past year?												
1. One	11	73.3	48.0	98.7	3	75.0	0.0	100.0	14	73.4	49.3	97.5
2. Two	3	20.0	0.0	42.9	0	0.0	NA	NA	3	19.3	0.0	41.0
3. Three to five	D	6.7	0.0	21.0	D	25.0	0.0	100.0	D	7.3	0.0	21.0
4. Six to ten	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
5. More than ten	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
6. Total		100.0				100.0				100.0		

	Small (n = 14)			Large (n = 4)			All Operations (n = 18)		
	Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
S7.2 For pigs and hogs sold under a procurement or marketing contract during the past year, what was the length of the contract (% of head)?									
a. Less than 6 months	9.5	<0	25.4	0.0	0.0	0.0	9.1	<0	24.1
b. 6 to 11 months	0.0	0.0	0.0	52.5	<0	>100	2.0	<0	4.3
c. 1 to 2 years	42.9	13.2	72.5	25.0	<0	>100	42.2	14.1	70.2
d. 3 to 5 years	21.4	<0	46.0	22.5	<0	94.1	21.5	<0	44.7
e. 6 to 10 years	7.1	<0	22.6	0.0	0.0	0.0	6.9	<0	21.4
f. More than 10 years or evergreen	19.1	<0	41.4	0.0	0.0	0.0	18.3	<0	39.4
Total	100.0			100.0			100.0		

D = Results suppressed.
NA = Confidence interval not calculable.

(continued)

Table 6-14. Terms of Procurement or Marketing Contracts for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S7.3* Which of the following terms were specified in the procurement or marketing contracts used by your operation during the past year?												
1. Number of pigs or hogs to be delivered each specified time period	12	85.7	64.7	100.0	4	100.0	100.0	100.0	16	86.3	66.5	100.0
2. Average weight of pigs or hogs	D	42.9	13.2	72.5	D	50.0	0.0	100.0	8	43.1	15.1	71.2
3. Quality of pigs or hogs	D	50.0	20.0	80.0	D	50.0	0.0	100.0	9	50.0	21.6	78.4
4. Yield percentage of market hogs	D	21.4	0.0	46.0	D	25.0	0.0	100.0	4	21.6	0.0	44.8
5. Producer must sell 100 percent of production to your operation	3	21.4	0.0	46.0	0	0.0	NA	NA	3	20.6	0.0	43.8
6. Minimum guaranteed price for pigs or hogs	D	35.7	7.0	64.4	D	25.0	0.0	100.0	6	35.3	8.1	62.5
7. Includes a ledger account	D	7.1	0.0	22.6	0	0.0	NA	NA	D	6.9	0.0	21.4
8. Includes a price window	D	21.4	0.0	46.0	D	25.0	0.0	100.0	4	21.6	0.0	44.8
9. Specifications for production facilities	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
10. Breeding/genetics used by producer	D	14.3	0.0	35.3	0	0.0	NA	NA	D	13.7	0.0	33.5
11. Feeding programs used by producer	D	7.1	0.0	22.6	0	0.0	NA	NA	D	6.9	0.0	21.4
12. PSE requirements	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
13. Producer must be Pork Quality Assurance (PQA) certified	10	71.4	44.4	98.5	4	100.0	100.0	100.0	14	72.5	47.0	98.1
14. Allows packer to inspect and monitor production facilities	D	14.3	0.0	35.3	D	25.0	0.0	100.0	3	14.7	0.0	34.6
15. Allows producer to visit and monitor packing facilities	D	7.1	0.0	22.6	D	25.0	0.0	100.0	D	7.8	0.0	22.5
16. Allows packer to change carcass pricing grid without producer's consent	D	50.0	20.0	80.0	D	50.0	0.0	100.0	9	50.0	21.6	78.4
17. Includes definition of viable or acceptable pig or hog	7	50.0	20.0	80.0	3	75.0	0.0	100.0	10	51.0	22.6	79.3
18. Price adjustment for single or multiple sources of pigs or hogs	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
19. None of the above	D	7.1	0.0	22.6	0	0.0	NA	NA	D	6.9	0.0	21.4

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 6-15. Reasons for Using Sales Methods for Pork Producers, by Size (Small = 206, Large = 23)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S8.1* What are the three most important reasons why your operation only uses the cash or spot market for selling pigs and hogs?												
1. Can sell pigs and hogs at higher prices	34	35.1	25.4	44.7	3	100.0	100.0	100.0	37	35.3	25.7	45.0
2. Reduces risk exposure	D	11.3	4.9	17.8	D	33.3	0.0	100.0	12	11.4	5.0	17.8
3. Reduces costs of activities for selling pigs and hogs	20	20.6	12.4	28.8	0	0.0	NA	NA	20	20.5	12.4	28.7
4. Reduces price variability for pigs and hogs	3	3.1	0.0	6.6	0	0.0	NA	NA	3	3.1	0.0	6.6
5. Reduces potential liability and litigation concerns	3	3.1	0.0	6.6	0	0.0	NA	NA	3	3.1	0.0	6.6
6. Increases supply chain information	0	0.0	NA	NA	D	33.3	0.0	100.0	D	0.1	0.0	0.4
7. Allows for sale of higher quality pigs	D	9.3	3.4	15.2	D	66.7	0.0	100.0	11	9.5	3.7	15.4
8. Facilitates or increases market access	14	14.4	7.3	21.6	0	0.0	NA	NA	14	14.4	7.3	21.5
9. Allows for adjusting operations quickly in response to changes in market conditions	D	19.6	11.5	27.6	D	33.3	0.0	100.0	20	19.6	11.6	27.7
10. Does not require identifying and recruiting long-term contracting partners	D	16.5	9.0	24.0	D	33.3	0.0	100.0	17	16.6	9.1	24.1
11. Does not require managing complex and costly contracts	24	24.7	16.0	33.5	0	0.0	NA	NA	24	24.6	15.9	33.3
12. Eliminates possible negative public perceptions about use of contracts	D	2.1	0.0	4.9	0	0.0	NA	NA	D	2.1	0.0	4.9
13. Allows for independence, complete control, and flexibility of own business	78	80.4	72.4	88.5	0	0.0	NA	NA	78	80.1	72.1	88.1
14. Enhances ability to benefit from favorable market conditions	40	41.2	31.3	51.2	0	0.0	NA	NA	40	41.1	31.1	51.0
15. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
16. No other choice *(write-in response)*	D	1.0	0.0	3.1	0	0.0	NA	NA	D	1.0	0.0	3.1
17. Can easily sell small number of animals *(write-in response)*	7	7.2	2.0	12.5	0	0.0	NA	NA	7	7.2	2.0	12.4
18. Convenience *(write-in response)*	3	3.1	0.0	6.6	0	0.0	NA	NA	3	3.1	0.0	6.6

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-15. Reasons for Using Sales Methods for Pork Producers, by Size (Small = 206, Large = 23) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S8.2* What are the three most important reasons why your operation uses alternative sales methods for selling pigs and hogs?												
1. Can sell pigs and hogs at higher prices	4	22.2	0.9	43.5	0	0.0	NA	NA	4	21.4	1.2	41.6
2. Reduces risk exposure	D	77.8	56.5	99.1	D	40.0	0.0	100.0	16	76.4	56.1	96.6
3. Reduces costs of activities for selling pigs and hogs	D	22.2	0.9	43.5	D	40.0	0.0	100.0	6	22.9	2.6	43.2
4. Reduces price variability for pigs and hogs	D	44.4	19.0	69.9	D	40.0	0.0	100.0	10	44.3	20.1	68.5
5. Reduces potential liability and litigation concerns	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
6. Increases supply chain information	D	5.6	0.0	17.3	D	20.0	0.0	75.5	D	6.1	0.0	17.3
7. Allows for sale of higher quality pigs	D	11.1	0.0	27.2	0	0.0	NA	NA	D	10.7	0.0	25.9
8. Facilitates or increases market access	3	16.7	0.0	35.7	3	60.0	0.0	100.0	6	18.3	0.1	36.5
9. Increases flexibility in responding to consumer demand	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
10. Allows for product branding in retail sales	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
11. Allows for food safety and biosecurity assurances	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
12. Allows for product traceability	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
13. Improves week-to-week production management	D	16.7	0.0	35.7	D	20.0	0.0	75.5	4	16.8	0.0	34.9
14. Secures a buyer for pigs and hogs	D	38.9	13.9	63.8	D	40.0	0.0	100.0	9	38.9	15.2	62.7
15. Provides detailed carcass data	D	16.7	0.0	35.7	D	20.0	0.0	75.5	4	16.8	0.0	34.9
16. Enhances access to credit	D	11.1	0.0	27.2	D	20.0	0.0	75.5	3	11.4	0.0	26.8
17. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

6.3 LAMB PRODUCERS

Table 6-16 provides weighted tabulations for all survey questions for lamb producers (n = 302). Tables 6-17 through 6-22 provide weighted tabulations for selected questions by size (n = 267 for small lamb producers and n = 35 for large lamb producers).

6.3.1 Characteristics of Lamb Producer Operations

Most operations identified themselves as lamb producers (i.e., lambing operations) (94%) and some as lamb feeder or feedlot operations (22%). Thus, some lamb producers also conduct feeding operations. For operations that reported having lambs in inventory on January 1, 2005, two-thirds had fewer than 100 lambs, and 17% had more than 500 lambs. (See Table 6-16, Questions 1.2 and 8.3.)

The majority of lamb producers can be characterized as independent businesses that do not participate in alliances, marketing agreements, or certification programs.

The majority of lamb producers can be characterized as independent businesses that do not participate in alliances, marketing agreements, or certification programs. For example, 88% of producers did not participate in any type of certification program. For the 12% of producers who did participate in alliances, a variety of alliances were used. (See Table 6-16, Questions 1.3 and 1.4.)

Producers identified an average of four auctions operating within a 200-mile radius of their location. The majority of the auctions closest to the operation have sales at least weekly. (See Table 6-16, Questions 8.4 and 8.5.)

For most operations, the owner completed the questionnaire. Of these, the majority of respondents were over 45 years of age. Nearly one-half have a college degree. Almost 86% of operations reported gross lamb sales of less than $99,999, and almost 96% had total gross lamb sales of less than $499,999. Approximately 79% of operations reported total gross farm sales of less than $99,999, 16% reported gross farm sales between $100,000 and $999,999, and 5% reported gross farm sales of more than $999,999. For operations in which the owner completed the questionnaire, almost 55% of their household income came from off-farm sources. (See Table 6-16, Questions 8.6 through 8.11.)

6.3.2 Methods for Purchasing or Receiving Lambs by Lamb Producers

Relatively few of the operations surveyed purchased lambs. This is because the respondents were lambing operations or feeders that self-produce their feeder lambs or only custom feed. Operations that purchased lambs bought an average of 10,368 lambs during the past year. More than half of these operations purchased fewer than 500 lambs during the past year. (See Table 6-16, Question 2.1.)

Nearly 85% of the lambs received were owned solely by the operation, 8% were under partner arrangements, and 7% were not purchased but delivered to the operation for custom feeding.[8] For 74% of operations, all of their lambs were owned solely by the operation during the past year. Operations' ownership arrangements were very similar 3 years ago and are not expected to change within the next 3 years. (See Table 6-16, Question 2.2.)

> Most lambs were purchased through spot market transactions. The most frequently cited pricing methods were individually negotiated pricing and public auction.

For 83% of the operations that received lambs, all of the lambs received were from spot market transactions. During the past year, 49% of lamb purchases were through direct trade, 26% through auctions, and 13% through dealers/brokers. Five percent were delivered for custom feeding, and 6% of purchases were conducted using formula pricing or marketing agreements. As in the cattle industry, there appears to be a slight trend away from auction markets and a slightly increased use of other types of cash market transactions such as direct trade. (See Table 6-16, Question 2.3.)

For operations that purchased lambs, several pricing methods were employed. The most frequently cited pricing methods were individually negotiated pricing (78% of operations) and public auction (53%).[9] Less than 8% of operations used formula pricing. (See Table 6-16, Questions 2.4 and 2.5.)

Lamb buyers paid transportation costs in 71% of the purchase transactions. Few lambs were purchased under a written agreement (8% of the total number of lambs sold). For lambs purchased under a preexisting agreement, the agreement was

[8] These values were computed as the mean percentage of head weighted by the number of eligible operations. Other reported means were computed similarly (i.e., weighted by the number of eligible operations).

[9] Respondents could select multiple responses.

typically less than 6 months. Nearly 73% of lambs purchased were scheduled for delivery within 2 weeks; another 14% were scheduled for delivery 3 to 4 weeks in advance. (See Table 6-1, Questions 3.1 through 3.4.)

Producers that used only spot market transactions were asked to identify the three most important reasons for using the spot market. The three most frequently selected choices emphasize the business philosophy of the manager. Sixty-three percent identified "Allows for independence, complete control, and flexibility of own business" as an important reason for using the spot market; 50% chose "Secures higher quality lambs," and 32% chose "Allows for adjusting operations quickly in response to changes in market conditions." Because the number of lamb producers that use AMAs is very small, we cannot characterize their reasons for using AMAs. (See Table 6-16, Questions 4.1 and 4.2.)

6.3.3 Methods for Selling or Shipping Lambs by Lamb Producers

Most lambs were sold through spot market transactions. Producers' methods for selling lambs were very similar 3 years ago and are not expected to change much within the next 3 years.

During the past year, operations that sold feeder lambs sold an average of 561 feeder lambs. Operations that sold slaughter lambs sold an average of 137 slaughter lambs weighing less than 105 pounds, and 2,218 slaughter lambs weighing 105 pounds or more. About 60% or more of operations sold fewer than 100 head. More than 41% of the lambs sold were sent through auction markets, 31% through direct trade, and 11% through a dealer or broker. About 16% were sold or shipped through some type of AMA. During the past year, nearly 78% of operations sold all of their lambs through spot market transactions. Producers' methods for selling lambs were very similar 3 years ago and are not expected to change much within the next 3 years. (See Table 6-16, Questions 5.1 and 5.2.)

Two pricing methods dominate lamb sales. Lamb prices were primarily determined through public auctions (57% of operations) or individual negotiations (51%). For operations using formula pricing with a grid, most prices were based on an individual or multiple-plant average price (39%). USDA-reported prices, retail prices, and other market prices also were used as bases for pricing formulas. For operations that sell slaughter lambs, the most frequently cited valuation methods were liveweight (75%), followed by per-head valuation (24%).

Producers expect no change in valuation methods in the next 3 years. (See Table 6-16, Questions 5.3 through 5.5.)

For more than one-half of lambs sold during the past year, the seller reported paying transportation costs. Less than 7% of lambs were sold under a written agreement. For lambs sold under a preexisting agreement, the agreement was typically less than 6 months. Most deliveries (66%) occurred within 7 days, and 16% were delivered within 8 to 14 days. (See Table 6-16, Questions 6.1 through 6.4.)

As with purchasing lambs, the most frequently cited reason for using only cash markets to sell lambs was that it "Allows for independence, complete control, and flexibility of own business" (61%), followed by "Can sell lambs at higher prices" (44%) and then "Reduces costs of activities for selling lambs" (33%). The most cited reason for using AMAs to sell lambs was "Can sell lambs at higher prices" (67%), followed by "Secures a buyer for lambs" (46%), and then "Reduces risk exposure" (41%). Note that producers using only the cash market and those using AMAs both identified selling lambs at higher prices as a reason for using their respective methods. (See Table 6-16, Questions 7.1 and 7.2.)

6.3.4 Lamb Producers' Marketing Practices, by Size of Operation

During the past year, large producers purchased, on average, almost seven times more lambs than small producers purchased (36,500 versus 5,400). Almost 77% of small producers solely owned all of their lambs, compared with 57% of large producers. For large producers, 59% of lambs were solely owned, 14% were owned under a partner arrangement, and 26% were delivered for custom feeding. (See Table 6-17, Questions S2.1 and S2.2.)

Nearly 85% of small producers and 71% of large producers purchased all of their lambs through spot market transactions. Small producers had a greater reliance on auctions than large producers.

Nearly 85% of small producers and 71% of large producers purchased all of their lambs through spot market transactions. Small producers had a greater reliance on auctions than large producers. For large producers, 28% of lambs were delivered for custom feeding and the rest were purchased through spot market transactions. Both small and large producers primarily used individually negotiated pricing and public auctions to price lambs. (See Table 6-17, Questions S2.3 and S2.4.)

Small producers paid to transport more of their lambs compared with large producers (73% versus 56% of transactions). Few small producers (7% of transactions) and large producers (14% of transactions) used written agreements. For lambs purchased under a contract, most were under an agreement of less than 6 months. Small producers scheduled 75% of purchased lambs to be delivered in less than 2 weeks, while large producers scheduled 63% in this time frame. Large producers scheduled 29% of purchased lambs to be delivered between 5 and 12 weeks in advance; small producers scheduled 11% in this time frame. (See Table 6-18.)

Both large and small producers reported similar reasons for only using the spot market for purchasing lambs, with "Allows for independence, complete control, and flexibility of own business," as the most frequently cited reason. Because the number of producers in each size category who use AMAs is very small, we cannot compare their reasons for using AMAs. (See Table 6-19.)

For selling lambs, small producers had a much greater reliance on the spot market compared with large producers. Nearly 81% of small producers and 36% of large producers sold all their lambs through spot market transactions during the past year.

For selling lambs, small producers had a much greater reliance on the spot market compared with large producers. Nearly 81% of small producers and 36% of large producers sold all their lambs through spot market transactions during the past year. Large producers sold 44% of their lambs through the spot market, 25% through forward contracts, and 11% through marketing agreements. Eleven percent of lambs were custom fed. (See Table 6-20, Question S5.2.)

Small producers (60% of operations) were more likely than large producers (15%) to use public auctions to price lambs. Individual negotiation was frequently used by small producers (51%) and large producers (61%) to price lambs. (See Table 6-20, Question S5.3.)

For operations that sell slaughter lambs, liveweight was the most frequently cited valuation method among small producers (76%) and large producers (53%). More than one-half of large producers sold lambs on a carcass weight basis with grid pricing, compared with only 5% of small producers. (See Table 6-20, Question S5.5.)

Small producers paid to transport more of their lambs compared with large producers (54% versus 32% of transactions). Use of a written agreement was more prevalent for large producers than for small producers (25% versus 5% of transactions). For large producers, most contracts were for less than 6 months. As with purchases, large producers scheduled deliveries farther in advance than did small producers; 69% of lambs sold by small producers were scheduled for delivery within 7 days. About one-third of lambs sold by large producers were scheduled for delivery within 7 days, 16% within 8 to 14 days, and 32% more than 1 month in advance. (See Table 6-21.)

Small and large producers had similar reasons for only using the cash market for selling lambs. For both small and large producers, the most frequently cited reason was "Allows for independent, complete control, and flexibility of own business." Small and large producers had somewhat different reasons for using AMAs for selling lambs. Seventy-two percent of small producers versus 53% of large producers mainly used AMAs to sell lambs at higher prices. Sixty-five percent of large producers versus 32% of small producers mainly used AMAs to reduce risk exposure. (See Table 6-22.)

6.3.5 Lamb Producer Survey Summary

Small and large lamb producers value the cash market because they believe it allows for greater independence and secures higher quality lambs.

Most operations described themselves as lamb producers and nearly one-fourth also operated feedlots. The majority of operations can be characterized as independent businesses that do not participate in alliances, marketing agreements, or certification programs. About 83% of operations received all of their lambs through spot market transactions. The use of AMAs for purchasing lambs was not widespread among small or large producers. However, custom feeding was generally more common among large producers than among small producers. Small and large producers value the cash market because they believe it allows for greater independence and secures higher quality lambs.

The use of the cash market for selling lambs was more widespread among small producers than among large producers. Nearly 81% of small producers and 36% of large producers sold all their lambs through spot market transactions during the past year. Small and large producers had differing reasons for using AMAs. Small producers believe that AMAs allow them to sell lambs at higher prices and large producers believe that AMAs reduce risk exposure.

Compared with small producers, large producers were less likely to incur transportation costs, used written contracts more often, and scheduled delivery more than 2 weeks ahead of time for lamb purchases and sales.

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302)

	n	%	Lower	Upper
1.2* Which of the following describes your operation during the past year?				
1. Lamb producer	282	93.6	90.8	96.4
2. Lamb feeder or feedlot	69	22.3	17.5	27.0
3. Other	4	1.4	0.0	2.8
4. Wool producer *(write-in response)*	3	1.0	0.0	2.2
5. Seed stock producer *(write-in response)*	7	2.4	0.6	4.2
1.3* What types of certification programs did your operation participate in during the past year?				
1. None	243	87.5	83.7	91.4
2. Kosher certification	5	1.7	0.2	3.2
3. Halal certification	3	1.0	0.0	2.1
4. Organic certification	3	1.1	0.0	2.4
5. Animal welfare certification	D	0.2	0.0	0.7
6. Third-party certification of breed or livestock quality	8	2.7	0.8	4.6
7. Own-company certification of breed or livestock quality	11	3.5	1.4	5.6
8. Buyer certification of breed or livestock quality	4	1.2	0.0	2.4
9. Other	5	1.4	0.1	2.7
10. Scrapie-free certification program *(write-in response)*	9	3.2	1.1	5.3
1.4a What types of alliances did your operation participate in during the past year for the receipt and/or sale of lambs?				
– Operations participating in an alliance	38	11.5	8.0	15.0
– Respondents with one alliance	28	74.7	59.9	89.5
– Respondents with two alliances	6	13.2	2.7	23.7
– Respondents with three alliances	4	12.1	0.6	23.6

D = Results suppressed.
* Respondents could select multiple responses.

(continued)

A description of the notation used in the table headers is provided below.
n = number of respondents
% = estimated proportion weighted by the number of eligible operations
Mean = estimated mean weighted by the number of eligible operations
Lower = lower bound of the 95% confidence interval for the weighted proportion or mean
Upper = upper bound of the 95% confidence interval for the weighted proportion or mean

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

	n	%	Lower	Upper
1.4b For producers that participate in alliances, what types of alliances did your operation participate in during the past year for the receipt and/or sale of lambs?				
1. Seed stock supplier only	5	11.0	1.7	20.3
2. Feed company only	D	4.4	0.0	10.6
3. Producer only	12	24.6	12.0	37.2
4. Feedlot only	5	10.1	1.3	18.9
5. Packer/processor/breaker only	6	8.7	2.0	15.4
6. Retailer only	D	2.2	0.0	6.6
7. Other only	8	17.6	6.4	28.8
8. Producer and seed stock supplier	D	3.5	0.0	8.6
9. Packer/processor/breaker and feedlot	D	4.4	0.0	10.6
10. Other and retailer	D	2.2	0.0	6.6
11. Producer, packer/processor/breaker, and food service	D	1.3	0.0	3.9
12. Producer, feedlot, and food service	D	1.3	0.0	3.9
13. Producer, feedlot, and packer/processor/breaker	3	3.9	0.0	8.1
14. Producer, feedlot, packer/processor/breaker, and other	D	1.3	0.0	3.9
15. Producer, feedlot, packer/processor/breaker, and retailer	D	2.2	0.0	6.6
16. Producer, feedlot, packer/processor/breaker, food service, and retail	D	1.3	0.0	3.9
Total		100.0		

D = Results suppressed.

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

		n	Mean	Lower	Upper
2.1	How many lambs did your operation receive or purchase during the past year?	33	10,368.4	3,616.8	17,119.9
		n	**%**	**Lower**	**Upper**
	1–99	13	42.4	24.4	60.3
	100–499	4	13.5	0.6	26.3
	500–1,999	5	14.1	1.5	26.6
	2,000–9,999	4	12.1	0.0	24.2
	10,000 or more	7	18.0	5.1	31.0
	Total		100.1†		

† Total does not sum to 100% because of rounding.

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

		3 Years Ago (n = 25)				During Past Year (n = 29)				Expected in 3 Years (n = 24)		
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
2.2 For all lambs received or purchased by your operation, what were the ownership arrangements (% of head)?												
a. Sole ownership by your operation		83.9	70.3	97.6		84.5	72.4	96.6		83.2	68.9	97.5
b. Partner arrangement		8.0	<0	18.0		7.8	<0	17.0		8.3	<0	19.6
c. Shared ownership		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
d. Joint venture		0.5	<0	1.4		0.5	<0	1.2		0.6	<0	1.5
e. Delivered for custom feeding		7.6	<0	16.1		7.2	<0	15.0		7.9	<0	16.9
f. Other		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Total		100.0				100.0				100.0		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Operations for which 100% are sole ownership	18	72.6	53.2	91.9	21	74.1	57.0	91.2	18	77.8	60.4	95.3

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

	3 Years Ago (n = 26)				During Past Year (n = 33)				Expected in 3 Years (n = 30)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
2.3 What methods are used by your operation for receiving or purchasing lambs (% of head)?												
a. Auction barns		26.1	12.4	39.8		21.6	9.5	33.6		21.5	10.0	33.0
b. Video/electronic auctions		4.2	<0	12.8		4.1	<0	11.1		3.6	<0	11.1
c. Dealers or brokers		13.7	1.8	25.5		13.3	2.3	24.3		11.9	1.7	22.0
d. Direct trade		43.6	25.6	61.6		49.0	32.6	65.3		50.9	33.5	68.2
e. Forward contract		4.2	<0	12.8		3.3	<0	10.1		3.6	<0	11.1
f. Marketing agreement		4.2	<0	12.8		3.3	<0	10.1		3.6	<0	11.1
g. Internal transfer		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
h. Delivered for custom feeding		4.1	<0	10.3		5.4	<0	11.1		4.9	<0	10.4
i. Other		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Total		100.1†				100.0				100.0		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Operations for which 100% are cash or spot market purchases	22	85.0	70.0	100.0	27	82.8	69.1	96.5	25	84.8	71.3	98.3

† Total does not sum to 100% because of rounding.

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
2.4* What types of pricing methods are used by your operation for purchasing lambs?								
1. Individually negotiated pricing	30	78.1	64.0	92.3	26	81.1	66.3	95.8
2. Public auction	20	52.9	35.8	69.9	17	52.0	33.3	70.7
3. Sealed bid	D	1.7	0.0	5.2	0	0.0	NA	NA
4. Formula pricing (using another price as the base)	3	7.5	0.0	16.3	3	8.8	0.0	19.2
5. Internal transfer	D	1.7	0.0	5.2	0	0.0	NA	NA
6. Delivered for custom feeding	5	10.9	1.3	20.4	5	12.8	1.7	23.8
7. Other	D	1.7	0.0	5.2	D	2.0	0.0	6.1

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

		n	%	Lower	Upper
2.5*	For lambs purchased by your operation during the past year using formula pricing, what was the base price of the formula?				
	1. USDA live quote	3	45.5	0.0	97.8
	2. Subscription service price (for example, Urner Barry)	0	0.0	NA	NA
	3. Cost of production	D	24.1	0.0	63.1
	4. Other market price	D	15.2	0.0	54.2
	5. Other	D	15.2	0.0	54.2
	6. Auction price *(write-in response)*	3	39.3	0.0	88.6
		n	**Mean**	**Lower**	**Upper**
2.6	For lambs purchased using a slide during the past year, what were the most common terms of the slide?				
	a. Minimum target weight (pounds)	3	78.1	43.7	112.5
	b. Maximum target weight (pounds)	3	108.1	73.7	142.5
	c. First slide premium below target weight (cents per pound)	3	25.4	21.9	28.8
	d. First slide discount above target weight (cents per pound)	3	25.4	21.9	28.8
3.1	For what percentage of lambs purchased during the past year did the buyer (your operation) pay for transportation?	33	70.6	55.2	86.1
3.2	What percentage of lambs purchased during the past year were under a written agreement (versus oral)?	32	8.0	<0	16.9
			Mean (n = 28)	**Lower**	**Upper**
3.3	For lambs purchased during the past year, what was the length of the agreement or contract (oral or written) (% of head)?				
	a. Purchases not under agreement or contract		88.3	77.0	99.5
	b. Less than 6 months		7.6	<0	15.9
	c. 6 to 11 months		0.2	<0	0.6
	d. 1 to 2 years		0.0	0.0	0.0
	e. 3 to 5 years		0.0	0.0	0.0
	f. 6 to 10 years		0.0	0.0	0.0
	g. More than 10 years or evergreen		3.9	<0	12.0
	Total		100.0		

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

		Mean (n = 32)	**Lower**	**Upper**
3.4	For lambs purchased during the past year, how far in advance of delivery was the delivery scheduled (% of head)?			
	a. Less than 2 weeks	72.9	57.2	88.5
	b. 3 to 4 weeks	13.8	2.0	25.6
	c. 5 to 8 weeks	4.9	<0	11.4
	d. 9 to 12 weeks	8.4	<0	18.3
	e. 13 to 16 weeks	0.0	0.0	0.0
	f. More than 16 weeks	0.0	0.0	0.0
	Total	100.0		

		n	**%**	**Lower**	**Upper**
4.1*	What are the three most important reasons why your operation only uses the cash or spot market for purchasing lambs?				
	1. Can purchase lambs at lower prices	9	27.8	11.7	43.9
	2. Reduces risk exposure	7	21.6	6.8	36.5
	3. Reduces costs of activities for buying lambs	4	12.4	0.4	24.3
	4. Reduces price variability for lambs	4	11.1	0.0	22.3
	5. Reduces potential liability and litigation concerns	0	0.0	NA	NA
	6. Increases supply chain information	0	0.0	NA	NA
	7. Secures higher quality lambs	17	50.0	32.0	68.0
	8. Facilitates or increases market access	3	9.3	0.0	19.8
	9. Allows for adjusting operations quickly in response to changes in market conditions	11	31.5	14.8	48.1
	10. Does not require identifying and recruiting long-term contracting partners	D	6.2	0.0	14.9
	11. Does not require managing complex and costly contracts	6	18.5	4.5	32.6
	12. Eliminates possible negative public perceptions about use of contracts	D	3.1	0.0	9.4
	13. Allows for independence, complete control, and flexibility of own business	22	62.9	45.7	80.1
	14. Enhances ability to benefit from favorable market conditions	9	25.3	9.8	40.7
	15. Other	D	1.8	0.0	5.5

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

		n	%	Lower	Upper
4.2*	What are the three most important reasons why your operation uses alternative purchase methods for purchasing lambs?				
	1. Can purchase lambs at lower prices	0	0.0	NA	NA
	2. Reduces risk exposure	D	37.1	37.1	37.1
	3. Reduces costs of activities for buying lambs	0	0.0	NA	NA
	4. Reduces price variability for lambs	0	0.0	NA	NA
	5. Reduces potential liability and litigation concerns	0	0.0	NA	NA
	6. Increases supply chain information	0	0.0	NA	NA
	7. Secures higher quality lambs	D	31.4	0.0	100.0
	8. Facilitates or increases market access	0	0.0	NA	NA
	9. Allows for food safety and biosecurity assurances	D	31.4	0.0	100.0
	10. Allows for product traceability	D	62.9	62.9	62.9
	11. Improves week-to-week supply management	D	31.4	0.0	100.0
	12. Improves efficiency of operations due to animal uniformity	0	0.0	NA	NA
	13. Reduces investment requirements for facilities and equipment	D	37.1	37.1	37.1
	14. Reduces operating capital requirements	D	37.1	37.1	37.1
	15. Enhances access to credit	0	0.0	NA	NA
	16. Other	D	31.4	0.0	100.0
		n	**Mean**	**Lower**	**Upper**
5.1a	How many feeder lambs did your operation sell or ship during the past year?	121	561.4	345.1	777.7
		n	**%**	**Lower**	**Upper**
	1–99	66	58.0	49.4	66.6
	100–499	26	23.1	15.4	30.9
	500–1,999	14	9.9	4.8	15.0
	2,000 or more	15	9.0	5.1	12.8
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
5.1b	How many slaughter lambs (less than 105 pounds liveweight) did your operation sell or ship during the past year?	112	137.3	69.2	205.4
		n	**%**	**Lower**	**Upper**
	1–99	89	80.9	73.8	88.0
	100–499	17	14.8	8.1	21.4
	500–9,999	6	4.4	0.9	7.8
	10,000 or more	0	0.0	NA	NA
	Total		100.1†		

D = Results suppressed.
NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.
* Respondents could select multiple responses.

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

		n	Mean	Lower	Upper
5.1c	How many slaughter lambs (105 pounds liveweight or more) did your operation sell or ship during the past year?	154	2,217.9	781.4	3,654.5
		n	**%**	**Lower**	**Upper**
	1–99	100	67.4	60.1	74.6
	100–499	19	12.7	7.3	18.1
	500–1,999	14	8.4	4.1	12.8
	2,000–9,999	15	8.3	4.2	12.4
	10,000 or more	6	3.3	0.6	5.9
	Total		100.1†		

NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

	3 Years Ago (n = 271)				During Past Year (n = 278)				Expected in 3 Years (n = 256)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
5.2 What methods for selling or shipping lambs are used by your operation (% of head)?												
a. Auction barns		42.1	36.5	47.6		41.3	35.8	46.8		38.7	33.0	44.3
b. Video/electronic auctions		0.7	<0	1.6		0.7	<0	1.5		0.6	<0	1.5
c. Dealers or brokers		11.0	7.5	14.5		10.9	7.3	14.4		10.3	6.8	13.9
d. Direct trade		30.8	25.5	36.1		31.3	26.0	36.5		32.4	27.0	37.7
e. Forward contract		3.4	1.6	5.3		4.3	2.3	6.3		4.9	2.7	7.2
f. Marketing agreement		2.6	0.8	4.5		2.6	0.9	4.3		2.9	0.9	4.8
g. Packer fed/owned		0.4	<0	1.2		0.4	<0	1.2		0.5	<0	1.3
h. Internal transfer		0.2	<0	0.7		0.7	<0	1.6		0.4	<0	0.9
i. Custom fed, not marketed by your operation		1.4	0.3	2.4		1.3	0.3	2.4		1.7	0.5	2.9
j. Custom slaughtered for your operation		6.5	3.8	9.3		5.4	2.9	7.9		6.9	4.0	9.8
k. Other		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
l. Co-operative *(write-in response)*		0.8	<0	1.9		1.2	<0	2.5		0.8	<0	1.8
Total		99.9†				100.1†				100.1†		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are cash or spot market sales	207	78.3	73.6	83.1	210	77.5	72.8	82.3	185	74.3	69.1	79.5

† Total does not sum to 100% because of rounding.

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

	During Past Year				Expected in 3 Years			
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
5.3* What types of pricing methods are used by your operation for selling lambs?								
1. Individually negotiated pricing	151	51.3	45.5	57.1	139	53.4	47.2	59.5
2. Public auction	161	57.1	51.4	62.7	141	56.0	50.0	62.0
3. Sealed bid	9	2.8	0.9	4.6	10	3.5	1.3	5.8
4. Formula pricing (using another price as the base)	27	8.7	5.5	11.9	22	7.9	4.6	11.1
5. Internal transfer	3	0.8	0.0	1.7	D	0.5	0.0	1.1
6. Custom fed, not marketed by your operation	10	2.7	1.0	4.4	12	3.7	1.6	5.8
7. Custom slaughtered for your operation	34	11.8	8.0	15.5	37	14.4	10.1	18.8
8. Other	3	1.1	0.0	2.3	D	0.8	0.0	1.9
9. Co-operative *(write-in response)*	3	0.9	0.0	2.0	3	1.0	0.0	2.3
	With Grid				**Without Grid**			
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
5.4* For lambs sold by your operation during the past year using formula pricing, what was the base price of the formula?								
1. Individual or multiple packing plant average price	8	39.1	15.0	63.2	8	29.9	11.0	48.9
2. USDA live quote	3	15.0	0.0	32.8	7	22.8	6.9	38.6
3. USDA dressed or carcass quote	6	22.8	6.3	39.4	5	19.7	3.3	36.1
4. USDA boxed lamb price	0	0.0	NA	NA	D	7.9	0.0	19.1
5. Subscription service price (for example, Urner Barry)	0	0.0	NA	NA	D	3.9	0.0	12.1
6. Cost of production	0	0.0	NA	NA	D	3.9	0.0	12.1
7. Retail price	4	20.7	0.5	41.0	4	14.2	0.0	28.4
8. Other market price	D	11.5	0.0	27.8	D	7.9	0.0	19.1
9. Other	D	3.4	0.0	10.6	0	0.0	NA	NA
10. Auction price *(write-in response)*	D	5.8	0.0	17.9	3	11.8	0.0	25.2
11. Co-op grid *(write-in response)*	D	3.4	0.0	10.6	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
5.5* What types of valuation methods are used by your operation for selling slaughter lambs?								
1. Per head	35	23.9	16.9	30.9	28	23.3	15.6	31.0
2. Liveweight	110	74.7	67.7	81.8	91	75.2	67.4	83.0
3. Carcass weight, not dependent on grid value	22	14.3	8.6	19.9	19	15.0	8.6	21.4
4. Carcass weight, dependent on grid value	14	7.5	3.8	11.2	12	8.4	3.8	13.0
5. Other	0	0.0	NA	NA	0	0.0	NA	NA

NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

		n	Mean	Lower	Upper
5.6	For feeder lambs sold using a slide during the past year, what were the most common terms of the slide?				
	a. Minimum target weight (pounds)	7	84.1	73.7	94.4
	b. Maximum target weight (pounds)	13	94.7	87.9	101.6
	c. First slide premium below target weight (cents per pound)	7	28.7	<0	65.0
	d. First slide discount above target weight (cents per pound)	13	24.9	5.3	44.5
6.1	For what percentage of lambs sold during the past year did the seller (your operation) pay for transportation?	206	52.4	45.8	58.9
6.2	What percentage of lambs sold during the past year were under a written agreement (versus oral)?	207	6.8	3.6	10.0
			Mean (n = 182)	**Lower**	**Upper**
6.3	For lambs sold during the past year, what was the length of the agreement or contract (oral or written) (% of head)?				
	a. Sales not under agreement or contract		82.6	77.5	87.7
	b. Less than 6 months		10.9	6.9	15.0
	c. 6 to 11 months		3.3	0.8	5.9
	d. 1 to 2 years		0.6	<0	1.6
	e. 3 to 5 years		1.6	0.0	3.2
	f. 6 to 10 years		0.0	0.0	0.0
	g. More than 10 years or evergreen		1.0	<0	2.2
	Total		100.0		
			Mean (n = 197)	**Lower**	**Upper**
6.4	For lambs sold during the past year, how far in advance of delivery was the delivery scheduled (% of head)?				
	a. Less than 7 days		65.6	59.2	71.9
	b. 8 to 14 days		16.4	11.4	21.3
	c. 15 to 21 days		3.1	0.9	5.2
	d. 22 to 30 days		6.7	3.3	10.2
	e. 1 to 2 months		4.8	2.0	7.7
	f. More than 2 months		3.4	1.3	5.5
	Total		100.0		

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

	n	%	Lower	Upper
7.1* What are the three most important reasons why your operation only uses the cash or spot market for selling lambs?				
1. Can sell lambs at higher prices	94	44.3	37.5	51.1
2. Reduces risk exposure	32	15.1	10.2	20.0
3. Reduces costs of activities for selling lambs	70	33.3	26.8	39.7
4. Reduces price variability for lambs	16	7.7	4.1	11.4
5. Reduces potential liability and litigation concerns	12	5.8	2.6	9.0
6. Increases supply chain information	D	1.0	0.0	2.3
7. Allows for sale of higher quality lambs	28	13.5	8.9	18.2
8. Facilitates or increases market access	23	11.1	6.8	15.4
9. Allows for adjusting operations quickly in response to changes in market conditions	35	15.9	11.0	20.9
10. Does not require identifying and recruiting long-term contracting partners	35	16.5	11.5	21.6
11. Does not require managing complex and costly contracts	35	16.3	11.3	21.4
12. Eliminates possible negative public perceptions about use of contracts	D	0.5	0.0	1.4
13. Allows for independence, complete control, and flexibility of own business	130	60.7	54.1	67.4
14. Enhances ability to benefit from favorable market conditions	70	32.7	26.3	39.1
15. Other	3	1.5	0.0	3.1
16. No other choice *(write-in response)*	4	1.9	0.0	3.8
17. Can easily sell small number of animals *(write-in response)*	3	1.5	0.0	3.1
18. Convenience *(write-in response)*	5	2.4	0.3	4.5
7.2* What are the three most important reasons why your operation uses alternative sales methods for selling lambs?				
1. Can sell lambs at higher prices	27	66.5	51.5	81.6
2. Reduces risk exposure	19	41.4	26.0	56.7
3. Reduces costs of activities for selling lambs	7	16.5	4.4	28.6
4. Reduces price variability for lambs	8	19.3	6.3	32.3
5. Reduces potential liability and litigation concerns	D	1.7	0.0	5.1
6. Increases supply chain information	0	0.0	NA	NA
7. Allows for sale of higher quality lambs	15	37.0	21.1	52.8
8. Facilitates or increases market access	4	10.2	0.1	20.4
9. Increases flexibility in responding to consumer demand	4	9.1	0.0	18.3
10. Allows for product branding in retail sales	3	8.6	0.0	18.1
11. Allows for food safety and biosecurity assurances	D	5.7	0.0	13.7
12. Allows for product traceability	D	2.9	0.0	8.6
13. Improves week-to-week production management	D	2.9	0.0	8.6
14. Secures a buyer for lambs	19	46.0	29.7	62.4
15. Provides detailed carcass data	3	6.2	0.0	13.6
16. Enhances access to credit	D	3.4	0.0	8.0
17. Other	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

		n	Mean	Lower	Upper
8.1	Approximately how many people (including yourself and family members) were employed for livestock production at your operation during the past year?				
	a. Full time	167	2.9	2.5	3.2
	b. Part time	141	1.9	1.7	2.1
	c. Seasonal	54	2.9	2.2	3.7
8.2	What is the total acreage of your operation used for livestock production?	294	11,238.9	5,609.4	16,868.4
		n	**Mean**	**Lower**	**Upper**
8.3a	How many lambs were on your operation on January 1, 2005?	209	962.3	342.9	1,581.8
		n	**%**	**Lower**	**Upper**
	1–99	132	66.5	60.3	72.6
	100–499	33	16.5	11.3	21.6
	500–1,999	18	7.7	4.2	11.3
	2,000–9,999	20	7.1	4.3	9.9
	10,000 or more	6	2.2	0.4	4.1
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
8.3b	How many ewes were on your operation on January 1, 2005?	283	478.7	390.9	566.5
		n	**%**	**Lower**	**Upper**
	1–99	176	64.8	59.3	70.2
	100–499	51	18.7	14.1	23.4
	500–1,999	27	9.4	6.0	12.8
	2,000 or more	29	7.1	5.2	9.0
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
8.3c	How many rams were on your operation on January 1, 2005?	270	15.6	12.5	18.7
		n	**%**	**Lower**	**Upper**
	1–99	253	95.6	93.8	97.4
	100–499	17	4.4	2.6	6.2
	500 or more	0	0.0	NA	NA
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
8.4	How many auctions operate for selling lambs within 200 miles of your operation?				
	a. Number of auctions operating 3 years ago	257	4.2	3.7	4.7
	b. Number of auctions currently operating	256	4.0	3.6	4.5

NA = Confidence interval not calculable.

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

	3 Years Ago				Currently			
	n	%	Lower	Upper	n	%	Lower	Upper
8.5* For the auction located closest to your operation, how often does it operate for selling lambs?								
1. Monthly	26	11.7	7.4	15.9	34	14.6	10.0	19.2
2. Every 2 weeks	26	11.8	7.5	16.2	29	12.6	8.2	16.9
3. Weekly	158	71.0	65.0	77.1	156	66.7	60.6	72.9
4. 2 times per week	11	5.0	2.1	7.9	11	4.7	2.0	7.5
5. 3 to 5 times per week	D	0.5	0.0	1.4	D	0.9	0	2.1
6. Daily	0	0.0	NA	NA	0	0.0	NA	NA
7. Other	0	0.0	NA	NA	D	0.4	0.0	1.3
8. Less than monthly *(write-in response)*	3	1.4	0.0	3.0	5	2.2	0.3	4.2

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-16. Weighted Responses for the Lamb Producer Survey (n = 302) (continued)

		n	%	Lower	Upper
8.6	What were your operation's approximate total gross sales for lambs during the past year?				
	1. Under $99,999	244	85.8	82.4	89.2
	2. $100,000 to $499,999	35	9.8	6.8	12.9
	3. $500,000 to $999,999	6	1.4	0.3	2.5
	4. $1,000,000 to $2,499,999	6	1.8	0.3	3.3
	5. $2,500,000 to $4,999,999	0	0.0	NA	NA
	6. $5,000,000 or more	4	1.1	0.0	2.3
	Total		99.9†		
8.7	What were your operation's approximate total gross sales for all farm outputs during the past year?				
	1. Under $99,999	224	78.7	74.5	82.9
	2. $100,000 to $499,999	38	12.3	8.5	16.0
	3. $500,000 to $999,999	19	4.5	2.7	6.4
	4. $1,000,000 to $4,999,999	12	3.4	1.4	5.3
	5. $5,000,000 or more	4	1.1	0.0	2.3
	Total		100.0		
8.8	Which of the following best describes your position with this operation?				
	1. Owner	271	91.6	88.6	94.6
	2. Manager	17	4.8	2.5	7.1
	3. Family member (not owner or manager)	9	2.9	1.0	4.8
	4. Other hired employee	D	0.2	0.0	0.6
	5. Other	D	0.6	0.0	1.4
	Total		100.1†		
8.9	If owner, what is your age?				
	1. Less than 25	D	0.2	0.0	0.7
	2. 26 to 35	D	0.8	0.0	1.8
	3. 36 to 45	16	5.8	3.0	8.6
	4. 46 to 55	72	26.1	20.8	31.4
	5. 56 to 65	84	31.2	25.6	36.8
	6. Older than 65	96	35.9	30.1	41.7
	Total		100.0		
8.10	If owner, what is your education level?				
	1. Less than high school graduate	10	3.7	1.4	6.0
	2. High school graduate/GED	48	18.1	13.4	22.8
	3. Some college or technical school, no degree	80	29.4	23.9	35.0
	4. College graduate	89	32.6	26.9	38.2
	5. Post-graduate	43	16.2	11.7	20.7
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
8.11	If owner, what percentage of your total annual household income comes from off-farm sources?	266	54.9	50.2	59.6

D = Results suppressed.
NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.

Table 6-17. Use of Purchase Methods for Lamb Producers, by Size (Small = 267, Large = 35)

		Small (n = 25)			Large (n = 8)			All Operations (n = 33)		
		Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
S2.1	How many lambs did your operation receive or purchase during the past year?	5,422.8	29.4	10,816.1	36,520.1	<0	73,330.0	10,368.4	3,616.8	17,119.9

		Small (n = 22)			Large (n = 7)			All Operations (n = 29)		
		Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
S2.2	For all lambs received or purchased by your operation during the past year, what were the ownership arrangements (% of head)?									
	a. Sole ownership by your operation	89.4	77.0	>100	58.6	10.7	>100	84.5	72.4	96.6
	b. Partner arrangement	6.6	<0	16.2	14.3	<0	49.2	7.8	<0	17.0
	c. Shared ownership	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	d. Joint venture	0.4	<0	1.2	0.7	<0	2.5	0.5	<0	1.2
	e. Delivered for custom feeding	3.6	<0	10.2	26.4	<0	68.4	7.2	<0	15.0
	f. Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	100.0			100.0			100.0		

	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
Operations for which 100% are sole ownership	17	77.3	58.3	96.3	4	57.1	7.7	100.0	21	74.1	57.0	91.2

(continued)

Table 6-17. Use of Purchase Methods for Lamb Producers, by Size (Small = 267, Large = 35) (continued)

	Small (n = 26)				Large (n = 7)				All Operations (n = 33)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
S2.3 What methods were used by your operation during the past year for receiving or purchasing lambs (% of head)?												
a. Auction barns		24.2	10.2	38.2		5.0	<0	15.3		21.6	9.5	33.6
b. Video/electronic auctions		4.8	<0	12.9		0.0	0.0	0.0		4.1	<0	11.1
c. Dealers or brokers		13.2	1.1	25.2		14.3	<0	49.2		13.3	2.3	24.3
d. Direct trade		48.4	30.3	66.5		52.9	6.1	99.6		49.0	32.6	65.3
e. Forward contract		3.8	<0	11.8		0.0	0.0	0.0		3.3	<0	10.1
f. Marketing agreement		3.8	<0	11.8		0.0	0.0	0.0		3.3	<0	10.1
g. Internal transfer		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
h. Delivered for custom feeding		1.8	<0	5.0		27.9	<0	71.9		5.4	<0	11.1
i. Other		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Total		100.0				100.1†				100.0		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Operations for which 100% are cash or spot market purchases	22	84.6	69.8	99.5	5	71.4	26.3	100.0	27	82.8	69.1	96.5

† Total does not sum to 100% because of rounding.

(continued)

Table 6-17. Use of Purchase Methods for Lamb Producers, by Size (Small = 267, Large = 35) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S2.4* What types of pricing methods were used by your operation during the past year for purchasing lambs?												
1. Individually negotiated pricing	23	76.7	60.6	92.7	7	87.5	57.9	100.0	30	78.1	64.0	92.3
2. Public auction	16	53.3	34.4	72.3	4	50.0	5.3	94.7	20	52.9	35.8	69.9
3. Sealed bid	0	0.0	NA	NA	D	12.5	0.0	42.1	D	1.7	0.0	5.2
4. Formula pricing (using another price as the base)	D	6.7	0.0	16.1	D	12.5	0.0	42.1	3	7.5	0.0	16.3
5. Internal transfer	0	0.0	NA	NA	D	12.5	0.0	42.1	D	1.7	0.0	5.2
6. Delivered for custom feeding	D	6.7	0.0	16.1	D	37.5	0.0	80.8	5	10.9	1.3	20.4
7. Other	0	0.0	NA	NA	D	12.5	0.0	42.1	D	1.7	0.0	5.2
S2.5* For lambs purchased by your operation during the past year using formula pricing, what was the base price of the formula?	(results suppressed)				(results suppressed)							
1. USDA live quote									3	45.5	0.0	97.8
2. Subscription service price (for example, Urner Barry)									0	0.0	NA	NA
3. Cost of production									D	24.1	0.0	63.1
4. Other market price									D	15.2	0.0	54.2
5. Other									D	15.2	0.0	54.2
6. Auction price *(write-in response)*									3	39.3	0.0	88.6

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 6-18. Terms of Purchase Methods for Lamb Producers, by Size (Small = 267, Large = 35)

	Small				Large				All Operations			
	n	**Mean**	**Lower**	**Upper**	**n**	**Mean**	**Lower**	**Upper**	**n**	**Mean**	**Lower**	**Upper**
S3.1 For what percentage of lambs purchased during the past year did the buyer (your operation) pay for transportation?	26	73.0	55.9	90.1	7	55.7	11.7	99.7	33	70.6	55.2	86.1
S3.2 What percentage of lambs purchased during the past year were under a written agreement (versus oral)?	25	7.0	<0	16.2	7	14.3	<0	49.2	32	8.0	<0	16.9
	Small (n = 22)				**Large** (n = 6)				**All Operations** (n = 28)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
S3.3 For lambs purchased during the past year, what was the length of the agreement or contract (oral or written) (% of head)?												
a. Purchases not under agreement or contract		88.3	75.7	>100		88.3	58.3	>100		88.3	77.0	99.5
b. Less than 6 months		7.0	<0	15.9		11.7	<0	41.7		7.6	<0	15.9
c. 6 to 11 months		0.2	<0	0.7		0.0	0.0	0.0		0.2	<0	0.6
d. 1 to 2 years		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
e. 3 to 5 years		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
f. 6 to 10 years		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
g. More than 10 years or evergreen		4.5	<0	14.0		0.0	0.0	0.0		3.9	<0	12.0
Total		100.0				100.0				100.0		

(continued)

Table 6-18. Terms of Purchase Methods for Lamb Producers, by Size (Small = 267, Large = 35) (continued)

	Small (n = 25)			Large (n = 7)			All Operations (n = 32)		
	Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
S3.4 For lambs purchased during the past year, how far in advance of delivery was the delivery scheduled (% of head)?									
a. Less than 2 weeks	74.5	57.2	91.8	62.9	18.3	>100	72.9	57.2	88.5
b. 3 to 4 weeks	14.7	1.1	28.3	8.6	<0	29.5	13.8	2.0	25.6
c. 5 to 8 weeks	3.4	<0	9.3	14.3	<0	49.2	4.9	<0	11.4
d. 9 to 12 weeks	7.4	<0	18.0	14.3	<0	49.2	8.4	<0	18.3
e. 13 to 16 weeks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
f. More than 16 weeks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.0			100.1†			100.0		

† Total does not sum to 100% because of rounding.

Table 6-19. Reasons for Using Purchase Methods for Lamb Producers, by Size (Small = 267, Large = 35)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S4.1* What are the three most important reasons why your operation only uses the cash or spot market for purchasing lambs?												
1. Can purchase lambs at lower prices	9	30.0	12.6	47.4	0	0.0	NA	NA	9	27.8	11.7	43.9
2. Reduces risk exposure	7	23.3	7.3	39.4	0	0.0	NA	NA	7	21.6	6.8	36.5
3. Reduces costs of activities for buying lambs	4	13.3	0.4	26.2	0	0.0	NA	NA	4	12.4	0.4	24.3
4. Reduces price variability for lambs	D	10.0	0.0	21.4	D	25.0	0.0	100.0	4	11.1	0.0	22.3
5. Reduces potential liability and litigation concerns	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
6. Increases supply chain information	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
7. Secures higher quality lambs	D	50.0	31.0	69.0	D	50.0	0.0	100.0	17	50.0	32.0	68.0
8. Facilitates or increases market access	3	10.0	0.0	21.4	0	0.0	NA	NA	3	9.3	0.0	19.8
9. Allows for adjusting operations quickly in response to changes in market conditions	D	30.0	12.6	47.4	D	50.0	0.0	100.0	11	31.5	14.8	48.1
10. Does not require identifying and recruiting long-term contracting partners	D	6.7	0.0	16.1	0	0.0	NA	NA	D	6.2	0.0	14.9
11. Does not require managing complex and costly contracts	6	20.0	4.8	35.2	0	0.0	NA	NA	6	18.5	4.5	32.6
12. Eliminates possible negative public perceptions about use of contracts	D	3.3	0.0	10.2	0	0.0	NA	NA	D	3.1	0.0	9.4
13. Allows for independence, complete control, and flexibility of own business	18	60.0	41.4	78.6	4	100.0	100.0	100.0	22	62.9	45.7	80.1
14. Enhances ability to benefit from favorable market conditions	D	23.3	7.3	39.4	D	50.0	0.0	100.0	9	25.3	9.8	40.7
15. Other	0	0.0	NA	NA	D	25.0	0.0	100.0	D	1.8	0.0	5.5

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-19. Reasons for Using Purchase Methods for Lamb Producers, by Size (Small = 267, Large = 35) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S4.2* What are the three most important reasons why your operation uses alternative purchase methods for purchasing lambs?	(results suppressed)				(results suppressed)							
1. Can purchase lambs at lower prices									0	0.0	NA	NA
2. Reduces risk exposure									D	37.1	37.1	37.1
3. Reduces costs of activities for buying lambs									0	0.0	NA	NA
4. Reduces price variability for lambs									0	0.0	NA	NA
5. Reduces potential liability and litigation concerns									0	0.0	NA	NA
6. Increases supply chain information									0	0.0	NA	NA
7. Secures higher quality lambs									D	31.4	0.0	100.0
8. Facilitates or increases market access									0	0.0	0.0	0.0
9. Allows for food safety and biosecurity assurances									D	31.4	0.0	100.0
10. Allows for product traceability									D	62.9	62.9	62.9
11. Improves week-to-week supply management									D	31.4	0.0	100.0
12. Improves efficiency of operations due to animal uniformity									0	0.0	NA	NA
13. Reduces investment requirements for facilities and equipment									D	37.1	37.1	37.1
14. Reduces operating capital requirements									D	37.1	37.1	37.1
15. Enhances access to credit									0	0.0	NA	NA
16. Other									D	31.4	0.0	100.0

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 6-20. Use of Sales Methods for Lamb Producers, by Size (Small = 267, Large = 35)

		Small				Large				All Operations			
		n	Mean	Lower	Upper	n	Mean	Lower	Upper	n	Mean	Lower	Upper
S5.1a	How many feeder lambs did your operation sell or ship during the past year?	100	289.1	71.3	506.8	21	2,755.70	1,828.60	3,682.70	121	561.4	345.1	777.7
S5.1b	How many slaughter lambs (less than 105 pounds liveweight) did your operation sell or ship during the past year?	106	74.7	46.5	102.9	6	2,008.20	<0	4,508.30	112	137.3	69.2	205.4
S5.1c	How many slaughter lambs (105 pounds liveweight or more) did your operation sell or ship during the past year?	136	1,251.2	192.8	2,309.6	18	14,577.5	<0	30,031.2	154	2,217.9	781.4	3,654.5

(continued)

Table 6-20. Use of Sales Methods for Lamb Producers, by Size (Small = 267, Large = 35) (continued)

	Small (n = 245)				Large (n = 33)				All Operations (n = 278)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
S5.2 What methods for selling or shipping lambs were used by your operation during the past year (% of head)?												
a. Auction barns		44.2	38.3	50.2		3.9	<0	10.1		41.3	35.8	46.8
b. Video/electronic auctions		0.5	<0	1.3		2.7	<0	8.3		0.7	<0	1.5
c. Dealers or brokers		10.9	7.2	14.6		10.6	0.0	21.2		10.9	7.3	14.4
d. Direct trade		31.6	26.1	37.1		27.1	12.3	41.9		31.3	26.0	36.5
e. Forward contract		2.6	0.8	4.5		25.2	10.6	39.7		4.3	2.3	6.3
f. Marketing agreement		1.9	0.3	3.6		11.2	0.6	21.8		2.6	0.9	4.3
g. Packer fed/owned		0.4	<0	1.3		0.0	0.0	0.0		0.4	<0	1.2
h. Internal transfer		0.4	<0	1.2		4.2	<0	10.7		0.7	<0	1.6
i. Custom fed, not marketed by your operation		0.5	<0	1.4		11.1	1.0	21.3		1.3	0.3	2.4
j. Custom slaughtered for your operation		5.6	3.0	8.2		3.1	<0	9.3		5.4	2.9	7.9
k. Other		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
l. Co-operative *(write-in response)*		1.2	<0	2.6		0.9	<0	2.8		1.2	<0	2.5
Total		99.8†				100.0				100.1†		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are cash or spot market sales	198	80.8	75.9	85.8	12	36.4	19.0	53.7	210	77.5	72.8	82.3

† Total does not sum to 100% because of rounding.

(continued)

Table 6-20. Use of Sales Methods for Lamb Producers, by Size (Small = 267, Large = 35) (continued)

	Small				Large				All Operations			
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
S5.3* What types of pricing methods were used by your operation during the past year for selling lambs?												
1. Individually negotiated pricing	131	50.6	44.4	56.7	20	60.6	43.0	78.2	151	51.3	45.5	57.1
2. Public auction	156	60.2	54.2	66.2	5	15.2	2.2	28.1	161	57.1	51.4	62.7
3. Sealed bid	6	2.3	0.5	4.2	3	9.1	0.0	19.4	9	2.8	0.9	4.6
4. Formula pricing (using another price as the base)	20	7.7	4.4	11.0	7	21.2	6.5	35.9	27	8.7	5.5	11.9
5. Internal transfer	D	0.4	0.0	1.1	D	6.1	0.0	14.7	3	0.8	0.0	1.7
6. Custom fed, not marketed by your operation	4	1.5	0.0	3.1	6	18.2	4.3	32.1	10	2.7	1.0	4.4
7. Custom slaughtered for your operation	31	12.0	8.0	15.9	3	9.1	0.0	19.4	34	11.8	8.0	15.5
8. Other	3	1.2	0.0	2.5	0	0.0	NA	NA	3	1.1	0.0	2.3
9. Co-operative *(write-in response)*	D	0.8	0.0	1.8	D	3.0	0.0	9.2	3	0.9	0.0	2.0

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-20. Use of Sales Methods for Lamb Producers, by Size (Small = 267, Large = 35) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S5.4a* For lambs sold by your operation during the past year using formula pricing with a grid, what was the base price of the formula?												
1. Individual or multiple packing plant average price	5	41.7	8.9	74.4	3	33.3	0.0	71.8	8	39.1	15.0	63.2
2. USDA live quote	D	16.7	0.0	41.4	D	11.1	0.0	36.7	3	15.0	0.0	32.8
3. USDA dressed or carcass quote	D	8.3	0.0	26.7	D	55.6	15.0	96.1	6	22.8	6.3	39.4
4. USDA boxed lamb price	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
5. Subscription service price (for example, Urner Barry)	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
6. Cost of production	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
7. Retail price	D	25.0	0.0	53.7	D	11.1	0.0	36.7	4	20.7	0.5	41.0
8. Other market price	D	16.7	0.0	41.4	0	0.0	NA	NA	D	11.5	0.0	27.8
9. Other	0	0.0	NA	NA	D	11.1	0.0	36.7	D	3.4	0.0	10.6
10. Auction price *(write-in response)*	D	8.3	0.0	26.7	0	0.0	NA	NA	D	5.8	0.0	17.9
11. Co-op grid *(write-in response)*	0	0.0	NA	NA	D	11.1	0.0	36.7	D	3.4	0.0	10.6

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-20. Use of Sales Methods for Lamb Producers, by Size (Small = 267, Large = 35) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S5.4b* For lambs sold by your operation during the past year using formula pricing without a grid, what was the base price of the formula?												
1. Individual or multiple packing plant average price	D	30.4	10.1	50.8	D	25.0	0.0	100.0	8	29.9	11.0	48.9
2. USDA live quote	4	17.4	0.6	34.2	3	75.0	0.0	100.0	7	22.8	6.9	38.6
3. USDA dressed or carcass quote	5	21.7	3.5	40.0	0	0.0	NA	NA	5	19.7	3.3	36.1
4. USDA boxed lamb price	D	8.7	0.0	21.2	0	0.0	NA	NA	D	7.9	0.0	19.1
5. Subscription service price (for example, Urner Barry)	D	4.3	0.0	13.4	0	0.0	NA	NA	D	3.9	0.0	12.1
6. Cost of production	D	4.3	0.0	13.4	0	0.0	NA	NA	D	3.9	0.0	12.1
7. Retail price	D	13.0	0.0	27.9	D	25.0	0.0	100.0	4	14.2	0.0	28.4
8. Other market price	D	8.7	0.0	21.2	0	0.0	NA	NA	D	7.9	0.0	19.1
9. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
10. Auction price *(write-in response)*	3	13.0	0.0	27.9	0	0.0	NA	NA	3	11.8	0.0	25.2

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-20. Use of Sales Methods for Lamb Producers, by Size (Small = 267, Large = 35) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S5.5* What types of valuation methods were used by your operation during the past year for selling slaughter lambs?												
1. Per head	D	24.6	17.2	32.0	D	13.3	0.0	32.8	35	23.9	16.9	30.9
2. Liveweight	102	76.1	68.8	83.4	8	53.3	24.7	81.9	110	74.7	67.7	81.8
3. Carcass weight, not dependent on grid value	18	13.4	7.6	19.3	4	26.7	1.3	52.0	22	14.3	8.6	19.9
4. Carcass weight, dependent on grid value	6	4.5	0.9	8.0	8	53.3	24.7	81.9	14	7.5	3.8	11.2
5. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 6-21. Terms of Sales Methods for Lamb Producers, by Size (Small = 267, Large = 35)

	Small				Large				All Operations			
	n	**Mean**	**Lower**	**Upper**	**n**	**Mean**	**Lower**	**Upper**	**n**	**Mean**	**Lower**	**Upper**
S6.1 For what percentage of lambs sold during the past year did the seller (your operation) pay for transportation?	179	54.2	47.1	61.2	27	32.3	16.1	48.4	206	52.4	45.8	58.9
S6.2 What percentage of lambs sold during the past year were under a written agreement (versus oral)?	179	5.1	2.0	8.3	28	24.8	8.5	41.1	207	6.8	3.6	10.0
	Small (n = 157)				**Large** (n = 25)				**All Operations** (n = 182)			
S6.3 For lambs sold during the past year, what was the length of the agreement or contract (oral or written) (% of head)?												
a. Sales not under agreement or contract		86.8	81.6	92.1		37.5	18.5	56.5		82.6	77.5	87.7
b. Less than 6 months		7.9	3.8	12.0		43.2	24.5	61.9		10.9	6.9	15.0
c. 6 to 11 months		3.4	0.6	6.2		2.6	<0	8.0		3.3	0.8	5.9
d. 1 to 2 years		0.6	<0	1.8		0.0	0.0	0.0		0.6	<0	1.6
e. 3 to 5 years		0.6	<0	1.9		12.0	<0	25.7		1.6	0.0	3.2
f. 6 to 10 years		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
g. More than 10 years or evergreen		0.6	<0	1.9		4.7	<0	10.2		1.0	<0	2.2
Total		99.9†				100.0				100.0		

† Total does not sum to 100% because of rounding.

(continued)

Table 6-21. Terms of Sales Methods for Lamb Producers, by Size (Small = 267, Large = 35) (continued)

	Small (n = 169)			Large (n = 28)			All Operations (n = 197)		
S6.4 For lambs sold during the past year, how far in advance of delivery was the delivery scheduled (% of head)?									
a. Less than 7 days	68.7	62.0	75.5	33.4	15.7	51.1	65.6	59.2	71.9
b. 8 to 14 days	16.4	11.1	21.7	16.4	4.1	28.8	16.4	11.4	21.3
c. 15 to 21 days	2.5	0.3	4.6	9.5	<0	20.5	3.1	0.9	5.2
d. 22 to 30 days	6.6	2.9	10.2	8.4	<0	18.7	6.7	3.3	10.2
e. 1 to 2 months	4.2	1.2	7.1	11.6	0.4	22.9	4.8	2.0	7.7
f. More than 2 months	1.7	<0	3.5	20.7	5.7	35.6	3.4	1.3	5.5
Total	100.1†			100.0			100.0		

† Total does not sum to 100% because of rounding.

Table 6-22. Reasons for Using Sales Methods for Lamb Producers, by Size (Small = 267, Large = 35)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S7.1* What are the three most important reasons why your operation only uses the cash or spot market for selling lambs?												
1. Can sell lambs at higher prices	88	44.2	37.3	51.2	6	46.2	14.8	77.5	94	44.3	37.5	51.1
2. Reduces risk exposure	D	15.1	10.1	20.1	D	15.4	0.0	38.1	32	15.1	10.2	20.0
3. Reduces costs of activities for selling lambs	67	33.7	27.0	40.3	3	23.1	0.0	49.6	70	33.3	26.8	39.7
4. Reduces price variability for lambs	16	8.0	4.2	11.9	0	0.0	NA	NA	16	7.7	4.1	11.4
5. Reduces potential liability and litigation concerns	12	6.0	2.7	9.4	0	0.0	NA	NA	12	5.8	2.6	9.0
6. Increases supply chain information	D	1.0	0.0	2.4	0	0.0	NA	NA	D	1.0	0.0	2.3
7. Allows for sale of higher quality lambs	28	14.1	9.2	18.9	0	0.0	NA	NA	28	13.5	8.9	18.2
8. Facilitates or increases market access	23	11.6	7.1	16.0	0	0.0	NA	NA	23	11.1	6.8	15.4
9. Allows for adjusting operations quickly in response to changes in market conditions	30	15.1	10.1	20.1	5	38.5	7.9	69.1	35	15.9	11.0	20.9
10. Does not require identifying and recruiting long-term contracting partners	D	16.6	11.4	21.8	D	15.4	0.0	38.1	35	16.5	11.5	21.6
11. Does not require managing complex and costly contracts	32	16.1	10.9	21.2	3	23.1	0.0	49.6	35	16.3	11.3	21.4
12. Eliminates possible negative public perceptions about use of contracts	D	0.5	0.0	1.5	0	0.0	NA	NA	D	0.5	0.0	1.4
13. Allows for independence, complete control, and flexibility of own business	119	59.8	52.9	66.7	11	84.6	61.9	100.0	130	60.7	54.1	67.4
14. Enhances ability to benefit from favorable market conditions	64	32.2	25.6	38.7	6	46.2	14.8	77.5	70	32.7	26.3	39.1
15. Other	3	1.5	0.0	3.2	0	0.0	NA	NA	3	1.5	0.0	3.1
16. No other choice *(write-in response)*	4	2.0	0.0	4.0	0	0.0	NA	NA	4	1.9	0.0	3.8
17. Can easily sell small number of animals *(write-in response)*	3	1.5	0.0	3.2	0	0.0	NA	NA	3	1.5	0.0	3.1
18. Convenience *(write-in response)*	5	2.5	0.3	4.7	0	0.0	NA	NA	5	2.4	0.3	4.5

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 6-22. Reasons for Using Sales Methods for Lamb Producers, by Size (Small = 267, Large = 35) (continued)

	Small				Large				All Operations			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S7.2* What are the three most important reasons why your operation uses alternative sales methods for selling lambs?												
1. Can sell lambs at higher prices	18	72.0	53.1	90.9	9	52.9	26.5	79.4	27	66.5	51.5	81.6
2. Reduces risk exposure	8	32.0	12.3	51.7	11	64.7	39.4	90.0	19	41.4	26.0	56.7
3. Reduces costs of activities for selling lambs	4	16.0	0.6	31.4	3	17.6	0.0	37.9	7	16.5	4.4	28.6
4. Reduces price variability for lambs	5	20.0	3.1	36.9	3	17.6	0.0	37.9	8	19.3	6.3	32.3
5. Reduces potential liability and litigation concerns	0	0.0	NA	NA	D	5.9	0.0	18.4	D	1.7	0.0	5.1
6. Increases supply chain information	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
7. Allows for sale of higher quality lambs	10	40.0	19.4	60.6	5	29.4	5.3	53.6	15	37.0	21.1	52.8
8. Facilitates or increases market access	D	12.0	0.0	25.7	D	5.9	0.0	18.4	4	10.2	0.1	20.4
9. Increases flexibility in responding to consumer demand	D	8.0	0.0	19.4	D	11.8	0.0	28.8	4	9.1	0.0	18.3
10. Allows for product branding in retail sales	3	12.0	0.0	25.7	0	0.0	NA	NA	3	8.6	0.0	18.1
11. Allows for food safety and biosecurity assurances	D	8.0	0.0	19.4	0	0.0	NA	NA	D	5.7	0.0	13.7
12. Allows for product traceability	D	4.0	0.0	12.3	0	0.0	NA	NA	D	2.9	0.0	8.6
13. Improves week-to-week production management	D	4.0	0.0	12.3					D	2.9	0.0	8.6
14. Secures a buyer for lambs	12	48.0	27.0	69.0	7	41.2	15.1	67.3	19	46.0	29.7	62.4
15. Provides detailed carcass data	D	4.0	0.0	12.3	D	11.8	0.0	28.8	3	6.2	0.0	13.6
16. Enhances access to credit	0	0.0	NA	NA	D	11.8	0.0	28.8	D	3.4	0.0	8.0
17. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

7 Survey Results: Meat Packers

This section presents the weighted tabulations for beef packers, pork packers, and lamb packers. We provide tables with weighted tabulations for all survey questions, tables with weighted tabulations for selected questions by size (small versus large) for beef packers and pork packers (results are not provided by size for lamb packers because of the small number of respondents), and a brief summary of the key findings from the survey.

For weighted proportions, the tables provide the number of respondents (n), the estimated proportion weighted by the number of eligible plants (%), and the corresponding 95% confidence interval (lower and upper) for each response item. For questions for which respondents could select only one response, the sum of the responses equals 100%. For questions for which respondents could select more than one response, the total may sum to more than 100%. These questions are noted with an asterisk (*).

For weighted means, the tables provide the number of respondents used in the mean calculation (n), the estimated mean weighted by the number of eligible plants (mean), and the corresponding 95% confidence interval (lower and upper).

In reporting the survey findings for beef and pork packers, we make comparisons between small and large plants and changes in marketing practices between 3 years ago, the past year, and the next 3 years. These comparisons are based on the magnitude of the point estimates and not on statistical testing. The confidence intervals provided in the tables can be used to make comparisons between survey estimates. That is, overlapping confidence intervals suggest that the difference between the corresponding point estimates is not statistically significant.

7.1 BEEF PACKERS

Table 7-1 provides weighted tabulations for all survey questions for beef packers (n = 64). The survey response rate by beef packers was low, but the results provide useful information about use of AMAs in the industry. Tables 7-2 through 7-7 provide weighted tabulations for selected questions by size (n = 34 for small beef packers and n = 30 for large beef packers).

7.1.1 Characteristics of Beef Packing Plants

During the past year, 67% of beef packers purchased fewer than 1,000 steers, and 88% purchased fewer than 500,000 steers. About 66% of beef packers purchased fewer than 1,000 heifers, and 92% purchased fewer than 500,000 heifers. During calendar year 2002 (prior to the ban on importation of cattle from Canada), less than 1% of the fed cattle purchased for slaughter were imported from Canada. Relatively few plants custom slaughter. Of the plants that performed custom slaughter in the past year, 60% custom slaughtered fewer than 500 fed cattle. (See Table 7-1, Questions 1.4, 1.5, and 8.8.)

More than one-half of beef packers also slaughtered other beef cattle, dairy cattle, hogs, and/or lambs, in addition to fed beef cattle (including fed Holsteins). More than 80% of plants conducted slaughter, fabrication, and further processing activities. The maximum slaughter capacity averaged 4,700 head per week, with an average slaughter speed line of 114 head per hour. The maximum processing capacity averaged 3.2 million pounds of beef product per week. (See Table 7-1, Questions 1.2, 1.3, 8.4, 8.5, and 8.6.)

Of the fed cattle slaughtered during the past year, 24% (percentage of total head) were classified as heavy weight carcasses, 13% were classified as light weight carcasses, and 63% were standard weight carcasses.[1] On average, carcasses weighing more than 854 pounds were considered heavy weight,

[1] These values were computed as the mean percentage of head weighted by the number of eligible plants. Other reported means were computed similarly (i.e., weighted by the number of eligible plants).

and light weight carcasses weighed less than 578 pounds. (See Table 7-1, Question 1.8.)

According to USDA data on industry averages, the largest number of beef carcasses is Yield Grade 3. However, of the fed cattle slaughtered during the past year in the plants surveyed, 8% were Yield Grade 1, 27% were Yield Grade 2, 20% were Yield Grade 3, 8% were Yield Grade 4 or 5, and 37% had no yield grade. Of the fed cattle slaughtered during the past year, 3% were USDA Prime, 39% were USDA Choice, 12% were USDA Select, 8% were USDA standard, and 38% had an other or no quality grade (No-Roll). In contrast, USDA data suggest the industry average had more carcasses graded as Select and fewer graded as No-Roll. (See Table 7-1, Questions 1.6 and 1.7.)

Most plants (78%) are small, independently owned businesses and are not part of a company that owns another slaughter or processing plant. Additionally, more than half are not part of a company that owns other upstream or downstream businesses. (See Table 7-1, Questions 1.10 and 8.7.)

Many beef packing plants did not participate in any type of certification program or alliances.

Nearly 60% of plants did not participate in any type of certification program. For plants that participated in a certification program last year, the most frequently cited programs were CAB and own-company certification programs. Nearly one-fourth of plants identified themselves as participating in an alliance, with most participating in only one alliance. For plants participating in alliances, more than 44% of plants participated in alliances with feedlot operators only, and 19% participated in alliances that included three or more other stages of production. (See Table 7-1, Questions 1.9 and 1.11.)

About 45% of plants reported total gross sales for fresh, frozen, and processed beef products of less than $500,000, and 75% reported total gross sales of less than $5 million. About 74% of plants reported total gross sales for beef by-products of less than $500,000, and 79% reported total gross sales of less than $5 million. For total gross sales for all products, 41% of plants reported sales of less than $500,000, and 69% reported sales of less than $5 million. Thirteen percent of plants had total gross sales of more than $500 million. (See Table 7-1, Questions 8.10 and 8.11.)

During the past year, 32% of total beef product sales were for carcasses or sides; 30% were for primal or subprimal cuts; 14% were for ground beef (including trimmings); and more than 20% were either for portion cuts, case-ready cuts, or processed cuts. Of the beef products sold during the past year, 4% were branded. (See Table 7-1, Questions 1.12 and 1.13.)

7.1.2 Methods for Purchasing or Receiving Fed Cattle by Beef Packers

Of the fed cattle received during the past year, more than 86% were owned solely by the operation. For 76% of plants, all of their fed cattle were owned solely by the operation during the past year. Plants' ownership arrangements were very similar 3 years ago and are not expected to change within the next 3 years. (See Table 7-1, Question 2.1.)

Beef packers used a variety of methods to receive fed cattle. However, nearly 60% of plants used only spot market transactions for purchases of cattle during the past year.

Beef packers used a variety of methods to receive fed cattle. However, nearly 60% of plants used only spot market transactions for purchases of cattle during the past year. Of these spot market transactions, 44% of purchases of fed cattle were through direct trade, 19% through auctions, and 11% through dealers/brokers. More than one-fourth of purchases were through AMAs (i.e., marketing agreement, forward contract, packer-fed owned, or other). Plants' purchase methods were very similar 3 years ago and are not expected to change within the next 3 years. (See Table 7-1, Question 2.2.)

The most frequently cited pricing methods were individually negotiated pricing (73%), public auction (44%), and formula pricing (37%).[2] Plants that used formula pricing used many sources for the base price of the formula. The sources used most often as the base for grid pricing included CME cattle futures, individual or multiple-plant average price, USDA dressed or carcass quote, and USDA live quote. For formula pricing without a grid, CME cattle futures and USDA dressed or carcass quote were used most often as the base. The most frequently cited valuation methods for fed cattle purchases were carcass weight without grid pricing (69%) and liveweight (61%). Little change is expected in valuation methods in the next 3 years. (See Table 7-1, Questions 2.3 through 2.6.)

Buyers paid transportation costs in 31% of transactions. There were few cattle purchased using a written contract (7% of

[2] Respondents could select multiple responses.

transactions). When contracts or agreements were used, they were either short term (less than 6 months), which were likely based on market conditions and perception of the need for risk management, or long term (more than 10 years or evergreen), which were likely based on strategic business decisions. More than 93% of cattle purchased were scheduled for delivery within 2 weeks, and another 3% were scheduled for delivery 2 to 4 weeks in advance. (See Table 7-1, Questions 3.1 through 3.4.)

Of the fed cattle purchased during the last year, plants provided information back to the feeder or finisher on 26% of the total head purchased. Of plants that provided information, 93% provided information on carcass weight for individual animals. More than 60% provided information on USDA carcass quality grade, USDA carcass yield grade, or price paid for individual animals. Almost 80% provided information at the request of the seller for no charge. Plants provided information as a result of use of marketing agreements (47% of plants), alliances (36%), and forward contracts (36%). (See Table 7-1, Questions 3.5 through 3.7.)

Procuring fed cattle in cash markets allows those plants to respond to market conditions and to take advantage of market opportunities. However, cash procurement also allows plants to focus on their own operations without concerns about strategic partner behavior or issues of working with a strategic partner.

Plants that used only spot market transactions to purchase cattle were asked to identify the three most important reasons for using the spot market. More than 51% identified “Allows for independence, complete control, and flexibility of own business” as an important reason. About 44% chose “Secures higher quality fed cattle,” and more than 38% chose “Allows for adjusting operations quickly in response to changes in market conditions.” The main reason for using only the spot or cash market appears to be opportunistic. Procuring fed cattle in cash markets allows those plants to respond to market conditions and to take advantage of market opportunities. However, cash procurement also allows plants to focus on their own operations without concerns about strategic partner behavior or issues of working with a strategic partner. Furthermore, some respondents perceived that cattle can be purchased more cheaply in the cash market and that high-quality cattle can be obtained. (See Table 7-1, Question 4.1.)

Plants using AMAs were asked to identify their reasons for choosing an alternative to the cash market. Almost 58% chose “Improves week-to-week supply management.” Fifty-four percent of plants chose “Secures higher quality calves and cattle," and 46% chose "Allows for product branding in retail stores." Thus, it appears that AMAs allow plants to focus on operational efficiency improvements. Also, AMAs appear to be important for economic plant management and to be quality-improving and demand-satisfying arrangements. However, respondents did not indicate that AMAs allow plants to pay reduced prices or decrease price risk. (See Table 7-1, Question 4.2.)

7.1.3 Methods for Selling or Transferring Beef Product by Beef Packers

Beef packers sell their products to a variety of buyers/recipients through a variety of methods. Thirty-five percent of total beef product dollar sales were to retail establishments, 22% were direct sales to consumers, 17% were to meat processors or food manufacturers, 15% were to wholesalers or distributors, and 10% were to other types of buyers. (See Table 7-1, Question 5.1.)

Almost 84% of beef products were sold through spot market transactions, 10% through AMAs (forward contracts or marketing agreements), and 4% through internal transfers.

Almost 84% of beef products were sold through spot market transactions, 10% through AMAs (forward contracts or marketing agreements), and 4% through internal transfers. All or nearly all plants used the cash market when selling, regardless of the type of buyer or recipient. Use of forward contracts and marketing agreements was more common for beef packers selling to food service establishments. Most beef packers selling to foreign buyers used marketing agreements. Beef packers transferring beef products to processors and manufacturers were doing so through internal transfers to other establishments owned by the company. (See Table 7-1, Questions 5.2 and 5.3.)

The most frequently cited methods for pricing beef products were price lists, individually negotiated pricing, and formula pricing. The type of pricing method used varied depending on the type of buyer or recipient. For sales to processors/manufacturers and wholesalers/distributors, most plants used individually negotiated pricing, with price lists used to a lesser extent. For sales to retail establishments, most plants used price lists, with individually negotiated pricing used to a lesser extent. For sales to food service establishments, nearly all plants used price lists, and about one-half used individually negotiated pricing and/or formula pricing. For sales to foreign buyers, all plants used individually negotiated pricing, and about half also used price lists. The USDA publicly reported price was most often used as the base price for formula pricing. About 17% to 38% of plants used volume discounts, depending on the type of buyer. Use of exclusive dealings was most common when selling to food service establishments (28% of plants). Fewer plants used two-part pricing and bundling. (See Table 7-1, Questions 5.4 through 5.7.)

On average, 32% of plants reported paying transportation costs for beef products sold. Less than 7% of the beef products sold were under a written agreement. Most agreements, both written and oral, were for less than 1 month. Delivery was also scheduled short term; 67% of deliveries were scheduled less than 7 days in advance. (See Table 7-1, Questions 6.1 through 6.4.)

For plants that only used spot market methods, the three most frequently cited reasons for doing so were (1) “Allows for independence, complete control, and flexibility of own business” (61%), (2) “Allows for adjusting operations quickly in response to changes in market conditions” (37%), and (3) “Does not require managing complex and costly contracts” (31%). Most reasons for using the spot market appear to be opportunistic or entrepreneurial. Selling beef products in cash markets allows plants to respond to market conditions and to take advantage of market opportunities. Furthermore, cash market procurement allows businesses to focus on their own operations, without concern about strategic partner management or behavior. To some extent, there appears to be a perception that the cash market allows for sales at higher prices and higher quality products. (See Table 7-1, Question 7.1.)

For plants that used alternatives to the cash or spot market, the most frequently cited reason for doing so was that it “Increases flexibility in responding to consumer demand” (72%). About 44% to 58% also chose “Reduces risk of exposure,” “Reduces price variability for beef products,” and “Improves week-to-week production management” as important reasons for using AMAs to sell beef products. It appears that plants use AMAs to satisfy consumer needs, but AMAs also allow plants to reduce risk and to focus on operational efficiency. (See Table 7-1, Question 7.2.)

7.1.4 Beef Packers' Marketing Practices, by Size of Plant

Most large beef packers only slaughtered fed cattle, while small beef packers slaughtered other livestock, such as other beef cattle, dairy cattle, hogs, and lambs. Custom slaughter was more common among small packers than among large packers. Further processing activities were more common among small packers than among large packers (85% versus 67%). Compared with small packers, large packers were more likely to participate in certification programs (90% versus 25%). Among large packers, 87% participated in the CAB certification program, and 53% participated in company programs that certify breed or livestock. Likewise, large packers were more likely to participate in an alliance (77% or larger packers versus 9% of small packers). Large packers also were more likely to be integrated.[3]

Ownership methods for fed cattle purchased for slaughter were similar for small and large plants. Most small (87%) and large (84%) plants were sole owners of fed cattle, and 5% or less of both small and large plants were shared owners of fed cattle. (See Table 7-2, Question S2.1.)

Purchasing practices for fed cattle differed by size of plant. About 78% of small plants purchased all of their fed cattle on the spot market compared with only 10% of large plants.

Purchasing practices for fed cattle differed by size of plant. About 78% of small plants purchased all of their fed cattle on the spot market compared with only 10% of large plants. Large plants used a variety of AMAs, with 11% of purchases through forward contracts and 20% thorough marketing agreements. (See Table 7-2, Question S2.2.)

Small packers priced cattle purchased using individually negotiated pricing (68% of plants) and public auctions (42%). Large plants also used individually negotiated pricing (90%) and public auctions (50%), but they had a greater reliance on formula pricing (93%).[4] Most small packers used carcass weight without a grid or liveweight as a valuation method. Large packers used these and carcass weight with a grid as valuation methods. (See Table 7-2, Questions S2.3, S2.4, and S2.6.)

Large plants paid to transport more of the fed cattle purchased compared with small plants (50% versus 25% of transactions). One-fourth of large plants' purchase transactions were under a

[3] We do not present results by size for these questions in the tables.
[4] Respondents could select multiple responses.

written agreement, compared with only 2% of small plants' transactions. For fed cattle purchased under contract, most small and large plants specified an agreement of less than 6 months. Both large and small plants scheduled approximately 93% of purchased fed cattle to be delivered in less than 2 weeks. Large plants were more likely than small plants to provide information back to the feeder or finisher (49% versus 18% of plants). (See Table 7-3.)

Because of the small number of respondents, we cannot compare plants' reasons for using only the cash market for purchasing fed cattle by size of plant. No small plants responding to the survey used AMAs to purchase fed cattle. The three most frequently cited reasons given by large plants for using AMAs to purchase fed cattle were "Improves week-to-week supply management," "Secures higher quality fed cattle," and "Allows for product branding in retail sales." (See Table 7-4.)

Small plants primarily sold their beef products to retail establishments (37% of total sales), and 29% of their sales were direct to consumers. Large plants sold beef products to a variety of buyers or recipients. Of large plants' total beef product dollar sales, 30% were to retail establishments, 27% were to wholesalers or distributors, 19% were to meat processors or food manufacturers, 9% were to food service establishments, 3% were to foreign buyers, and 12% were internal transfers. (See Table 7-5, Question S5.1.)

Compared with large plants, small plants had a greater reliance on spot market methods for selling beef products.

Compared with large plants, small plants had a greater reliance on spot market methods for selling beef products. Eighty-eight percent of small plants sold all of their beef products using spot market methods, while only 19% of large plants sold all of their beef products using spot market methods. For large plants, 61% of sales were spot market transactions, 15% were through marketing agreements, 10% were through forward contracts, and 14% were internal transfers. (See Table 7-5, Question S5.2.)

Both small and large plants primarily used price lists and individually negotiated pricing to price their beef products. Use of formula pricing and internal transfers were more common among large plants than among small plants. Large plants most often used USDA publicly reported prices as the base price for formula pricing. (See Table 7-5, Questions S5.5 and S5.6.)

Large plants were more likely than small plants to pay transportation costs for beef products sold (67% versus 22% of total beef meat sales). Few small or large plants used written contracts (7% of total beef sales). Large plants had longer contract lengths compared with small plants. Large plants also had longer delivery schedules, with 17% of sales delivered within 3 days, 24% of sales delivered between 4 and 6 days, and 59% of sales delivered a week or more ahead. (See Table 7-6.)

Because of the small number of respondents, we suppressed packers' stated reasons for using the spot market or AMAs. Thus, we cannot compare plants' stated reasons for use of sales methods by size of plant. (See Table 7-7.)

7.1.5 Beef Packer Survey Summary

The majority of plants within the beef packing industry are small plants; however, these small businesses purchased a relatively small portion of the fed cattle in the industry. Many beef packing plants did not participate in any type of certification program or alliance; however, large plants were more likely than small plants to participate in such programs.

Many beef packers relied on spot market transactions for purchasing fed cattle. Small plants were more likely to use spot market transactions to purchase fed cattle than were large plants. For large plants, the most common types of AMAs were marketing agreements and forward contracts. Plants employed a variety of methods for pricing fed cattle, including individually negotiated pricing, formula pricing, and public auctions. Most purchases were not under a written agreement and were delivered within 7 days. Plants that only used cash markets for purchasing fed cattle did so because it allows for independence, control, and flexibility over business operations. Plants that used AMAs did so to improve operational efficiency. Furthermore, it appears AMAs were important for plant management and helped improve quality and satisfy buyers' requirements.

Most beef product sales were through the cash or spot market, with small plants having a much greater reliance than large plants on the cash market. Plants used price lists, individually negotiated pricing, and formula pricing to price beef products. Most sales were not under a written agreement and were delivered within 3 days. Plants that only used cash markets to sell beef products did so because of the flexibility and simplicity of using the cash market. Plants that used AMAs did so to satisfy consumer demand, reduce risk, and improve operational efficiency.

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64)

		n	%	Lower	Upper
1.2*	What types of livestock did your plant slaughter during the past year?				
	1. Fed beef cattle (including fed Holsteins)	64	100.0	100.0	100.0
	2. Other beef cattle	33	67.5	56.8	78.3
	3. Dairy cattle	26	51.6	38.1	65.0
	4. Hogs	28	63.8	53.5	74.0
	5. Lambs or sheep	24	54.6	42.4	66.9
	6. Other	0	0.0	NA	NA
	7. Goats	8	16.7	5.7	27.7
	8. Buffalo, elk, or deer	7	15.9	5.0	26.8
1.3	Which of the following best describes your plant's operations during the past year?				
	1. Only conducted slaughter operations	3	2.3	0.0	4.8
	2. Conducted slaughter and fabrication operations, but no further processing activities	12	16.7	6.5	26.8
	3. Conducted slaughter operations, fabrication operations, and further processing activities	49	81.1	70.8	91.4
	Total		100.1†		
		n	**Mean**	**Lower**	**Upper**
1.4a	How many steers were purchased by your plant during the past year?	59	114,181.6	84,663.7	143,699.6
		n	**%**	**Lower**	**Upper**
	1–999	26	66.8	58.2	75.4
	1,000–9,999	4	8.6	0.0	17.3
	10,000–99,999	5	4.2	0.7	7.8
	100,000–499,999	10	8.5	4.0	13.0
	500,000–1,999,999	14	11.9	7.2	16.6
	2,000,000 or more	0	0.0	NA	NA
	Total		100.0		

NA = Confidence interval not calculable.

(continued)

* Respondents could select multiple responses.

† Total does not sum to 100% because of rounding.

A description of the notation used in the table headers is provided below.
- n = number of respondents
- % = estimated proportion weighted by the number of eligible plants
- Mean = estimated mean weighted by the number of eligible plants
- Lower = lower bound of the 95% confidence interval for the weighted proportion or mean
- Upper = upper bound of the 95% confidence interval for the weighted proportion or mean

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

		n	Mean	Lower	Upper
1.4b	How many heifers were purchased by your plant during the past year?	47	96,539.2	68,299.5	124,778.9
		n	**%**	**Lower**	**Upper**
	1–999	19	65.7	58.7	72.6
	1,000–9,999	4	6.9	0.0	14.8
	10,000–99,999	5	5.7	1.0	10.4
	100,000–499,999	12	13.7	7.7	19.8
	500,000–999,999	7	8.0	2.7	13.3
	1,000,000 or more	0	0.0	NA	NA
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
1.4c	How many mixed steers/heifers were purchased by your plant during the past year?	5	57,616.2	20,547.5	94,684.9
		n	**%**	**Lower**	**Upper**
	1–999	0	0.0	NA	NA
	1,000–99,999	5	100.0	100.0	100.0
	100,000 or more	0	0.0	NA	NA
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
1.4d	How many other cattle were purchased by your plant during the past year?	21	4,441.1	<0	10,006.1
		n	**%**	**Lower**	**Upper**
	1–499	11	61.0	36.1	86.0
	500–999	4	14.6	0.0	31.9
	1,000 or more	6	24.4	2.2	46.5
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
1.5	How many fed cattle were custom slaughtered by your plant during the past year?	39	1,329.0	82.4	2,575.5
		n	**%**	**Lower**	**Upper**
	1–499	22	60.2	43.6	76.8
	500–999	9	24.3	9.5	39.1
	1,000–99,999	8	15.5	4.0	27.1
	100,000 or more	0	0.0	NA	NA
	Total		100.0		

NA = Confidence interval not calculable.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

	Percentage of Total Head (n = 43)			Percentage of Total Weight (n = 32)		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
1.6 What was the carcass yield grade for fed cattle slaughtered by your plant during the past year?						
a. Yield grade 1	8.2	1.3	15.1	9.7	<0	19.8
b. Yield grade 2	26.8	16.3	37.4	25.3	12.4	38.2
c. Yield grade 3	20.1	13.5	26.7	15.6	9.8	21.4
d. Yield grade 4	6.9	0.9	12.8	7.5	<0	15.7
e. Yield grade 5	0.7	0.0	1.5	0.3	0.1	0.5
f. Other yield grade or no yield grade	37.2	20.8	53.7	41.7	22.3	61.1
Total	99.9†			100.1†		

	Percentage of Total Head (n = 47)			Percentage of Total Weight (n = 34)		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
1.7 What was the carcass quality grade for fed cattle slaughtered by your plant during the past year?						
a. Prime	2.5	0.7	4.2	0.8	0.5	1.1
b. Choice	39.1	27.0	51.2	37.2	21.9	52.5
c. Select	12.2	7.9	16.4	11.1	4.0	18.3
d. Standard	7.9	1.8	14.0	8.3	<0	17.0
e. Other quality grade or no quality grade	38.4	22.7	54.1	42.5	23.5	61.5
Total	100.1†			99.9†		

† Total does not sum to 100% because of rounding.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

	Weight Range (pounds)				Percentage of Total Head (n = 44)			Percentage of Total Weight (n = 30)		
	n	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
1.8 What was the carcass weight classification for fed cattle slaughtered by your plant during the past year?										
a. Standard weight carcasses	—	—	—	—	63.4	51.0	75.9	62.3	46.1	78.5
b. Heavy weight carcasses	49	854.3	787.0	921.5	23.8	13.8	33.7	25.4	12.0	38.7
c. Light weight carcasses	44	577.5	521.7	633.2	12.8	6.4	19.1	12.3	3.7	21.0
Total					100.0			100.0		

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

		n	%	Lower	Upper
1.9*	What types of certification programs did your plant participate in during the past year?				
	1. None	24	58.0	45.3	70.7
	2. Kosher certification	3	2.6	0.0	5.5
	3. Halal certification	3	4.4	0.0	10.2
	4. Organic certification	6	12.3	2.0	22.5
	5. USDA Process Verified certification	10	12.2	3.7	20.8
	6. ISO certification	0	0.0	NA	NA
	7. Certified Angus Beef	27	25.3	19.1	31.5
	8. Other third-party certification of breed or livestock quality (not including Certified Angus Beef)	9	11.4	3.0	19.8
	9. Own-company certification of breed or livestock quality	17	16.6	9.4	23.8
	10. Buyer certification of breed or livestock quality	D	2.6	0.0	7.9
	11. Other	D	2.6	0.0	7.9
1.10*	What levels of production were owned by the same company that owns your plant during the past year?				
	1. None	28	52.4	38.4	66.5
	2. Seed stock supplier	0	0.0	NA	NA
	3. Feed company	5	3.9	0.7	7.2
	4. Cow calf operation	D	4.8	0.0	11.4
	5. Feedlot	12	14.3	5.3	23.2
	6. Food manufacturer or meat processor	28	33.3	21.2	45.3
	7. Restaurant, hotel, or other food service	0	0.0	NA	NA
	8. Grocery store, meat market, or other retailer	8	19.1	7.2	31.0
	9. Exporter	9	7.1	3.1	11.1
	10. Other	0	0.0	NA	NA
1.11a	What types of alliances did your plant participate in during the past year for purchasing fed cattle and/or selling beef products?				
	– Plants participating in an alliance	26	24.1	15.7	32.6
	– Respondents with one alliance	10	37.5	12.7	62.3
	– Respondents with two alliances	4	25.1	3.7	46.5
	– Respondents with three alliances	4	12.5	0.5	24.4
	– Respondents with four alliances	D	3.1	0.0	9.6
	– Respondents with five alliances	7	21.8	7.3	36.3

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

		n	%	Lower	Upper
1.11b	For beef packers that participated in alliances, what types of alliances did your plant participate in during the past year for purchasing fed cattle and/or selling beef products?				
	1. Seed stock supplier only	D	1.3	0.0	3.8
	2. Feedlot only	29	44.3	30.6	58.0
	3. Other packer only	12	15.2	7.2	23.1
	4. Retailer only	4	10.2	0.2	20.2
	5. Feedlot, cow-calf operation	3	3.8	0.0	8.1
	6. Retailer and food service	5	6.3	0.9	11.8
	7. Seed stock supplier, cow-calf operation, and feedlot	13	16.4	8.2	24.6
	8. Seed stock supplier, feed company, cow-calf operation, and feedlot	D	2.5	0.0	6.1
	Total		100.0		
			Mean (n = 52)	**Lower**	**Upper**
1.12	What was your plant's percentage of total beef product dollar sales during the past year, by product category?				
	a. Carcass or side		32.4	20.4	44.4
	b. Primal cuts		8.5	2.7	14.4
	c. Subprimal cuts		21.7	16.8	26.6
	d. Ground, including trimmings		14.1	8.0	20.1
	e. Portion cuts		4.5	<0	9.8
	f. Case ready		3.7	<0	8.6
	g. Processed, ready-to-eat		4.9	<0	10.8
	h. Processed, not-ready-to-eat		7.5	<0	15.1
	i. Other		2.6	<0	7.8
	Total		99.9†		
		n	**Mean**	**Lower**	**Upper**
1.13	What percentage of beef product sold by your plant during the past year was branded?	58	4.4	0.2	8.5

D = Results suppressed.

† Total does not sum to 100% because of rounding.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

		3 Years Ago (n = 48)				During Past Year (n = 49)				Expected in 3 Years (n = 47)		
		Mean	Lower	Upper		Mean	Lower	Upper		Mean	Lower	Upper
2.1 For all fed cattle purchased or received by your operation, what were the ownership arrangements (% of head)?												
a. Sole ownership by your plant		83.1	71.1	95.1		86.4	76.0	96.8		85.8	74.6	96.9
b. Joint venture		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
c. Shared ownership		7.8	<0	16.4		4.7	<0	10.8		4.8	<0	11.4
d. Other		9.1	0.0	18.3		8.9	0.0	17.8		9.4	0.0	18.9
Total		100.0				100.0				100.0		
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
Operations for which 100% are sole ownership	34	75.5	62.0	89.1	35	76.3	63.1	89.4	34	77.9	65.0	90.8

		3 Years Ago (n = 57)				During Past Year (n = 57)				Expected in 3 Years (n = 55)		
		Mean	Lower	Upper		Mean	Lower	Upper		Mean	Lower	Upper
2.2 What methods are used by your plant for purchasing fed cattle (% of head)?												
a. Auction barns		22.4	10.6	34.2		19.1	7.9	30.3		19.2	7.2	31.1
b. Video/electronic auctions		0.0	0.0	0.1		0.0	0.0	0.0		0.0	0.0	0.0
c. Dealers or brokers		10.3	1.3	19.3		11.0	1.6	20.5		9.7	0.2	19.2
d. Direct trade		40.9	27.2	54.7		44.0	30.2	57.8		42.1	28.1	56.1
e. Forward contract		2.7	0.6	4.9		3.1	0.8	5.3		3.2	1.0	5.3
f. Marketing agreement		13.5	6.0	21.1		10.7	3.0	18.3		12.7	4.4	21.0
g. Packer fed/owned		6.5	<0	14.1		8.5	<0	17.4		9.3	<0	18.9
h. Other		3.6	<0	9.3		3.6	<0	9.3		3.8	<0	9.9
Total		99.9†				100.0				100.0		
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
Operations for which 100% are cash or spot market sales	24	61.4	49.9	72.8	24	59.6	47.2	71.9	22	57.3	44.3	70.2

† Total does not sum to 100% because of rounding.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
2.3* What types of pricing methods are used by your plant for purchasing fed cattle?								
1. Individually negotiated pricing	48	73.1	59.9	86.4	46	73.5	60.0	86.9
2. Public auction	28	43.9	29.5	58.3	24	35.9	22.0	49.7
3. Sealed bid	3	2.4	0.0	5.1	3	2.5	0.0	5.4
4. Formula pricing (using another price as the base)	34	37.3	26.1	48.5	35	40.1	28.5	51.6
5. Internal transfer	14	17.9	7.7	28.1	13	17.9	7.3	28.6
6. Other	D	2.4	0.0	7.3	D	2.6	0.0	7.7

	Grid Pricing				Without Grid Pricing			
	n	%	Lower	Upper	n	%	Lower	Upper
2.4* For fed cattle purchased by your plant during the past year using formula pricing, what was the base price of the formula?								
1. Individual or multiple plant average price	16	50.0	32.5	67.4	3	12.5	0.0	27.7
2. Individual or multiple plant average cost of production	6	18.7	4.5	32.9	6	14.3	1.1	27.4
3. USDA live quote	13	40.6	23.2	58.0	9	19.6	5.8	33.4
4. USDA dressed or carcass quote	12	43.8	26.8	60.8	8	28.6	9.1	48.1
5. USDA boxed beef price	6	25.1	11.8	38.3	5	8.9	1.6	16.2
6. Chicago Mercantile Exchange (CME) cattle futures	18	56.2	39.2	73.2	16	32.0	18.2	45.9
7. Retail price	5	15.6	2.4	28.9	7	19.6	3.2	36.0
8. Subscription service price (for example, Cattle Fax, Urner Barry)	11	34.3	17.3	51.4	7	12.4	4.3	20.6
9. Other market price	0	0.0	NA	NA	D	10.8	0.0	25.4
10. Other	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

		n	%	Lower	Upper
2.5*	For fed cattle received during the past year from another business unit owned by the same company, what was the source of the internal transfer price?				
	1. Price paid for purchased fed cattle	5	61.3	45.0	77.6
	2. Reported market price	8	55.5	14.8	96.2
	3. Measure of internal production cost with a profit margin	0	0.0	NA	NA
	4. Measure of internal production cost without a profit margin	0	0.0	NA	NA
	5. Other	0	0.0	NA	NA

NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
2.6* What types of valuation methods are used by your plant for purchasing fed cattle?								
1. Liveweight	40	61.0	46.2	75.9	38	60.7	45.5	76.0
2. Carcass weight, not dependent on grid value	40	68.5	54.0	83.0	37	65.7	50.5	80.8
3. Carcass weight, dependent on grid value	27	26.7	20.1	33.3	28	29.3	22.5	36.0
4. Other	0	0.0	NA	NA	0	0.0	NA	NA

NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

		n	Mean	Lower	Upper
3.1	For what percentage of fed cattle purchased during the past year did the buyer (your plant) pay for transportation?	60	30.8	18.8	42.9
3.2	What percentage of fed cattle purchased during the past year were under a written agreement (versus oral)?	61	7.2	4.1	10.4

		Mean (n = 57)	Lower	Upper
3.3	For fed cattle purchased during the past year, what was the length of the agreement or contract (oral or written) (% of head)?			
	a. Purchases not under agreement or contract	79.3	68.3	90.2
	b. Less than 6 months	7.2	0.5	13.9
	c. 6 to 11 months	1.7	0.1	3.3
	d. 1 to 2 years	4.0	<0	9.7
	e. 3 to 5 years	2.7	<0	8.1
	f. 6 to 10 years	0.4	<0	0.9
	g. More than 10 years or evergreen	4.7	<0	10.3
	Total	100.0		

		Mean (n = 59)	Lower	Upper
3.4	For fed cattle purchased during the past year, how far in advance of slaughter was the delivery scheduled (% of head)?			
	a. Less than 7 days	76.4	65.1	87.7
	b. 8 to 14 days	16.8	7.3	26.3
	c. 15 to 21 days	1.5	<0	4.1
	d. 22 to 30 days	1.3	<0	3.9
	e. 1 to 2 months	0.0	0.0	0.0
	f. More than 2 months	4.0	<0	9.4
	Total	100.0		

		n	Mean	Lower	Upper
3.5	For what percentage of fed cattle purchased during the past year did your plant provide information back to the feeder or finisher?	59	25.6	15.2	36.0

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

		n	%	Lower	Upper
3.6*	Under what conditions did your plant provide information back to the feeder or finisher?				
	1. Requested by seller, no charge	30	79.2	62.2	96.3
	2. Requested by seller, for a set fee	10	26.4	8.6	44.2
	3. Cash or spot market purchases	3	5.6	0.0	12.0
	4. Forward contract	19	35.7	25.8	45.7
	5. Marketing agreement	25	47.0	39.8	54.2
	6. Alliance	19	35.7	25.8	45.7
	7. Joint venture	D	1.9	0.0	5.7
	8. Shared ownership	12	22.6	12.3	32.9
	9. Other	D	5.7	0.0	17.2
3.7*	What types of information did your plant provide back to the feeder or finisher?				
	1. USDA carcass quality grade for individual animals	31	65.9	49.2	82.7
	2. USDA carcass yield grade for individual animals	30	60.6	45.7	75.4
	3. Carcass weight for individual animals	36	92.8	81.3	100.0
	4. Price paid for individual carcasses	22	60.7	41.6	79.8
	5. USDA carcass quality grade by lot	27	48.0	43.0	53.0
	6. USDA carcass yield grade by lot	27	48.0	43.0	53.0
	7. Carcass weight by lot	27	48.0	43.0	53.0
	8. Average dressing percentage by lot	28	53.4	41.4	65.4
	9. Other	D	1.8	0.0	5.4
	10. Price paid by similar weight range *(write-in response)*	10	17.8	8.4	27.2
	11. Vision machine yield grade, ribeye area, backfat *(write-in response)*	6	10.7	2.7	18.7

D = Results suppressed.

* Respondents could select multiple responses.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

		n	%	Lower	Upper
4.1*	What are the three most important reasons why your plant only uses the cash or spot market for purchasing fed cattle?				
	1. Can purchase fed cattle at lower prices	7	27.1	8.0	46.3
	2. Reduces risk exposure	3	12.9	0.0	27.5
	3. Reduces costs of activities for buying fed cattle	4	17.1	0.6	33.7
	4. Reduces price variability for fed cattle	D	8.6	0.0	20.9
	5. Reduces potential liability and litigation concerns	D	1.4	1.4	1.4
	6. Increases supply chain information	D	4.3	0.0	13.2
	7. Secures higher quality fed cattle	11	44.3	22.7	65.9
	8. Allows for market access	3	12.9	0.0	27.5
	9. Allows for adjusting operations quickly in response to changes in market conditions	9	38.6	17.3	59.8
	10. Does not require identifying and recruiting long-term contracting partners	3	12.9	0.0	27.5
	11. Does not require managing complex and costly contracts	4	17.1	0.6	33.7
	12. Eliminates possible negative public perceptions about use of contracts	D	4.3	0.0	13.2
	13. Allows for independence, complete control, and flexibility of own business	12	51.4	29.7	73.2
	14. Enhances ability to benefit from favorable market conditions	5	21.4	3.5	39.4
	15. Other	0	0.0	NA	NA
	16. Can easily purchase small quantity of fed cattle *(write-in response)*	D	4.3	0.0	13.2
4.2*	What are the three most important reasons why your plant uses alternative purchase methods for purchasing fed cattle?				
	1. Can purchase fed cattle at lower prices	0	0.0	NA	NA
	2. Reduces risk exposure	0	0.0	NA	NA
	3. Reduces costs of activities for buying fed cattle	9	34.6	15.0	54.2
	4. Reduces price variability for fed cattle	0	0.0	NA	NA
	5. Reduces potential liability and litigation concerns	0	0.0	NA	NA
	6. Increases supply chain information	0	0.0	NA	NA
	7. Secures higher quality fed cattle	14	53.8	33.3	74.4
	8. Allows for market access	11	42.3	22.0	62.7
	9. Increases flexibility in responding to consumer demand	5	19.2	3.0	35.5
	10. Allows for product branding in retail sales	12	46.2	25.6	66.7
	11. Allows for food safety and biosecurity assurances	0	0.0	NA	NA
	12. Allows for product traceability	D	3.8	0.0	11.8
	13. Improves week-to-week supply management	15	57.7	37.3	78.0
	14. Improves efficiency of operations due to animal uniformity	11	42.3	22.0	62.7
	15. Enhances access to credit	0	0.0	NA	NA
	16. Other	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

	Mean (n = 56)	**Lower**	**Upper**
5.1 What was your plant's percentage of total beef product dollar sales during the past year by type of buyer or recipient?			
a. Meat processors or food manufacturers	17.2	8.3	26.1
b. Wholesalers or distributors	15.2	8.7	21.7
c. Retail establishments	35.2	24.0	46.4
d. Food service establishments	6.7	1.5	11.9
e. Foreign buyers	0.7	0.5	1.0
f. Other	0.1	0.0	0.1
g. Directly to consumer *(write-in response)*	22.2	9.7	34.7
h. Intercompany transfer *(write-in response)*	2.7	<0	5.6
Total	100.0		

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

		3 Years Ago (n = 53)				During Past Year (n = 52)				Expected in 3 Years (n = 50)		
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
5.2 What sales methods are used by your plant for selling beef products (% of dollar sales)?												
a. Cash or spot market (less than 3 weeks forward)		85.2	76.8	93.6		83.6	74.9	92.3		81.4	72.0	90.8
b. Forward contract		4.7	<0	10.5		5.5	<0	11.5		6.8	0.5	13.1
c. Marketing agreement		3.5	2.2	4.8		4.2	2.7	5.7		4.4	2.9	5.9
d. Internal company transfer		3.7	0.7	6.7		3.7	0.6	6.8		4.3	1.0	7.6
e. Other		2.9	<0	8.6		2.9	<0	8.9		3.1	<0	9.2
Total		100.0				99.9†				100.0		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are cash or spot market sales	28	70.6	60.3	80.9	27	69.7	59.1	80.3	26	69.5	58.5	80.5

† Total does not sum to 100% because of rounding.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

		Processors/Manufacturers				Wholesalers/Distributors				Retail Establishments			
		n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
5.3*	What sales methods did your plant use during the past year for selling beef products to different types of recipients?												
	1. Cash or spot market (less than 3 weeks forward)	32	100.0	100.0	100.0	30	89.3	74.5	100.0	37	91.5	79.8	100.0
	2. Forward contract	15	31.1	20.9	41.4	8	14.2	6.1	22.4	20	33.7	20.6	46.7
	3. Marketing agreement	17	35.3	25.6	44.9	6	14.3	1.1	27.4	16	22.4	16.0	28.8
	4. Internal company transfer	13	27.0	16.4	37.5	6	14.3	1.1	27.4	7	9.8	3.4	16.2
	5. Other	0	0.0	NA	NA	D	5.4	0.0	16.3	D	4.2	0.0	12.8

		Food Service Establishments				Foreign Buyers			
		n	%	Lower	Upper	n	%	Lower	Upper
	1. Cash or spot market (less than 3 weeks forward)	25	100.0	100.0	100.0	9	100.0	100.0	100.0
	2. Forward contract	18	54.4	44.1	64.7	0	0.0	NA	NA
	3. Marketing agreement	18	54.4	44.1	64.7	8	88.9	63.3	100.0
	4. Internal company transfer	0	0.0	NA	NA	0	0.0	NA	NA
	5. Other	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

		Processors/Manufacturers				Wholesalers/Distributors				Retail Establishments			
		n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
5.4*	What types of pricing methods did your plant use during the past year for selling beef products to different types of recipients?												
	1. Price list	23	60.7	40.0	81.4	21	54.6	34.2	75.0	30	60.9	43.6	78.2
	2. Individually negotiated pricing	29	80.3	61.8	98.8	24	67.9	47.1	88.7	20	41.4	24.2	58.6
	3. Formula pricing (using another price as the base)	20	43.0	28.5	57.5	10	22.6	8.0	37.1	18	21.8	17.3	26.4
	4. Sealed bid	D	7.9	0.0	20.5	D	1.9	0.0	5.7	6	7.3	2.0	12.5
	5. Internal transfer	10	19.5	9.7	29.3	6	11.3	3.2	19.3	8	12.2	2.9	21.4
	6. Other	0	0.0	NA	NA	D	5.7	0.0	17.3	D	3.7	0.0	11.1
	7. Online auction *(write-in response)*	5	9.8	1.7	17.9	5	9.4	1.8	17.0	5	6.1	1.1	11.0

		Food Service Establishments				Foreign Buyers			
		n	%	Lower	Upper	n	%	Lower	Upper
	1. Price list	23	96.9	90.4	100.0	9	56.3	28.9	83.6
	2. Individually negotiated pricing	13	46.8	22.5	71.2	16	100.0	100.0	100.0
	3. Formula pricing (using another price as the base)	18	56.1	47.2	65.0	5	31.3	5.7	56.8
	4. Sealed bid	5	15.6	2.7	28.4	0	0.0	NA	NA
	5. Internal transfer	0	0.0	NA	NA	0	0.0	NA	NA
	6. Other	0	0.0	NA	NA	0	0.0	NA	NA
	7. Online auction *(write-in response)*	5	15.6	2.7	28.4	5	31.3	5.7	56.8

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

		n	%	Lower	Upper
5.5*	For beef products sold by your plant during the past year using formula pricing, what was the base price of the formula?				
	1. Individual or multiple plant average price	6	15.7	4.4	27.1
	2. Individual or multiple plant average cost of production	8	21.0	8.8	33.1
	3. USDA publicly reported price	21	65.7	44.3	87.1
	4. Retail price	10	42.1	17.2	67.1
	5. Subscription service price (for example, Urner Barry)	0	0.0	NA	NA
	6. Other market price	D	7.9	0.0	24.3
	7. Other	D	2.6	0.0	8.0
5.6*	What types of pricing methods does your plant expect to use in 3 years for selling beef products?				
	1. Price list	36	59.2	44.0	74.5
	2. Individually negotiated pricing	35	56.4	41.2	71.7
	3. Formula pricing (using another price as the base)	26	35.1	22.1	48.1
	4. Sealed bid	7	8.3	1.4	15.2
	5. Internal transfer	20	20.3	13.1	27.4
	6. Other	D	2.8	0.0	8.4
	7. Online auction *(write-in response)*	5	4.6	0.8	8.4

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

	Processors/Manufacturers				Wholesalers/Distributors				Retail Establishments			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
5.7* Which of the following marketing practices did your plant use during the past year for the sale of beef products?												
1. Two-part pricing	0	0.0	NA	NA	D	6.4	0.0	19.5	D	8.5	0.0	20.2
2. Volume discounts	7	22.9	4.1	41.8	8	16.9	7.2	26.7	9	18.3	4.9	31.6
3. Exclusive dealings	D	12.6	0.0	29.3	8	16.9	7.2	26.7	6	11.2	0.9	21.6
4. Bundling	0	0.0	NA	NA	5	10.6	2.0	19.2	5	7.0	1.3	12.7
5. None of the above	24	70.8	50.2	91.4	18	72.4	55.9	88.9	27	69.0	51.4	86.7

	Food Service Establishments				Foreign Buyers			
	n	%	Lower	Upper	n	%	Lower	Upper
1. Two-part pricing	0	0.0	NA	NA	0	0.0	NA	NA
2. Volume discounts	7	38.0	12.1	63.9	5	22.7	3.9	41.5
3. Exclusive dealings	6	27.6	1.7	53.5	D	4.5	0.0	14.1
4. Bundling	5	17.2	3.0	31.4	0	0.0	NA	NA
5. None of the above	16	62.0	36.1	87.9	14	72.8	52.9	92.6

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

		n	Mean	Lower	Upper
6.1	For what percentage of beef products sold during the past year did the seller (your plant) pay for transportation?	58	32.0	20.5	43.5
6.2	What percentage of beef products sold during the past year were under a written agreement (versus oral)?	58	6.6	<0	13.6
			Mean (n = 53)	**Lower**	**Upper**
6.3	For beef products sold during the past year, what was the length of the agreement or contract (oral or written) (% of dollar sales)?				
	a. Sales not under agreement or contract		89.8	80.3	99.2
	b. Less than 1 month		8.2	<0	17.3
	c. 1 to 2 months		0.6	0.1	1.1
	d. 3 to 5 months		0.1	0.0	0.3
	e. 6 to 11 months		0.7	0.1	1.3
	f. 1 to 2 years		0.2	0.0	0.4
	g. 3 to 5 years		0.0	0.0	0.0
	h. 6 to 10 years		0.0	0.0	0.0
	i. More than 10 years or evergreen		0.4	<0	1.1
	Total		100.0		
			Mean (n = 52)	**Lower**	**Upper**
6.4	For beef products sold during the past year, how far in advance of delivery was the delivery scheduled (% of dollar sales)?				
	a. Less than 3 days		48.1	34.8	61.4
	b. 4 to 6 days		18.7	10.1	27.2
	c. 1 to 2 weeks		19.3	9.6	29.0
	d. 3 to 4 weeks		10.7	1.9	19.5
	e. More than 1 month		3.2	1.8	4.6
	Total		100.0		

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

		n	%	Lower	Upper
7.1*	What are the three most important reasons why your plant only uses the cash or spot market for selling beef products?				
	1. Can sell beef products at higher prices	7	23.0	5.8	40.2
	2. Reduces risk exposure	9	28.4	10.1	46.6
	3. Reduces costs of activities for selling beef products	D	1.3	0.0	4.1
	4. Reduces price variability for beef products	D	4.1	0.0	12.4
	5. Reduces potential liability and litigation concerns	D	5.4	0.0	14.2
	6. Increases supply chain information	0	0.0	NA	NA
	7. Allows for sale of higher quality beef products	5	20.3	3.4	37.1
	8. Allows for market access	6	24.3	6.4	42.3
	9. Allows for adjusting operations quickly in response to changes in market conditions	9	36.5	16.6	56.5
	10. Does not require identifying and recruiting long-term contracting partners	4	13.5	0.0	27.6
	11. Does not require managing complex and costly contracts	9	31.1	12.0	50.2
	12. Eliminates possible negative public perceptions about use of contracts	3	6.7	0.0	15.7
	13. Allows for independence, complete control, and flexibility of own business	17	60.8	40.6	81.0
	14. Enhances ability to benefit from favorable market conditions	6	24.3	6.4	42.3
	15. Other	0	0.0	NA	NA
	16. Can easily sell small quantity of beef products *(write-in response)*	D	4.1	0.0	12.4
7.2*	What are the three most important reasons why your plant uses alternative sales methods for selling beef products?				
	1. Can sell beef products at higher prices	D	12.1	0.0	37.3
	2. Reduces risk exposure	12	47.9	29.9	66.0
	3. Reduces costs of activities for selling beef products	0	0.0	NA	NA
	4. Reduces price variability for beef products	11	43.9	25.4	62.4
	5. Reduces potential liability and litigation concerns	0	0.0	NA	NA
	6. Increases supply chain information	0	0.0	NA	NA
	7. Allows for sale of higher quality beef products	D	12.1	0.0	37.3
	8. Allows for market access	D	8.0	0.0	19.5
	9. Increases flexibility in responding to consumer demand	16	72.0	42.4	100.0
	10. Allows for product branding in retail sales	0	0.0	NA	NA
	11. Allows for food safety and biosecurity assurances	0	0.0	NA	NA
	12. Allows for product traceability	0	0.0	NA	NA
	13. Improves week-to-week production management	11	43.9	25.4	62.4
	14. Secures a buyer for beef products	6	24.0	6.6	41.3
	15. Enhances access to credit	0	0.0	NA	NA
	16. Other	D	12.1	0.0	37.3

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

	n	%	Lower	Upper
8.1 How many days per week did your plant usually slaughter fed cattle?				
1. Less frequently than once a week	7	17.1	5.5	28.7
2. 1 or 2 days per week	18	44.0	30.3	57.6
3. 3 or 4 days per week	8	13.0	3.2	22.8
4. 5 or 6 days per week	28	25.9	18.4	33.4
Total		100.0		
8.2 How many fed cattle slaughter shifts did your plant usually operate per day?				
1. One	46	87.9	83.4	92.4
2. Two	15	12.1	7.6	16.6
3. Three	0	0.0	NA	NA
Total		100.0		
8.3 How many beef processing shifts did your plant usually operate per day?				
1. None	16	22.7	11.0	34.5
2. One	29	64.3	53.0	75.7
3. Two	15	12.1	7.6	16.6
4. Three	D	0.8	0.0	2.4
Total		99.9†		
	n	**Mean**	**Lower**	**Upper**
8.4 What is your plant's maximum slaughter capacity (head per week) for fed cattle?	61	4,700	3,591	5,809
8.5 What is your plant's maximum processing capacity (pounds per week) for beef products?	54	3,232,681	2,271,655	4,193,707
8.6 What was the slaughter line speed (head per hour) for fed cattle?	42	113.5	93.3	133.7
	n	**%**	**Lower**	**Upper**
8.7 How many meat slaughter and processing plants, including this one, are owned by the company that owns your plant?				
1. One	33	77.9	74.7	81.1
2. 2 to 5	11	9.3	4.8	13.9
3. 6 to 10	0	0.0	NA	NA
4. 11 to 20	10	8.5	4.0	13.0
5. 21 or more	5	4.2	0.7	7.8
Total		99.9†		
	n	**Mean**	**Lower**	**Upper**
8.8 What percentage of fed cattle purchased for slaughter during calendar year 2002 (prior to the ban on importation of cattle from Canada) were imported from Canada?	60	0.6	0.2	0.9

D = Results suppressed.
NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

		n	Mean	Lower	Upper
8.9	Approximately how many people were employed at your plant during the past year?				
	a. Full time	57	371.2	270.5	471.8
	b. Part time or seasonal	36	6.6	4.5	8.7
		n	**%**	**Lower**	**Upper**
8.10	What were your plant's approximate total gross sales for fresh, frozen, and processed beef products during the past year?				
	1. Under $99,999	9	22.5	9.7	35.4
	2. $100,000 to $499,999	9	22.5	9.7	35.4
	3. $500,000 to $999,999	5	12.5	2.1	23.0
	4. $1,000,000 to $4,999,999	7	17.5	5.7	29.4
	5. $5,000,000 to $19,999,999	5	4.1	0.7	7.6
	6. $20,000,000 to $49,999,999	3	4.2	0.0	9.7
	7. $50,000,000 to $99,999,999	0	0.0	NA	NA
	8. $100,000,000 to $499,999,999	5	4.1	0.7	7.6
	9. $500,000,000 to $999,999,999	3	2.5	0.0	5.2
	10. $1,000,000,000 or more	12	9.9	5.6	14.3
	Total		99.8†		
8.11	What were your plant's approximate total gross sales for beef by-products during the past year?				
	1. Under $99,999	28	68.4	59.1	77.7
	2. $100,000 to $499,999	3	5.7	0.0	12.7
	3. $500,000 to $2,499,999	4	4.9	0.0	10.5
	4. $2,500,000 to $4,999,999	0	0.0	NA	NA
	5. $5,000,000 to $19,999,999	3	4.1	0.0	9.4
	6. $20,000,000 to $49,999,999	5	4.0	0.7	7.4
	7. $50,000,000 to $99,999,999	4	3.2	0.2	6.3
	8. $100,000,000 to $499,999,999	12	9.7	5.4	14.0
	9. $500,000,000 to $999,999,999	0	0.0	NA	NA
	10. $1,000,000,000 or more	0	0.0	NA	NA
	Total		100.0		

NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.

(continued)

Table 7-1. Weighted Responses for the Beef Packer Survey (n = 64) (continued)

	n	%	Lower	Upper
8.12 What were your plant's approximate total gross sales for all products during the past year?				
1. Under $99,999	5	11.9	1.9	21.9
2. $100,000 to $499,999	12	28.6	15.2	42.0
3. $500,000 to $999,999	4	9.5	0.5	18.6
4. $1,000,000 to $4,999,999	8	19.1	7.1	31.0
5. $5,000,000 to $19,999,999	5	8.7	0.4	17.0
6. $20,000,000 to $49,999,999	6	6.3	0.6	12.1
7. $50,000,000 to $99,999,999	0	0.0	NA	NA
8. $100,000,000 to $499,999,999	3	2.4	0.0	5.0
9. $500,000,000 to $999,999,999	5	3.9	0.7	7.2
10. $1,000,000,000 or more	12	9.5	5.3	13.6
Total		99.9†		

NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.

Table 7-2. Use of Purchase Methods for Beef Packing Plants, by Size (Small = 34, Large = 30)

	Small (n = 26)				Large (n = 23)				All Plants (n = 49)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
S2.1 For all fed cattle purchased or received by your operation, what were the ownership arrangements during the past year (% of head)?												
a. Sole ownership by your plant		87.1	74.0	>100		84.1	69.3	98.8		86.4	76.0	96.8
b. Joint venture		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
c. Shared ownership		5.2	<0	13.2		3.0	<0	6.1		4.7	<0	10.8
d. Other		7.7	<0	18.7		13.0	<0	27.7		8.9	0.0	17.8
Total		100.0				100.1†				100.0		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are sole ownership	21	80.8	64.5	97.0	14	60.9	39.3	82.4	35	76.3	63.1	89.4

† Total does not sum to 100% because of rounding.

(continued)

Table 7-2. Use of Purchase Methods for Beef Packing Plants, by Size (Small = 34, Large = 30) (continued)

	Small (n = 27)				Large (n = 30)				All Plants (n = 57)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
S2.2 What methods were used by your plant for purchasing fed cattle during the past year (% of head)?												
a. Auction barns		23.9	8.3	39.4		6.1	<0	13.0		19.1	7.9	30.3
b. Video/electronic auctions		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
c. Dealers or brokers		13.9	0.7	27.1		3.3	0.7	5.8		11.0	1.6	20.5
d. Direct trade		40.4	21.5	59.3		53.9	42.7	65.2		44.0	30.2	57.8
e. Forward contract		0.0	0.0	0.0		11.4	2.7	20.0		3.1	0.8	5.3
f. Marketing agreement		7.2	<0	17.5		20.0	12.2	27.9		10.7	3.0	18.3
g. Packer fed/owned		10.9	<0	23.3		2.0	<0	4.2		8.5	<0	17.4
h. Other		3.7	<0	11.3		3.3	<0	10.2		3.6	<0	9.3
Total		100.0				100.0				100.0		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are cash or spot market purchases	21	77.8	61.0	94.5	3	10.0	0.0	21.4	24	59.6	47.2	71.9

(continued)

Table 7-2. Use of Purchase Methods for Beef Packing Plants, by Size (Small = 34, Large = 30) (continued)

		Small				Large				All Plants			
		n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S2.3*	What types of pricing methods were used by your plant during the past year for purchasing fed cattle?												
	1. Individually negotiated pricing	21	67.7	50.3	85.2	27	90.0	78.6	100.0	48	73.1	59.9	86.4
	2. Public auction	13	41.9	23.5	60.3	15	50.0	31.0	69.0	28	43.9	29.5	58.3
	3. Sealed bid	0	0.0	NA	NA	3	10.0	0.0	21.4	3	2.4	0.0	5.1
	4. Formula pricing (using another price as the base)	6	19.4	4.6	34.1	28	93.3	83.9	100.0	34	37.3	26.1	48.5
	5. Internal transfer	4	12.9	0.4	25.4	10	33.3	15.4	51.2	14	17.9	7.7	28.1
	6. Other	D	3.2	0.0	9.8	0	0.0	NA	NA	D	2.4	0.0	7.3

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-2. Use of Purchase Methods for Beef Packing Plants, by Size (Small = 34, Large = 30) (continued)

	Small				Large				All Plants			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S2.4a* For fed cattle purchased by your plant during the past year using formula pricing with a grid, what was the base price of the formula?	(results suppressed)				(results suppressed)							
1. Individual or multiple plant average price									16	50.0	32.5	67.4
2. Individual or multiple plant average cost of production									6	18.7	4.5	32.9
3. USDA live quote									13	40.6	23.2	58.0
4. USDA dressed or carcass quote									12	43.8	26.8	60.8
5. USDA boxed beef price									6	25.1	11.8	38.3
6. Chicago Mercantile Exchange (CME) cattle futures									18	56.2	39.2	73.2
7. Retail price									5	15.6	2.4	28.9
8. Subscription service price (for example, Cattle Fax, Urner Barry)									11	34.3	17.3	51.4
9. Other market price									0	0.0	NA	NA
10. Other									0	0.0	NA	NA

NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-2. Use of Purchase Methods for Beef Packing Plants, by Size (Small = 34, Large = 30) (continued)

		Small				Large				All Plants			
		n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S2.4b*	For fed cattle purchased by your plant during the past year using formula pricing without a grid, what was the base price of the formula?												
	1. Individual or multiple plant average price	D	18.2	0.0	45.4	D	4.3	0.0	13.4	3	12.5	0.0	27.7
	2. Individual or multiple plant average cost of production	D	9.1	0.0	29.3	D	21.7	3.5	40.0	6	14.3	1.1	27.4
	3. USDA live quote	D	9.1	0.0	29.3	D	34.8	13.7	55.8	9	19.6	5.8	33.4
	4. USDA dressed or carcass quote	4	36.4	2.5	70.3	4	17.4	0.6	34.2	8	28.6	9.1	48.1
	5. USDA boxed beef price	0	0.0	NA	NA	5	21.7	3.5	40.0	5	8.9	1.6	16.2
	6. Chicago Mercantile Exchange (CME) cattle futures	D	9.1	0.0	29.3	D	65.2	44.2	86.3	16	32.0	18.2	45.9
	7. Retail price	D	18.2	0.0	45.4	D	21.7	3.5	40.0	7	19.6	3.2	36.0
	8. Subscription service price (for example, Cattle Fax, Urner Barry)	0	0.0	NA	NA	7	30.4	10.1	50.8	7	12.4	4.3	20.6
	9. Other market price	D	18.2	0.0	45.4	0	0.0	NA	NA	D	10.8	0.0	25.4
	10. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
S2.6*	What types of valuation methods were used by your plant for purchasing fed cattle during the past year?												
	1. Liveweight	13	50.0	29.4	70.6	27	90.0	78.6	100.0	40	61.0	46.2	75.9
	2. Carcass weight, not dependent on grid value	17	65.4	45.8	85.0	23	76.7	60.6	92.7	40	68.5	54.0	83.0
	3. Carcass weight, dependent on grid value	D	3.8	0.0	11.8	D	86.7	73.8	99.6	27	26.7	20.1	33.3
	4. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 7-3. Terms of Purchase Methods for Beef Packing Plants, by Size (Small = 34, Large = 30)

	Small				Large				All Plants			
	n	Mean	Lower	Upper	n	Mean	Lower	Upper	n	Mean	Lower	Upper
S3.1 For what percentage of fed cattle purchased during the past year did the buyer (your plant) pay for transportation?	30	24.6	8.8	40.5	30	49.6	37.5	61.7	60	30.8	18.8	42.9
S3.2 What percentage of fed cattle purchased during the past year were under a written agreement (versus oral)?	31	1.6	<0	4.9	30	24.9	16.8	32.9	61	7.2	4.1	10.4

	Small (n = 27)			Large (n = 30)			All Plants (n = 57)		
	Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
S3.3 For fed cattle purchased during the past year, what was the length of the agreement or contract (oral or written) (% of head)?									
a. Purchases not under agreement or contract	82.0	67.1	97.0	71.8	62.0	81.6	79.3	68.3	90.2
b. Less than 6 months	6.9	<0	16.2	8.2	4.3	12.0	7.2	0.5	13.9
c. 6 to 11 months	0.0	0.0	0.0	6.3	0.1	12.5	1.7	0.1	3.3
d. 1 to 2 years	3.7	<0	11.3	4.8	<0	11.4	4.0	<0	9.7
e. 3 to 5 years	3.7	<0	11.3	0.0	0.0	0.0	2.7	<0	8.1
f. 6 to 10 years	0.0	0.0	0.0	1.4	<0	3.4	0.4	<0	0.9
g. More than 10 years or evergreen	3.7	<0	11.3	7.5	2.7	12.3	4.7	<0	10.3
Total	100.0			100.0			100.0		

(continued)

Table 7-3. Terms of Purchase Methods for Beef Packing Plants, by Size (Small = 34, Large = 30) (continued)

	Small (n = 29)			Large (n = 30)			All Plants (n = 59)		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
S3.4 For fed cattle purchased during the past year, how far in advance of slaughter was the delivery scheduled (% of head)?									
a. Less than 7 days	79.8	64.8	94.9	66.4	55.2	77.6	76.4	65.1	87.7
b. 8 to 14 days	13.3	0.7	25.9	27.1	17.2	37.1	16.8	7.3	26.3
c. 15 to 21 days	1.7	<0	5.3	1.0	<0	2.1	1.5	<0	4.1
d. 22 to 30 days	1.7	<0	5.3	0.0	0.0	0.0	1.3	<0	3.9
e. 1 to 2 months	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
f. More than 2 months	3.4	<0	10.5	5.5	<0	12.2	4.0	<0	9.4
Total	99.9†			100.0			100.0		

	Small				Large				All Plants			
	n	**Mean**	**Lower**	**Upper**	**n**	**Mean**	**Lower**	**Upper**	**n**	**Mean**	**Lower**	**Upper**
S3.5 For what percentage of fed cattle purchased during the past year did your plant provide information back to the feeder or finisher?	29	17.6	3.8	31.5	30	48.8	38.7	58.9	59	25.6	15.2	36.0

† Total does not sum to 100% because of rounding.

(continued)

Table 7-3. Terms of Purchase Methods for Beef Packing Plants, by Size (Small = 34, Large = 30) (continued)

	Small				Large				All Plants			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S3.6* Under what conditions did your plant provide information back to the feeder or finisher?												
1. Requested by seller, no charge	6	75.0	36.3	100.0	24	82.8	68.1	97.4	30	79.2	62.2	96.3
2. Requested by seller, for a set fee	D	25.0	0.0	63.7	D	27.6	10.3	44.9	10	26.4	8.6	44.2
3. Cash or spot market purchases	0	0.0	NA	NA	3	10.3	0.0	22.1	3	5.6	0.0	12.0
4. Forward contract	0	0.0	NA	NA	19	65.5	47.1	83.9	19	35.7	25.8	45.7
5. Marketing agreement	0	0.0	NA	NA	25	86.2	72.9	99.6	25	47.0	39.8	54.2
6. Alliance	0	0.0	NA	NA	19	65.5	47.1	83.9	19	35.7	25.8	45.7
7. Joint venture	0	0.0	NA	NA	D	3.4	0.0	10.5	D	1.9	0.0	5.7
8. Shared ownership	0	0.0	NA	NA	12	41.4	22.3	60.4	12	22.6	12.3	32.9
9. Other	D	12.5	0.0	42.1	0	0.0	NA	NA	D	5.7	0.0	17.2
S3.7* What types of information did your plant provide back to the feeder or finisher?												
1. USDA carcass quality grade for individual animals	3	33.3	0.0	71.8	28	96.6	89.5	100.0	31	65.9	49.2	82.7
2. USDA carcass yield grade for individual animals	D	22.2	0.0	56.1	D	96.6	89.5	100.0	30	60.6	45.7	75.4
3. Carcass weight for individual animals	8	88.9	63.3	100.0	28	96.6	89.5	100.0	36	92.8	81.3	100.0
4. Price paid for individual carcasses	6	66.7	28.2	100.0	16	55.2	35.9	74.4	22	60.7	41.6	79.8
5. USDA carcass quality grade by lot	0	0.0	NA	NA	27	93.1	83.3	100.0	27	48.0	43.0	53.0
6. USDA carcass yield grade by lot	0	0.0	NA	NA	27	93.1	83.3	100.0	27	48.0	43.0	53.0
7. Carcass weight by lot	0	0.0	NA	NA	27	93.1	83.3	100.0	27	48.0	43.0	53.0
8. Average dressing percentage by lot	D	11.1	0.0	36.7	D	93.1	83.3	100.0	28	53.4	41.4	65.4
9. Other	0	0.0	NA	NA	D	3.4	0.0	10.5	D	1.8	0.0	5.4
10. Price paid by similar weight range *(write-in response)*	0	0.0	NA	NA	10	34.5	16.1	52.9	10	17.8	8.4	27.2
11. Vision machine yield grade, ribeye area, backfat *(write-in response)*	0	0.0	NA	NA	6	20.7	5.0	36.4	6	10.7	2.7	18.7

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 7-4. Reasons for Using Purchase Methods for Beef Packing Plants, by Size (Small = 34, Large = 30)

	Small				Large				All Plants			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S4.1* What are the three most important reasons why your plant only uses the cash or spot market for purchasing fed cattle?	(results suppressed)				(results suppressed)							
1. Can purchase fed cattle at lower prices									7	27.1	8.0	46.3
2. Reduces risk exposure									3	12.9	0.0	27.5
3. Reduces costs of activities for buying fed cattle									4	17.1	0.6	33.7
4. Reduces price variability for fed cattle									D	8.6	0.0	20.9
5. Reduces potential liability and litigation concerns									D	1.4	1.4	1.4
6. Increases supply chain information									D	4.3	0.0	13.2
7. Secures higher quality fed cattle									11	44.3	22.7	65.9
8. Allows for market access									3	12.9	0.0	27.5
9. Allows for adjusting operations quickly in response to changes in market conditions									9	38.6	17.3	59.8
10. Does not require identifying and recruiting long-term contracting partners									3	12.9	0.0	27.5
11. Does not require managing complex and costly contracts									4	17.1	0.6	33.7
12. Eliminates possible negative public perceptions about use of contracts									D	4.3	0.0	13.2
13. Allows for independence, complete control, and flexibility of own business									12	51.4	29.7	73.2
14. Enhances ability to benefit from favorable market conditions									5	21.4	3.5	39.4
15. Other									0	0.0	NA	NA
16. Can easily purchase small quantity of fed cattle *(write-in response)*									D	4.3	0.0	13.2

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-4. Reasons for Using Purchase Methods for Beef Packing Plants, by Size (Small = 34, Large = 30) (continued)

	Small				Large				All Plants			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S4.2* What are the three most important reasons why your plant uses alternative purchase methods for purchasing fed cattle?	(n = 0)											
1. Can purchase fed cattle at lower prices					0	0.0	NA	NA	0	0.0	NA	NA
2. Reduces risk exposure					0	0.0	NA	NA	0	0.0	NA	NA
3. Reduces costs of activities for buying fed cattle					9	34.6	15.0	54.2	9	34.6	15.0	54.2
4. Reduces price variability for fed cattle					0	0.0	NA	NA	0	0.0	NA	NA
5. Reduces potential liability and litigation concerns					0	0.0	NA	NA	0	0.0	NA	NA
6. Increases supply chain information					0	0.0	NA	NA	0	0.0	NA	NA
7. Secures higher quality fed cattle					14	53.8	33.3	74.4	14	53.8	33.3	74.4
8. Allows for market access					11	42.3	22.0	62.7	11	42.3	22.0	62.7
9. Increases flexibility in responding to consumer demand					5	19.2	3.0	35.5	5	19.2	3.0	35.5
10. Allows for product branding in retail sales					12	46.2	25.6	66.7	12	46.2	25.6	66.7
11. Allows for food safety and biosecurity assurances					0	0.0	NA	NA	0	0.0	NA	NA
12. Allows for product traceability					D	3.8	0.0	11.8	D	3.8	0.0	11.8
13. Improves week-to-week supply management					15	57.7	37.3	78.0	15	57.7	37.3	78.0
14. Improves efficiency of operations due to animal uniformity					11	42.3	22.0	62.7	11	42.3	22.0	62.7
15. Enhances access to credit					0	0.0	NA	NA	0	0.0	NA	NA
16. Other					0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 7-5. Use of Sales Methods for Beef Packing Plants, by Size (Small = 34, Large = 30)

	Small (n = 29)			Large (n = 27)			All Plants (n = 56)		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
S5.1 What was your plant's percentage of total beef product dollar sales during the past year by type of buyer or recipient?									
a. Meat processors or food manufacturers	16.7	5.1	28.4	18.9	12.0	25.7	17.2	8.3	26.1
b. Wholesalers or distributors	11.7	3.6	19.9	26.6	17.1	36.0	15.2	8.7	21.7
c. Retail establishments	36.7	21.9	51.6	30.2	22.9	37.5	35.2	24.0	46.4
d. Food service establishments	5.8	<0	12.7	9.5	5.8	13.3	6.7	1.5	11.9
e. Foreign buyers	0.0	0.0	0.0	3.1	2.0	4.3	0.7	0.5	1.0
f. Other	0.0	0.0	0.0	0.2	<0	0.5	0.1	0.0	0.1
g. Directly to consumer *(write-in response)*	29.0	12.3	45.8	0.0	0.0	0.0	22.2	9.7	34.7
h. Intercompany transfer *(write-in response)*	0.0	0.0	0.0	11.5	<0	23.9	2.7	<0	5.6
Total	99.9†			100.0			100.0		

	Small (n = 25)			Large (n = 27)			All Plants (n = 52)		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
S5.2 What sales methods were used by your plant during the past year for selling beef products (% of dollar sales)?									
a. Cash or spot market (less than 3 weeks forward)	91.6	80.2	>100	61.3	50.1	72.5	83.6	74.9	92.3
b. Forward contract	4.0	<0	12.3	9.7	6.1	13.4	5.5	<0	11.5
c. Marketing agreement	0.4	<0	1.2	14.8	9.5	20.1	4.2	2.7	5.7
d. Internal company transfer	0.0	0.0	0.0	14.2	2.1	26.3	3.7	0.6	6.8
e. Other	4.0	<0	12.3	0.0	0.0	0.0	2.9	<0	8.9
Total	100.0			100.0			99.9†		

	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are cash or spot market sales	22	88.0	74.3	100.0	5	18.5	2.9	34.2	27	69.7	59.1	80.3

† Total does not sum to 100% because of rounding.

(continued)

Table 7-5. Use of Sales Methods for Beef Packing Plants, by Size (Small = 34, Large = 30) (continued)

	Small				Large				All Plants			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S5.5* For beef products sold by your plant during the past year using formula pricing, what was the base price of the formula?												
1. Individual or multiple plant average price	0	0.0	NA	NA	6	30.0	8.0	52.0	6	15.7	4.4	27.1
2. Individual or multiple plant average cost of production	0	0.0	NA	NA	8	40.0	16.5	63.5	8	21.0	8.8	33.1
3. USDA publicly reported price	D	33.3	0.0	87.5	D	95.0	84.5	100.0	21	65.7	44.3	87.1
4. Retail price	3	50.0	0.0	100.0	7	35.0	12.1	57.9	10	42.1	17.2	67.1
5. Subscription service price (for example, Urner Barry)	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
6. Other market price	D	16.7	0.0	59.5	0	0.0	NA	NA	D	7.9	0.0	24.3
7. Other	0	0.0	NA	NA	D	5.0	0.0	15.5	D	2.6	0.0	8.0
S5.6* What types of pricing methods does your plant expect to use in 3 years for selling beef products?												
1. Price list	14	51.9	31.7	72.0	22	81.5	65.8	97.1	36	59.2	44.0	74.5
2. Individually negotiated pricing	13	48.1	28.0	68.3	22	81.5	65.8	97.1	35	56.4	41.2	71.7
3. Formula pricing (using another price as the base)	6	22.2	5.5	39.0	20	74.1	56.4	91.7	26	35.1	22.1	48.1
4. Sealed bid	D	3.7	0.0	11.3	D	22.2	5.5	39.0	7	8.3	1.4	15.2
5. Internal transfer	D	3.7	0.0	11.3	D	70.4	52.0	88.8	20	20.3	13.1	27.4
6. Other	D	3.7	0.0	11.3	0	0.0	NA	NA	D	2.8	0.0	8.4
7. Online auction *(write-in response)*	0	0.0	NA	NA	5	18.5	2.9	34.2	5	4.6	0.8	8.4

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 7-6. Terms of Sales Methods for Beef Packing Plants, by Size (Small = 34, Large = 30)

		Small				Large				All Plants			
		n	Mean	Lower	Upper	n	Mean	Lower	Upper	n	Mean	Lower	Upper
S6.1	For what percentage of beef products sold during the past year did the seller (your plant) pay for transportation?	31	21.8	7.5	36.1	27	67.4	51.4	83.4	58	32.0	20.5	43.5
S6.2	What percentage of beef products sold during the past year were under a written agreement (versus oral)?	31	6.5	<0	15.6	27	7.0	3.4	10.6	58	6.6	<0	13.6

		Small (n = 27)			Large (n = 26)			All Plants (n = 53)		
		Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
S6.3	For beef products sold during the past year, what was the length of the agreement or contract (oral or written) (% of dollar sales)?									
	a. Sales not under agreement or contract	88.9	76.2	>100	92.5	88.8	96.2	89.8	80.3	99.2
	b. Less than 1 month	10.8	<0	23.2	0.0	0.0	0.0	8.2	<0	17.3
	c. 1 to 2 months	0.3	<0	0.9	1.5	0.8	2.2	0.6	0.1	1.1
	d. 3 to 5 months	0.0	0.0	0.0	0.6	0.1	1.1	0.1	0.0	0.3
	e. 6 to 11 months	0.0	0.0	0.0	2.9	0.4	5.3	0.7	0.1	1.3
	f. 1 to 2 years	0.0	0.0	0.0	0.7	<0	1.6	0.2	0.0	0.4
	g. 3 to 5 years	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	h. 6 to 10 years	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	i. More than 10 years or evergreen	0.0	0.0	0.0	1.8	<0	4.5	0.4	<0	1.1
	Total	100.0			100.0			100.0		

(continued)

Table 7-6. Terms of Sales Methods for Beef Packing Plants, Size (Small = 34, Large = 30) (continued)

		Small (n = 28)			Large (n = 24)			All Plants (n = 52)		
		Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
S6.4	For beef products sold during the past year, how far in advance of delivery was the delivery scheduled (% of dollar sales)?									
	a. Less than 3 days	56.9	39.8	74.1	17.1	5.4	28.9	48.1	34.8	61.4
	b. 4 to 6 days	17.3	6.3	28.2	23.6	14.0	33.1	18.7	10.1	27.2
	c. 1 to 2 weeks	15.8	3.4	28.2	31.5	22.3	40.7	19.3	9.6	29.0
	d. 3 to 4 weeks	10.0	<0	21.5	13.2	9.7	16.6	10.7	1.9	19.5
	e. More than 1 month	0.0	0.0	0.0	14.6	8.1	21.1	3.2	1.8	4.6
	Total	100.0			100.0			100.0		

Table 7-7. Reasons for Using Sales Methods for Beef Packing Plants, by Size (Small = 34, Large = 30)

	Small				Large				All Plants			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S7.1* What are the three most important reasons why your plant only uses the cash or spot market for selling beef products?	(results suppressed)				(results suppressed)							
1. Can sell beef products at higher prices									7	23.0	5.8	40.2
2. Reduces risk exposure									9	28.4	10.1	46.6
3. Reduces costs of activities for selling beef products									D	1.3	0.0	4.1
4. Reduces price variability for beef products									D	4.1	0.0	12.4
5. Reduces potential liability and litigation concerns									D	5.4	0.0	14.2
6. Increases supply chain information									0	0.0	NA	NA
7. Allows for sale of higher quality beef products									5	20.3	3.4	37.1
8. Allows for market access									6	24.3	6.4	42.3
9. Allows for adjusting operations quickly in response to changes in market conditions									9	36.5	16.6	56.5
10. Does not require identifying and recruiting long-term contracting partners									4	13.5	0.0	27.6
11. Does not require managing complex and costly contracts									9	31.1	12.0	50.2
12. Eliminates possible negative public perceptions about use of contracts									3	6.7	0.0	15.7
13. Allows for independence, complete control, and flexibility of own business									17	60.8	40.6	81.0
14. Enhances ability to benefit from favorable market conditions									6	24.3	6.4	42.3
15. Other									0	0.0	NA	NA
16. Can easily sell small quantity of beef products *(write-in response)*									D	4.1	0.0	12.4

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-7. Reasons for Using Sales Methods for Beef Packing Plants, by Size (Small = 34, Large = 30) (continued)

	Small				Large				All Plants			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S7.2* What are the three most important reasons why your plant uses alternative sales methods for selling beef products?	(results suppressed)				(results suppressed)							
1. Can sell beef products at higher prices									D	12.1	0.0	37.3
2. Reduces risk exposure									12	47.9	29.9	66.0
3. Reduces costs of activities for selling beef products									0	0.0	NA	NA
4. Reduces price variability for beef products									11	43.9	25.4	62.4
5. Reduces potential liability and litigation concerns									0	0.0	NA	NA
6. Increases supply chain information									0	0.0	NA	NA
7. Allows for sale of higher quality beef products									D	12.1	0.0	37.3
8. Allows for market access									D	8.0	0.0	19.5
9. Increases flexibility in responding to consumer demand									16	72.0	42.4	100.0
10. Allows for product branding in retail sales									0	0.0	NA	NA
11. Allows for food safety and biosecurity assurances									0	0.0	NA	NA
12. Allows for product traceability									0	0.0	NA	NA
13. Improves week-to-week production management									11	43.9	25.4	62.4
14. Secures a buyer for beef products									6	24.0	6.6	41.3
15. Enhances access to credit									0	0.0	NA	NA
16. Other									D	12.1	0.0	37.3

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

7.2 PORK PACKERS

Table 7-8 provides weighted tabulations for all survey questions for pork packers (n = 88).[5] Some results from the pork packer survey appear different from information in other published sources; these differences could be due to the low response rate or other factors (see sidebar). Tables 7-9 through 7-14 provide weighted tabulations for selected questions, by size (n = 53 for small pork packers and n = 35 for large pork packers).

7.2.1 Characteristics of Pork Packing Plants

> A number of estimates obtained from the pork packer survey differ substantially from those obtained from other sources. Such differences could be due to small sample sizes, sampling frame error, differences in how the information was collected, and nonresponse bias, even though survey weights were calculated to compensate for some of the incurred bias.

In the past year, 44% of pork packers purchased fewer than 1,000 market hogs (barrows and gilts) for slaughter, and 65% purchased fewer than 10,000 market hogs. Thirteen percent purchased 2 million or more hogs. (See Table 7-8, Question 1.4.)

Most pork packers (81%) conducted slaughter, fabrication, and further processing activities. Some plants slaughtered other livestock, including non-market hogs (57%), beef cattle (63%), and lambs or sheep (45%). Of the plants that performed custom slaughter in the past year, 46% custom slaughtered fewer than 500 head, 44% custom slaughtered 500 to 9,999 head, and 10% custom slaughtered 10,000 to 499,999 head. (See Table 7-8, Questions 1.2, 1.3, and 1.5.)

Note that because of the wide range of pork packing plant sizes, comparing the mix of plants based on averages can be misleading. For example, the maximum slaughter capacity averaged 11,405 head per week, with an average slaughter line speed of 229 head per hour. However, a specialized hog slaughter plant with 2 million head capacity will average more than 38,000 head per week. The line speed in some large plants is more than 1,000 head per hour. The weight range of standard carcasses averaged a minimum of 183 pounds and a maximum of 253 pounds. The maximum processing capacity averaged more than 1.6 million pounds of pork product per week. (See Table 7-8, Questions 1.7 and 9.4 through 9.6.)

Most plants (80%) are small, independently owned businesses and are not part of a company that owns another slaughter or

[5] Volume 4 of the final report provides estimates of some survey questions that use weights benchmarked to external counts obtained from the Pork Check-off Program.

processing plant. Additionally, more than half are not part of a company that owns other upstream or downstream businesses. (See Table 7-8, Questions 1.9 and 9.7.)

Most plants (73%) did not participate in any type of certification program last year. Less than 10% participated in a USDA Processed Verified certification program, and less than 8% participated in an organic certification program. Few (5% to 7%) participated in some type of program that certifies breed or livestock quality. (See Table 7-8, Question 1.8.)

About 55% of plants reported total gross sales for fresh, frozen, and processed pork products of less than $500,000, and 75% reported total gross sales of less than $10 million. About 75% of plants reported total gross sales for pork by-products of less than $500,000, and 87% reported total gross by-product sales of less than $10 million. For total gross sales for all products, 34% of plants reported sales of less than $500,000, and 75% reported sales of less than $10 million. In contrast, 10% of plants had total gross sales of more than $500 million. (See Table 7-8, Questions 9.9 through 9.11.)

Pork packers produce a variety of products. During the past year, 31% of total pork product sales were carcasses; 31% were primal or subprimal cuts; 11% were ground products; and 27% were either portion cuts, case-ready cuts, or processed products. [6] Of the pork products sold during the past year, an average of 14% were branded. (See Table 7-8, Questions 1.10 and 1.11.)

A relatively large percentage (40%) of plants did not use any measures to assess the quality of slaughtered market hogs. Yet other plants did employ quality measures when buying market hogs, including weight standards (39%), backfat (30%), and lean percentage (25%). (See Table 7-8, Question 1.6.)

7.2.2 Methods for Procuring Market Hogs by Pork Packers

Most of the market hogs procured (92%) during the past year were owned solely by the operation. For nearly 90% of plants, all of the market hogs procured for slaughter were owned solely by the operation during the past year. Plants' ownership

[6] These values were computed as the mean percentage of pork product dollar sales weighted by the number of eligible plants. Other reported means were computed similarly (i.e., weighted by the number of eligible plants).

arrangements were similar 3 years ago and are not expected to change within the next 3 years. (See Table 7-8, Question 2.1.)

> A variety of methods were employed by plants to procure market hogs, including procurement or marketing contracts, marketing agreements, and production contracts.

A variety of methods were employed by plants to procure market hogs. During the past year, 73% of purchases were on the spot market, 10% of purchases were made through procurement or marketing contracts, 8% of purchases were made through marketing agreements, 2% of purchases were under production contracts, and 6% of purchases were made using other methods. For 65% of plants, all purchases were made on the spot market. These procurement methods differ from the sales methods reported by respondents to the pork producer survey. The producer survey reports fewer hogs sold through the spot market and more through an AMA. Plants' methods for purchasing market hogs were very similar 3 years ago and are not expected to change within the next 3 years. (See Table 7-8, Question 2.2.)

Plants used a variety of pricing methods for purchasing market hogs. Sixty-four percent used individually negotiated pricing, 53% used formula pricing, and 35% used public auctions.[7] Pricing methods are not expected to change much within the next 3 years. For plants that used formula pricing, 46% used USDA dressed or carcass quote, 42% used USDA live quote, 24% used individual or multiple-plant average price, and 22% used CME lean hog futures as formula base prices. The most frequently cited methods for valuation of market hogs were liveweight (79% of plants) and carcass weight dependent on merit (31%). This differs from industry reporting, in which most hogs are purchased on a carcass basis. The CME switched to a carcass-based contract in the mid-1990s, and USDA converted to predominately carcass reports in 2001. Valuation methods are not expected to change much in the next 3 years. (See Table 7-8, Questions 2.3 through 2.6.)

On average, packers paid transportation costs in 33% of all transactions. Almost 19% of market hogs were reportedly purchased under a written agreement. (See Table 7-8, Questions 2.7 and 2.8.)

Thirty-two respondents reported using procurement or marketing contracts to procure market hogs during the past year. The majority of these plants maintained contracts with

[7] Respondents could select multiple responses.

more than 10 producers. A variety of contract lengths were employed, with 27% lasting more than 10 years or being evergreen. Plants specified a variety of terms in their procurement or marketing contracts. The most frequently cited terms included the number of market hogs to be delivered in each specified time period, the quality and average weight of the market hogs purchased, and the ability to inspect and monitor the producers' facilities. (See Table 7-8, Questions 3.1 through 3.3.)

Only 10 respondents reported using production contracts to procure market hogs during the past year. Because of the small number of respondents, we are unable to characterize the terms of these contracts. (See Table 7-8, Questions 4.1 through 4.5.)

For plants that only used spot market transactions, the three most frequently cited reasons for doing so were (1) "Allows for independence, complete control, and flexibility of own business" (60%), (2) "Can purchase market hogs at lower prices" (37%), and (3) "Secures higher quality market hogs" (36%). For plants that used AMAs, the three most frequently cited reasons for doing so were (1) "Improves week-to-week supply management" (62%), (2) "Secures higher quality market hogs" (60%), and (3) "Allows for market access" (40%). Interestingly, plants perceive the ability to secure higher quality market hogs as an advantage of both the spot market and of AMAs. (See Table 6-8, Questions 5.1 and 5.2.)

7.2.3 Methods for Selling and Transferring Pork Products by Pork Packers

Pork packers sell their products to a variety of buyers/recipients through a variety of methods. Forty percent of total pork product dollar sales were to retail establishments, 18% were to meat processors or food manufacturers, 17% were direct sales to consumers, 17% were to wholesalers or distributors, and 9% were to other types of buyers. These results indicate that responses to the survey may not represent how most pork is sold. It is unlikely that 17% of pork product is sold directly to consumers. (See Table 7-8, Question 6.1.)

Almost 82% of pork products were sold through spot market transactions, and 10% were sold through marketing agreements. Other types of sales methods were not widely used.

Almost 82% of pork products were sold through spot market transactions, and 10% were sold through marketing agreements. Other types of sales methods were not widely used. Plants' methods for selling pork products were very similar 3 years ago and are not expected to change within the next 3 years. Sales methods vary somewhat, depending on the type of buyer or recipient. About 95% of plants used the spot market to sell to processors/manufacturers, wholesalers/distributors, and food service establishments. Fewer plants (82% to 85%) used the spot market to sell to retail establishments and foreign buyers. About 30% to 35% of plants used marketing agreements when selling product to retail establishments, food service establishments, and foreign buyers. Fewer plants used marketing agreements when selling to other types of recipients. About 64% of plants used forward contracts when selling to foreign buyers; fewer plants used this method when selling to other types of recipients. (See Table 7-8, Questions 6.2 and 6.3.)

The most frequently cited methods for pricing pork products were price lists, individually negotiated pricing, and formula pricing. The type of pricing method used varied depending on the type of buyer or recipient. For processors and manufacturers, the three methods were used about equally. Wholesalers and distributors most often used price lists and individually negotiated pricing. Retail establishments most often used price lists; food service establishments most often used price lists and individually negotiated pricing; and foreign buyers most often used individually negotiated pricing. For plants that used formula pricing, a USDA publicly reported price was most often used as the base price. About 30% to 40% of plants used volume discounts, depending on the type of buyer. Fewer plants used two-part pricing, exclusive dealings, and bundling. (See Table 7-8, Questions 6.4 through 6.7.)

On average, 44% of plants reported paying transportation costs for pork products sold. Less than 7% of pork product sales were under a written agreement. Most agreements were for less than 1 month. Delivery also was scheduled short term; 82% of deliveries were less than 7 days ahead. (See Table 7-8, Questions 7.1 through 7.4.)

Plants that only used cash markets to sell pork products did so because of the flexibility and simplicity of using the cash market. Plants that used AMAs placed more emphasis on production management and pricing.

Plants that only used cash markets to sell pork products did so because of the flexibility and simplicity of using the cash market. About 53% of plants chose “Allows for independence, complete control, and flexibility of own business” as one of the most important reasons for using only cash markets to sell pork products. Other responses included “Allows for adjusting operations quickly in response to changes in market conditions” (42%) and “Does not require managing complex and costly contracts” (28%). Plants that used AMAs placed more emphasis on production management and pricing. Almost 60% of plants chose “Improves week-to-week production management” as one of the most important reasons for using AMAs to sell pork products. About 51% chose “Can sell pork products at higher prices,” and 40% chose “Reduces risk of exposure” as important reasons for using AMAs to sell pork products. (See Table 7-8, Questions 8.1 and 8.2.)

7.2.4 Pork Packers’ Marketing Practices, by Size of Plant

Most small plants solely owned the market hogs procured for slaughter, while large plants used a variety of ownership arrangements, including sole ownership, joint ventures, and other methods. (See Table 7-9, Question S2.1.)

Small plants were more likely than large plants to rely on spot market transactions to purchase market hogs.

Small plants were more likely than large plants to rely on spot market transactions to purchase market hogs. About 80% of small plants procured all of their market hogs using spot market transactions, while only 15% of large plants procured all of their market hogs using spot market transactions. Large plants used a variety of marketing arrangements, with the most common method being procurement or marketing contracts; nearly 40% of market hogs were procured using this method. About 2% to 9% of plants employed other types of AMAs (i.e., production contracts, forward contracts, marketing agreements, and packer owned). (See Table 7-9, Question S2.2.)

Individually negotiated pricing was used by 62% of small plants to price market hogs. Large plants used a variety of pricing methods. About 85% of large plants used formula pricing, 71% used individually negotiated pricing, 32% used internal transfer pricing, and 21% used production contract terms to price market hogs. Large plants also used a variety of base prices for formula pricing; the most often used bases among plants using formula pricing were USDA dressed or carcass quote (81% of plants) and CME lean hog futures (55%). Almost 82% of small plants and 71% of large plants used liveweight to value market hogs. About 77% of large plants also used carcass weight dependent on merit; only 16% of small plants used this method. (See Table 7-9, Questions S2.3, S2.4, and S2.6.)

Small plants were more likely than large plants to pay transportation costs for market hogs procured (39% versus 12% of total head). Large plants were more likely than small plants to use written contracts (59% versus 6% of total head). (See Table 7-9, Questions 2.7 and 2.8.)

Most of the plants that used procurement or marketing contracts to procure market hogs were large plants (29 of the 32 respondents). We cannot compare the terms of these contracts by size of plant because of the small number of responses for small plants. (See Table 7-10.)

Because few large plants used only the spot market to procure market hogs, we cannot compare plants' reasons for using only the spot market by size of plant. Likewise, few small plants used only AMAs to procure market hogs, so we cannot compare plants' reasons for using only AMAs by size of plant. (See Table 7-11.)

Small plants primarily sold their pork products to retail establishments (43% of total sales), and 22% of sales were direct to consumers. Large plants sold pork products to a variety of buyers or recipients. Of large plants' total pork product dollar sales, 34% were to meat processors or food manufacturers, 29% were to retail establishments, 18% were to wholesalers or distributors, 11% were to foreign buyers, and 8% were to food service establishments. (See Table 7-12, Question S6.1.)

Compared with large plants, small plants had a greater reliance on spot market transactions for selling pork products.

Compared with large plants, small plants had a greater reliance on spot market transactions for selling pork products. About 81% of small plants sold all of their pork products using spot market methods, while only 22% of large plants sold all of their pork products using spot market methods. For large plants, 68% of sales were through spot market methods, 17% were through marketing agreements, 7% were through forward contracts, and 8% were through internal transfers. (See Table 7-12, Question S6.2.)

Both small and large plants used price lists, individually negotiated pricing, and formula pricing to price their products.

Small plants had a greater reliance on price lists, while large plants had a greater reliance on individually negotiated pricing and formula pricing. For plants that used formula pricing, both large and small plants used many sources for the base prices. (See Table 7-12, Questions S6.5 and S6.6.)

Large plants were more likely than small plants to pay transportation costs for pork product sold (66% versus 37% of total pork meat sales). Large plants were also more likely than small plants to use written contracts (20% versus 2% of total pork meat sales). For both large and small plants, most agreements were for less than 1 month. For small plants, most deliveries were scheduled within 3 days (60% of pork meat sales). Large plants tended to have longer delivery schedules: 45% of sales were delivered within 3 days, 27% of sales were delivered between 4 and 6 days, and 28% of sales were delivered a week or more ahead. (See Table 7-13.)

Few large plants used only the spot market to sell pork products, so we cannot compare plants' reasons for using the spot market by size of plant. Likewise, because few small plants used AMAs to sell pork products, we cannot compare plants' reasons for using AMAs by size of plant. (See Table 7-14.)

7.2.5 Pork Packer Survey Summary

Some results from the pork packer survey appear different from information in other published sources; these differences could be due to the low response rate or other factors. Many of the pork packers surveyed relied on spot market transactions for purchasing market hogs. Small plants were more likely than large plants to use spot market transactions to purchase market hogs. The most common AMAs employed by large plants were procurement or marketing contracts and marketing agreements. More than half of the plants with procurement or marketing contracts had them with more than 10 producers; these contracts varied in length and specified a variety of terms. Plants employed a variety of pricing methods for purchasing market hogs, including individually negotiated pricing, formula pricing, and public auctions. Liveweight was the most frequently cited valuation method. Plants that only used cash markets for purchasing market hogs said that it allows for independence, control, and flexibility over business operations. Plants that used AMAs did so to improve week-to-week supply management and secure higher quality market hogs.

Most pork product sales were made through the cash or spot market. Small plants had a greater reliance than large plants on spot market transactions for selling pork products. Both small and large plants used price lists, individually negotiated pricing, and formula pricing to price their products. Most sales were not under a written agreement and were delivered within 3 days. Plants that only used cash markets to sell pork products did so because of the flexibility and simplicity of using the cash market. Plants that used AMAs placed more emphasis on production management and pricing.

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88)

		n	%	Lower	Upper
1.2*	What types of livestock did your plant slaughter during the past year?				
	1. Market hogs	88	100.0	100.0	100.0
	2. Other hogs	44	57.2	46.9	67.6
	3. Beef cattle (including fed Holsteins)	44	62.6	54.3	70.9
	4. Dairy cattle	22	30.9	20.5	41.3
	5. Lambs or sheep	31	44.6	34.3	55.0
	6. Other	0	0.0	NA	NA
	7. Goats	7	10.1	3.0	17.2
	8. Buffalo, elk, or deer	10	14.4	6.2	22.6
	9. Ratites	3	4.3	0.0	9.2
	10. Other cattle	D	2.1	0.0	5.3
1.3	Which of the following best describes your plant's operations during the past year?				
	1. Only conducted slaughter operations	4	5.8	0.2	11.4
	2. Conducted slaughter and fabrication operations, but no further processing activities	13	13.5	6.0	20.9
	3. Conducted slaughter operations, fabrication operations, and further processing activities	70	80.7	71.8	89.6
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
1.4	How many market hogs (barrows and gilts) were procured by your plant during the past year?	85	532,197.1	378,386.7	686,007.4
		n	**%**	**Lower**	**Upper**
	1–499	19	28.1	17.8	38.5
	500–999	11	16.3	7.5	25.1
	1,000–9,999	14	20.7	11.2	30.3
	10,000–99,999	11	12.4	4.9	19.8
	100,000–499,999	6	5.7	0.9	10.6
	500,000–1,999,999	5	3.5	0.6	6.4
	2,000,000 or more	19	13.2	9.2	17.2
	Total		99.9†		

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.
† Total does not sum to 100% because of rounding.

(continued)

A description of the notation used in the table headers is provided below.
n = number of respondents
% = estimated proportion weighted by the number of eligible plants
Mean = estimated mean weighted by the number of eligible plants
Lower = lower bound of the 95% confidence interval for the weighted proportion or mean
Upper = upper bound of the 95% confidence interval for the weighted proportion or mean

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

		n	Mean	Lower	Upper
1.5	How many market hogs (barrows and gilts) were custom slaughtered by your plant during the past year?	54	7,635.8	858.1	14,413.5
		n	**%**	**Lower**	**Upper**
	1–499	23	45.6	31.7	59.6
	500–999	8	16.3	5.7	26.8
	1,000–9,999	16	28.2	15.6	40.8
	10,000–499,999	7	9.9	2.4	17.4
	500,000 or more	0	0.0	NA	NA
	Total		100.0		
		n	**%**	**Lower**	**Upper**
1.6*	Which of the following measures of quality were used for market hogs slaughtered by your plant during the past year?				
	1. None	28	39.4	28.6	50.1
	2. USDA carcass quality grade	8	10.1	3.1	17.2
	3. Lean percentage	29	24.6	16.8	32.4
	4. Backfat	34	30.3	21.5	39.1
	5. Loin eye depth	20	15.3	9.5	21.1
	6. Fat free lean index (FFLI)	D	1.4	0.0	3.3
	7. pH factor	4	2.7	0.1	5.4
	8. Weight standard	41	39.0	29.0	49.0
	9. Other	5	5.8	0.5	11.0
		n	**Mean**	**Lower**	**Upper**
1.7	What carcass weight range for market hogs did your plant use for standard weight carcasses during the past year?				
	a. Minimum carcass weight (pounds)	84	182.6	173.3	191.8
	b. Maximum carcass weight (pounds)	84	253.0	240.0	265.9
		n	**%**	**Lower**	**Upper**
1.8*	What types of certification programs did your plant participate in during the past year?				
	1. None	57	72.5	62.8	82.2
	2. Organic certification	6	7.5	1.3	13.8
	3. USDA Process Verified certification	12	8.6	4.5	12.7
	4. ISO certification	3	2.2	0.0	4.6
	5. Third-party certification of breed or livestock quality (for example, Berkshire Gold)	6	5.1	0.8	9.4
	6. Own-company certification of breed or livestock quality	7	7.5	1.6	13.3
	7. Buyer certification of breed or livestock quality	4	5.3	0.0	10.6
	8. Other	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

		n	%	Lower	Upper
1.9*	What levels of production were owned by the same company that owns your plant during the past year?				
	1. None	42	52.8	41.8	63.9
	2. Genetic supplier	5	3.4	0.6	6.3
	3. Feed company	8	6.3	1.9	10.6
	4. Farrow to wean	15	11.1	6.1	16.0
	5. Wean to feeder	18	13.1	8.1	18.2
	6. Feeder to finish	24	19.6	12.6	26.5
	7. Food manufacturer or meat processor	31	29.8	20.3	39.3
	8. Restaurant, hotel, or other food service	D	2.9	0.0	7.0
	9. Grocery store, meat market, or other retailer	17	24.1	14.2	33.9
	10. Exporter	8	5.5	2.1	8.9
	11. Other	0	0.0	NA	NA
			Mean (n = 76)	**Lower**	**Upper**
1.10	What was your plant's percentage of total pork product dollar sales during the past year by product category?				
	a. Carcass or side		31.4	22.0	40.8
	b. Primal cuts		18.8	13.0	24.5
	c. Subprimal cuts		12.1	8.4	15.8
	d. Ground, including trimmings		10.8	6.1	15.5
	e. Portion cuts		2.8	0.7	4.8
	f. Case ready		5.5	2.4	8.6
	g. Processed, ready-to-eat		5.2	2.5	8.0
	h. Processed, not-ready-to-eat		11.5	6.7	16.3
	i. Other		1.9	<0	5.1
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
1.11	What percentage of pork product sold by your plant during the past year was branded?	80	14.4	7.9	20.9

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

	3 Years Ago (n = 73)				During Past Year (n = 74)				Expected in 3 Years (n = 73)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
2.1 For all market hogs procured by your operation, what were the ownership arrangements (% of head)?												
a. Sole ownership by your plant		92.9	88.1	97.7		92.2	87.3	97.1		91.7	86.6	96.7
b. Joint venture		1.5	<0	3.6		2.3	<0	4.8		2.8	0.1	5.5
c. Shared ownership		1.7	<0	5.1		1.7	<0	5.0		1.7	<0	5.1
d. Other		3.9	0.9	6.9		3.8	0.8	6.8		3.9	0.8	6.9
Total		100.0				100.0				100.1†		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are sole ownership	63	91.2	86.0	96.3	62	89.7	84.4	94.9	60	87.8	81.5	94.1

	3 Years Ago (n = 81)				During Past Year (n = 85)				Expected in 3 Years (n = 83)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
2.2 What methods are used by your plant for procuring market hogs (% of head)?												
a. Auction barns		11.9	5.8	18.0		8.8	3.6	14.0		8.0	2.7	13.3
b. Video/electronic auctions		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
c. Dealers or brokers		21.1	12.4	29.9		22.9	14.1	31.7		22.2	13.3	31.1
d. Direct trade		39.5	29.3	49.8		41.7	31.6	51.8		40.8	30.3	51.2
e. Procurement or marketing contract		9.9	6.3	13.5		10.2	6.8	13.7		10.6	7.1	14.1
f. Production contract		1.9	<0	5.0		2.0	<0	5.1		2.3	<0	5.5
g. Forward contract		1.3	0.3	2.2		1.8	0.8	2.8		1.7	0.8	2.6
h. Marketing agreement		10.4	4.0	16.8		8.2	2.8	13.7		9.3	3.2	15.3
i. Packer owned		4.0	0.3	7.7		4.3	0.5	8.1		5.2	0.7	9.8
j. Other		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Total		100.0				99.9†				100.1†		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are cash or spot market purchases	44	64.0	54.4	73.6	46	64.7	55.7	73.7	44	63.6	54.4	72.9

† Total does not sum to 100% because of rounding.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
2.3* What types of pricing methods are used by your plant for purchasing market hogs?								
1. Individually negotiated pricing	55	64.1	53.0	75.2	51	61.9	50.5	73.4
2. Public auction	26	34.6	23.6	45.6	23	32.9	21.8	44.0
3. Sealed bid	0	0.0	NA	NA	0	0.0	NA	NA
4. Formula pricing (using another price as the base)	50	52.5	41.4	63.5	49	53.0	41.8	64.1
5. Internal transfer	14	12.4	5.9	18.8	16	15.2	7.8	22.5
6. Production contract terms	7	5.0	1.6	8.4	7	6.0	1.5	10.6
7. Other	0	0.0	NA	NA	0	0.0	NA	NA

NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

		n	%	Lower	Upper
2.4*	For market hogs purchased by your plant during the past year using formula pricing, what was the base price of the formula?				
	1. Individual or multiple plant average price	15	23.9	12.1	35.8
	2. Individual or multiple plant average cost of production	D	3.6	0.0	9.1
	3. USDA live quote	19	41.6	28.2	55.0
	4. USDA dressed or carcass quote	32	46.2	33.7	58.7
	5. USDA boxed pork price	5	5.8	1.0	10.6
	6. Chicago Mercantile Exchange (CME) lean hog futures	18	22.2	14.0	30.4
	7. Retail price	D	2.5	0.0	7.4
	8. Subscription service price (for example, Urner Barry)	D	2.5	0.0	7.4
	9. Other market price	0	0.0	NA	NA
	10. Other	D	2.5	0.0	7.4
	11. Corn/soybean meal markets *(write-in response)*	D	2.3	0.0	5.5
	12. Auction price *(write-in response)*	3	7.4	0.0	15.6
2.5*	For market hogs received during the past year from another business unit owned by the same company, what was the source of the internal transfer price?				
	1. Price paid for purchased market hogs	11	54.1	26.7	81.5
	2. Reported market price	9	41.3	15.9	66.7
	3. Measure of internal production cost with a profit margin	D	8.7	0.0	26.9
	4. Measure of internal production cost without a profit margin	0	0.0	NA	NA
	5. Other	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
2.6* What types of valuation methods are used by your plant for purchasing market hogs?								
1. Liveweight	64	78.9	69.7	88.2	60	75.6	65.8	85.3
2. Carcass weight, not dependent on merit	15	19.0	9.8	28.2	15	19.3	9.9	28.7
3. Carcass weight, dependent on merit	34	31.1	22.3	39.9	35	33.2	23.9	42.4
4. Other	0	0.0	NA	NA	0	0.0	NA	NA

NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

		n	Mean	Lower	Upper
2.7	For what percentage of market hogs purchased during the past year did the buyer (your plant) pay for transportation?	80	32.3	22.1	42.6
2.8	What percentage of market hogs purchased during the past year were under a written agreement (versus oral)?	81	18.8	12.8	24.9
		n	**%**	**Lower**	**Upper**
3.1	With how many pork producers did your plant maintain procurement or marketing contracts during the past year?				
	1. One	D	11.4	0.0	23.0
	2. Two	4	13.7	0.0	28.5
	3. Three to five	7	18.7	5.8	31.6
	4. Six to ten	D	2.7	0.0	8.1
	5. More than ten	20	53.5	38.7	68.3
	Total		100.0		
			Mean (n = 32)	**Lower**	**Upper**
3.2	For market hogs purchased under a procurement or marketing contract during the past year, what was the length of the contract (% of head)?				
	a. Less than 6 months		12.6	<0	26.3
	b. 6 to 11 months		14.9	5.7	24.1
	c. 1 to 2 years		17.5	2.6	32.5
	d. 3 to 5 years		27.0	14.4	39.7
	e. 6 to 10 years		1.2	<0	2.5
	f. More than 10 years or evergreen		26.8	10.0	43.5
	Total		100.0		

D = Results suppressed.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

		n	%	Lower	Upper
3.3*	Which of the following terms were specified in the procurement or marketing contracts used by your plant during the past year?				
	1. Number of market hogs to be delivered each specified time period	28	76.3	60.4	92.2
	2. Average weight of market hogs	21	61.5	42.4	80.6
	3. Quality of market hogs	27	76.7	59.5	93.8
	4. Yield percentage of market hogs	9	25.6	8.9	42.2
	5. Producer must sell 100% of production to your plant	14	35.3	21.2	49.4
	6. Minimum guaranteed price for market hogs	12	36.0	17.0	54.9
	7. Includes a ledger account	12	30.3	16.4	44.1
	8. Includes a price window	9	22.7	9.7	35.7
	9. Specifications for production facilities	11	27.8	14.1	41.4
	10. Breeding/genetics used by producer	15	37.8	23.8	51.9
	11. Feeding programs used by producer	11	27.8	14.1	41.4
	12. PSE requirements	D	5.0	0.0	12.2
	13. Producer must be Pork Quality Assurance (PQA) certified	21	53.0	40.4	65.6
	14. Allows packer to inspect and monitor production facilities	23	58.0	46.6	69.4
	15. Allows producer to visit and monitor packing facilities	18	45.4	31.7	59.1
	16. Allows packer to change carcass pricing grid without producer's consent	15	37.8	23.8	51.9
	17. Includes definition of viable or acceptable hog	20	50.5	37.4	63.5
	18. Price adjustment for single or multiple source hogs	5	18.3	2.4	34.2
	19. None of the above	0	0.0	NA	NA

		Mean (n = 10)	Lower	Upper
4.1	What types of contracts did your plant have during the past year for the production of market hogs (% of head)?			
	a. Farrow to finish	6.7	<0	17.7
	b. Wean to finish	23.3	<0	47.8
	c. Feeder to finish	46.4	19.3	73.4
	d. Other	23.6	13.3	34.0
	Total	100.0		

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

	Farrow to Finish				Wean to Finish				Feeder to Finish			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
4.2* What was the length of the production contracts offered by your plant during the past year?	(results suppressed)				(results suppressed)							
1. One batch of hogs at a time									D	42.9	0.0	92.3
2. Less than 1 year									D	42.9	0.0	92.3
3. 1 to 2 years									D	42.9	0.0	92.3
4. 3 to 5 years									D	71.4	26.3	100.0
5. 6 to 10 years									D	14.3	0.0	49.2
6. More than 10 years or evergreen									D	42.9	0.0	92.3
4.3* What was the compensation formula for production contracts offered by your plant during the past year?	(results suppressed)											
1. Payment per square foot of housing for each specified time period					D	83.3	40.5	100.0	D	85.7	50.8	100.0
2. Payment per hog delivered					D	50.0	0.0	100.0	D	57.1	7.7	100.0
3. Payment per pound of weight gain					D	16.7	0.0	59.5	D	42.9	0.0	92.3
4. Other					0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

	Farrow to Finish				Wean to Finish				Feeder to Finish			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
4.4* What type of efficiency adjustments were used as part of the compensation formula for production contracts offered by your plant during the past year?	(results suppressed)											
1. Feed conversion efficiency					D	25.0	0.0	100.0	D	57.1	7.7	100.0
2. Livability/survivability					D	50.0	0.0	100.0	D	71.4	26.3	100.0
3. Preferred weight category					D	75.0	0.0	100.0	D	71.4	26.3	100.0
4. Comparison between individual grower's performance and other growers' performance					0	0.0	NA	NA	0	0.0	NA	NA
5. Comparison between individual grower's performance and a fixed standard					0	0.0	NA	NA	0	0.0	NA	NA
6. Pigs weaned per sow					0	0.0	NA	NA	0	0.0	NA	NA
7. Backfat measurement within target range					0	0.0	NA	NA	0	0.0	NA	NA
8. Quality defects (for example, abscesses or injuries)					D	25.0	0.0	100.0	D	14.3	0.0	49.2
9. Other					0	0.0	NA	NA	0	0.0	NA	NA

Note: Question 4.4 only applies to respondents that use efficiency adjustments.
D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

	Farrow to Finish				Wean to Finish				Feeder to Finish			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
4.5* Which of the following terms were specified in the production contracts offered by your plant during the past year?	(results suppressed)											
1. Specifies minimum number of batches of hogs for each specified time period					D	60.0	0.0	100.0	D	66.7	12.5	100.0
2. Specifies genetics of hogs					0	0.0	NA	NA	D	16.7	0.0	59.5
3. Offers minimum guaranteed payment for each batch					D	60.0	0.0	100.0	D	83.3	40.5	100.0
4. Specifies that insurance premiums for hog mortality are paid by grower					0	0.0	NA	NA	0	0.0	NA	NA
5. Requires mandatory facilities/equipment upgrades					0	0.0	NA	NA	0	0.0	NA	NA
6. Offers payment incentives for facilities/equipment upgrades					0	0.0	NA	NA	D	16.7	0.0	59.5
7. Offers subsidized financing for facilities/equipment upgrades					D	20.0	0.0	75.5	D	16.7	0.0	59.5
8. Requires mandatory arbitration for conflict resolution					D	60.0	0.0	100.0	D	50.0	0.0	100.0
9. Allows packer to change compensation formula without grower's consent					0	0.0	NA	NA	D	16.7	0.0	59.5
10. Includes provision for dead on arrival, condemned, lightweight, or culled hogs					D	20.0	0.0	75.5	D	16.7	0.0	59.5
11. Includes definition of viable or acceptable pig					D	100.0	100.0	100.0	D	100.0	100.0	100.0
12. Other					0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

		n	%	Lower	Upper
5.1*	What are the three most important reasons why your plant only uses the cash or spot market for procuring market hogs?				
	1. Can purchase market hogs at lower prices	15	37.2	21.5	53.0
	2. Reduces risk exposure	4	8.9	0.0	18.0
	3. Reduces costs of activities for buying market hogs	4	10.3	0.3	20.2
	4. Reduces price variability for market hogs	D	5.1	0.0	12.4
	5. Reduces potential liability and litigation concerns	D	5.1	0.0	12.4
	6. Increases supply chain information	0	0.0	NA	NA
	7. Secures higher quality market hogs	14	36.0	20.4	51.6
	8. Allows for market access	5	11.5	1.2	21.8
	9. Allows for adjusting operations quickly in response to changes in market conditions	14	33.3	18.0	48.6
	10. Does not require identifying and recruiting long-term contracting partners	10	24.4	10.4	38.3
	11. Does not require managing complex and costly contracts	8	19.2	6.4	32.0
	12. Eliminates possible negative public perceptions about use of contracts	0	0.0	NA	NA
	13. Allows for independence, complete control, and flexibility of own business	24	60.4	44.6	76.1
	14. Enhances ability to benefit from favorable market conditions	8	17.8	5.7	30.0
	15. Other	D	2.6	0.0	7.8
	16. Can easily purchase small quantity of market hogs *(write-in response)*	5	7.2	1.1	13.3
5.2*	What are the three most important reasons why your plant uses alternative procurement methods for procuring market hogs?				
	1. Can purchase market hogs at lower prices	0	0.0	NA	NA
	2. Reduces risk exposure	8	22.6	8.5	36.7
	3. Reduces costs of activities for buying market hogs	7	23.0	5.2	40.7
	4. Reduces price variability for market hogs	3	11.7	0.0	26.3
	5. Reduces potential liability and litigation concerns	0	0.0	NA	NA
	6. Increases supply chain information	0	0.0	NA	NA
	7. Secures higher quality market hogs	20	59.7	40.3	79.1
	8. Allows for market access	13	39.9	20.1	59.8
	9. Increases flexibility in responding to consumer demand	D	8.8	0.0	22.4
	10. Allows for product branding in retail sales	D	5.7	0.0	13.7
	11. Allows for food safety and biosecurity assurances	D	5.7	0.0	13.7
	12. Allows for product traceability	4	14.5	0.0	30.1
	13. Improves week-to-week supply management	22	62.2	48.6	75.7
	14. Improves efficiency of operations due to animal uniformity	7	26.2	9.0	43.3
	15. Enhances access to credit	D	6.0	0.0	18.3
	16. Other	D	2.8	0.0	8.6

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

		Mean (n = 83)	Lower	Upper
6.1	What was your plant's percentage of total pork product dollar sales during the past year by type of buyer or recipient?			
	a. Meat processors or food manufacturers	17.7	12.2	23.2
	b. Wholesalers or distributors	16.7	11.4	22.1
	c. Retail establishments	39.9	30.9	48.9
	d. Food service establishments	6.2	3.0	9.4
	e. Foreign buyers	2.9	1.5	4.3
	f. Other	0.0	0.0	0.1
	g. Directly to consumers *(write-in response)*	16.5	8.1	25.0
	Total	99.9†		

† Total does not sum to 100% because of rounding.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

	3 Years Ago (n = 79)				During Past Year (n = 79)				Expected in 3 Years (n = 79)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
6.2 What sales methods are used by your plant for selling pork products (% of dollar sales)?												
a. Cash or spot market (less than 3 weeks forward)		82.6	74.7	90.4		81.6	73.7	89.5		79.2	71.3	87.1
b. Forward contract		2.4	0.6	4.2		2.9	1.0	4.8		4.1	1.9	6.3
c. Marketing agreement		9.7	3.7	15.6		10.2	4.3	16.2		11.0	5.0	17.0
d. Internal company transfer		5.4	0.7	10.1		5.3	0.5	10.0		5.7	0.9	10.4
e. Other		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Total		100.1†				100.0				100.0		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are cash or spot market sales	45	66.6	57.1	76.0	45	66.6	57.1	76.0	45	66.6	57.1	76.0
	Processors / Manufacturers				**Wholesalers / Distributors**				**Retail Establishments**			
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
6.3* What sales methods did your plant use during the past year for selling pork products to different types of recipients?												
1. Cash or spot market (less than 3 weeks forward)	40	95.0	89.4	100.0	46	94.2	86.2	100.0	51	81.8	70.9	92.7
2. Forward contract	12	20.0	11.0	29.0	12	19.3	8.8	29.8	13	14.4	7.4	21.3
3. Marketing agreement	10	18.6	7.5	29.7	17	24.5	15.7	33.4	23	29.2	18.7	39.6
4. Internal company transfer	11	18.4	9.5	27.2	D	2.9	0.0	8.7	D	4.3	0.0	10.4
5. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
	Food Service Establishments				**Foreign Buyers**							
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**				
1. Cash or spot market (less than 3 weeks forward)	38	96.5	91.6	100.0	23	85.4	66.9	100.0				
2. Forward contract	16	28.1	19.4	36.8	17	64.2	41.0	87.4				
3. Marketing agreement	17	29.9	21.4	38.3	9	35.8	12.6	59.0				
4. Internal company transfer	6	10.5	2.8	18.3	0	0.0	NA	NA				
5. Other	0	0.0	NA	NA	0	0.0	NA	NA				

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.
† Total does not sum to 100% because of rounding.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

		Processors/Manufacturers				Wholesalers/Distributors				Retail Establishments			
		n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
6.4*	What types of pricing methods did your plant use during the past year for selling pork products to different types of recipients?												
	1. Price list	17	43.1	27.1	59.1	31	54.1	39.6	68.6	45	69.5	56.7	82.3
	2. Individually negotiated pricing	26	55.6	39.1	72.0	33	63.8	48.9	78.7	26	34.9	23.3	46.4
	3. Formula pricing (using another price as the base)	25	50.4	34.4	66.3	23	36.6	24.0	49.3	31	44.6	31.7	57.6
	4. Sealed bid	5	7.9	1.3	14.6	4	5.1	0.3	9.9	12	12.3	6.9	17.8
	5. Internal transfer	10	15.9	7.5	24.2	0	0.0	NA	NA	6	6.2	1.6	10.7
	6. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

		Food Service Establishments				Foreign Buyers			
		n	%	Lower	Upper	n	%	Lower	Upper
	1. Price list	30	71.2	54.9	87.5	11	46.9	29.2	64.6
	2. Individually negotiated pricing	26	59.8	42.9	76.7	24	92.9	82.8	100.0
	3. Formula pricing (using another price as the base)	20	40.6	27.0	54.3	13	50.0	26.0	74.0
	4. Sealed bid	7	12.8	4.3	21.3	0	0.0	NA	NA
	5. Internal transfer	0	0.0	NA	NA	0	0.0	NA	NA
	6. Other	0	0.0	NA	NA	0	0.0	NA	NA

NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

	n	%	Lower	Upper
6.5* For pork products sold by your plant during the past year using formula pricing, what was the base price of the formula?				
1. Individual or multiple plant average price	14	26.3	12.9	39.7
2. Individual or multiple plant average cost of production	5	8.7	0.6	16.8
3. USDA publicly reported price	36	62.3	48.9	75.8
4. Retail price	8	24.2	10.7	37.6
5. Subscription service price (for example, Urner Barry)	7	14.7	3.4	26.0
6. Other market price	D	3.0	0.0	9.1
7. Other	0	0.0	NA	NA
6.6* What types of pricing methods does your plant expect to use in 3 years for selling pork products?				
1. Price list	45	58.0	46.3	69.8
2. Individually negotiated pricing	47	52.7	41.3	64.1
3. Formula pricing (using another price as the base)	46	48.5	37.8	59.3
4. Sealed bid	10	8.4	3.4	13.5
5. Internal transfer	15	13.1	6.9	19.3
6. Other	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

		Processors/Manufacturers				Wholesalers/Distributors				Retail Establishments			
		n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
6.7*	Which of the following marketing practices did your plant use during the past year for the sale of pork products?												
	1. Two-part pricing	D	7.9	0.0	18.8	11	20.0	8.1	31.9	17	25.9	14.1	37.7
	2. Volume discounts	11	33.0	15.8	50.2	22	43.2	27.7	58.7	22	32.6	20.1	45.0
	3. Exclusive dealings	D	1.9	0.0	5.6	3	8.9	0.0	18.7	9	13.5	4.4	22.6
	4. Bundling	D	1.9	0.0	5.6	9	14.1	5.1	23.1	12	13.1	7.3	18.9
	5. None of the above	24	59.3	41.5	77.1	21	44.9	29.0	60.9	27	50.3	36.3	64.3

		Food Service Establishments				Foreign Buyers			
		n	%	Lower	Upper	n	%	Lower	Upper
	1. Two-part pricing	11	23.5	10.7	36.3	0	0.0	NA	NA
	2. Volume discounts	15	37.8	20.3	55.3	7	28.7	10.4	47.0
	3. Exclusive dealings	4	9.9	0.0	20.5	3	12.3	0.0	26.3
	4. Bundling	10	19.4	9.7	29.1	7	28.7	10.4	47.0
	5. None of the above	16	46.3	27.9	64.6	12	63.1	44.4	81.8

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

	n	Mean	Lower	Upper
7.1 For what percentage of pork products sold during the past year did the seller (your plant) pay for transportation?	80	43.8	33.4	54.3
7.2 What percentage of pork products sold during the past year were under a written agreement (versus oral)?	78	6.5	3.1	9.9

	Mean (n = 72)	Lower	Upper
7.3 For pork products sold during the past year, what was the length of the agreement or contact (oral or written) (% of dollar sales)?			
a. Sales not under agreement or contract	84.3	76.5	92.1
b. Less than 1 month	7.1	1.5	12.6
c. 1 to 2 months	1.2	0.5	1.9
d. 3 to 5 months	2.1	<0	5.7
e. 6 to 11 months	2.0	<0	5.6
f. 1 to 2 years	2.5	0.1	4.9
g. 3 to 5 years	0.0	0.0	0.0
h. 6 to 10 years	0.0	0.0	0.0
i. More than 10 years or evergreen	0.8	<0	1.8
Total	100.0		

	Mean (n = 78)	Lower	Upper
7.4 For pork products sold during the past year, how far in advance of delivery was the delivery scheduled (% of dollar sales)?			
a. Less than 3 days	56.5	46.3	66.7
b. 4 to 6 days	25.4	16.9	33.9
c. 1 to 2 weeks	10.9	4.9	17.0
d. 3 to 4 weeks	5.5	1.2	9.9
e. More than 1 month	1.6	0.6	2.6
Total	99.9†		

† Total does not sum to 100% because of rounding.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

		n	%	Lower	Upper
8.1*	What are the three most important reasons why your plant only uses the cash or spot market for selling pork products?				
	1. Can sell pork products at higher prices	12	25.8	12.3	39.3
	2. Reduces risk exposure	9	17.5	6.3	28.7
	3. Reduces costs of activities for selling pork products	9	21.3	8.5	34.0
	4. Reduces price variability for pork products	D	4.7	0.0	11.4
	5. Reduces potential liability and litigation concerns	D	3.5	0.0	8.7
	6. Increases supply chain information	0	0.0	NA	NA
	7. Allows for sale of higher quality pork products	9	20.0	7.6	32.4
	8. Allows for market access	5	10.6	1.1	20.0
	9. Allows for adjusting operations quickly in response to changes in market conditions	19	42.4	27.0	57.7
	10. Does not require identifying and recruiting long-term contracting partners	9	18.7	6.8	30.7
	11. Does not require managing complex and costly contracts	12	28.3	14.4	42.3
	12. Eliminates possible negative public perceptions about use of contracts	0	0.0	NA	NA
	13. Allows for independence, complete control, and flexibility of own business	23	53.1	37.7	68.4
	14. Enhances ability to benefit from favorable market conditions	9	18.7	6.8	30.7
	15. Other	D	2.4	0.0	7.1
	16. Can easily sell small quantity of pork products *(write-in response)*	D	4.7	0.0	11.4
	17. No other choice *(write-in response)*	D	4.7	0.0	11.4
8.2*	What are the three most important reasons why your plant uses alternative sales methods for selling pork products?				
	1. Can sell pork products at higher prices	15	51.4	29.8	73.0
	2. Reduces risk exposure	13	39.5	20.9	58.1
	3. Reduces costs of activities for selling pork products	5	17.1	0.9	33.3
	4. Reduces price variability for pork products	3	11.5	0.0	26.1
	5. Reduces potential liability and litigation concerns	D	5.9	0.0	18.2
	6. Increases supply chain information	3	8.4	0.0	17.9
	7. Allows for sale of higher quality pork products	4	17.5	0.1	34.8
	8. Allows for market access	2	8.7	0.0	22.2
	9. Increases flexibility in responding to consumer demand	5	17.1	0.9	33.3
	10. Allows for product branding in retail sales	8	22.4	9.0	35.8
	11. Allows for food safety and biosecurity assurances	3	14.7	0.0	31.2
	12. Allows for product traceability	D	2.8	0.0	8.5
	13. Improves week-to-week production management	18	59.8	38.6	80.9
	14. Secures a buyer for pork products	5	20.3	2.2	38.4
	15. Other	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

		n	%	Lower	Upper
9.1	How many days per week did your plant usually slaughter market hogs?				
	1. Less frequently than once a week	7	10.1	3.0	17.3
	2. 1 or 2 days per week	37	53.6	43.9	63.4
	3. 3 or 4 days per week	5	5.7	0.5	11.0
	4. 5 or 6 days per week	38	30.5	23.5	37.5
	Total		99.9		
9.2	How many market hog slaughter shifts did your plant usually operate per day?				
	1. One	75	93.0	89.3	96.8
	2. Two	10	7.0	3.2	10.7
	3. Three	0	0.0	NA	NA
	Total		100.0		
9.3	How many pork processing shifts did your plant usually operate per day?				
	1. None	24	29.8	19.3	40.4
	2. One	42	56.3	45.8	66.8
	3. Two	20	13.8	9.8	17.8
	4. Three	0	0.0	NA	NA
	Total		99.9		
		n	**Mean**	**Lower**	**Upper**
9.4	What is your plant's maximum slaughter capacity (head per week) for market hogs?	87	11,405.2	7,898.2	14,912.2
9.5	What is your plant's maximum processing capacity (pounds per week) for pork products?	73	1,612,340.3	985,429.8	2,239,250.8
9.6	What was the slaughter line speed (head per hour) for market hogs?	55	229.1	170.9	287.3
		n	**%**	**Lower**	**Upper**
9.7	How many meat slaughter and processing plants, including this one, are owned by the company that owns your plant?				
	1. One	60	80.2	74.0	86.5
	2. 2 to 5	7	7.2	1.6	12.9
	3. 6 to 10	D	1.4	0.0	3.3
	4. 11 to 20	9	6.3	2.7	9.9
	5. 21 or more	7	4.9	1.6	8.2
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
9.8	Approximately how many people were employed at your plant during the past year?				
	a. Full time	85	292.7	200.5	384.8
	b. Part time or seasonal	47	13.9	3.7	24.2

D = Results suppressed.
NA = Confidence interval not calculable.

(continued)

Table 7-8. Weighted Responses for the Pork Packer Survey (n = 88) (continued)

		n	%	Lower	Upper
9.9	What were your plant's approximate total gross sales for fresh, frozen, and processed pork products during the past year?				
	1. Under $99,999	19	28.2	17.6	38.7
	2. $100,000 to $499,999	18	26.6	16.2	37.1
	3. $500,000 to $999,999	3	4.6	0.0	9.7
	4. $1,000,000 to $2,499,999	7	10.7	3.1	18.2
	5. $2,500,000 to $9,999,999	4	5.3	0.0	10.6
	6. $10,000,000 to $19,999,999	4	4.5	0.0	9.2
	7. $20,000,000 to $99,999,999	6	5.1	0.9	9.4
	8. $100,000,000 to $499,999,999	9	6.5	2.8	10.1
	9. $500,000,000 or more	12	8.6	4.7	12.5
	Total		100.1†		
9.10	What were your plant's approximate total gross sales for pork by-products during the past year?				
	1. Under $99,999	42	66.3	58.3	74.3
	2. $100,000 to $499,999	7	8.6	2.0	15.3
	3. $500,000 to $999,999	4	4.7	0.0	9.6
	4. $1,000,000 to $2,499,999	4	3.9	0.0	7.9
	5. $5,000,000 to $9,999,999	5	3.8	0.6	6.9
	6. $20,000,000 to $49,999,999	8	6.0	2.3	9.7
	7. $50,000,000 to $499,999,999	9	6.8	2.9	10.6
	8. $500,000,000 to $999,999,999	0	0.0	NA	NA
	9. 1,000,000,000 or more	0	0.0	NA	NA
	Total		100.1†		
9.11	What were your plant's approximate total gross sales for all products during the past year?				
	1. Under $99,999	9	12.9	4.8	21.0
	2. $100,000 to $499,999	14	21.4	11.6	31.1
	3. $500,000 to $999,999	9	13.7	5.4	22.1
	4. $1,000,000 to $2,499,999	12	18.3	9.0	27.6
	5. $2,500,000 to $4,999,999	3	4.6	0.0	9.7
	6. $5,000,000 to $9,999,999	3	3.8	0.0	8.2
	7. $10,000,000 to $19,999,999	4	4.5	0.0	9.2
	8. $20,000,000 to $49,999,999	3	3.0	0.0	6.6
	9. $50,000,000 to $99,999,999	3	2.2	0.0	4.5
	10. $100,000,000 to $499,999,999	8	5.7	2.2	9.3
	11. $500,000,000 or more	14	10.0	6.0	14.1
	Total		100.1†		

NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.

Table 7-9. Use of Purchase Methods for Pork Packing Plants, by Size (Small = 53, Large = 35)

		Small (n = 47)				Large (n = 27)				All Plants (n = 74)		
		Mean	Lower	Upper		Mean	Lower	Upper		Mean	Lower	Upper
S2.1 For all market hogs procured by your operation during the past year, what were the ownership arrangements (% of head)?												
a. Sole ownership by your plant		97.9	93.6	>100.0		71.1	53.8	88.5		92.2	87.3	97.1
b. Joint venture		0.0	0.0	0.0		10.7	<0	23.0		2.3	<0	4.8
c. Shared ownership		2.1	<0	6.4		0.0	0.0	0.1		1.7	<0	5.0
d. Other		0.0	0.0	0.0		18.1	3.5	32.6		3.8	0.8	6.8
Total		100.0				99.9†				100.0		
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
Establishments for which 100% are sole ownership	46	97.9	93.6	100.0	16	59.3	39.5	79.1	62	89.7	84.4	94.9

		Small (n = 51)				Large (n = 34)				All Plants (n = 85)		
		Mean	Lower	Upper		Mean	Lower	Upper		Mean	Lower	Upper
S2.2 What methods were used by your plant during the past year for procuring market hogs (% of head)?												
a. Auction barns		11.3	4.4	18.2		0.8	<0	1.8		8.8	3.6	14.0
b. Video/electronic auctions		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
c. Dealers or brokers		25.5	14.2	36.8		14.5	4.6	24.3		22.9	14.1	31.7
d. Direct trade		48.9	35.7	62.1		18.9	10.6	27.1		41.7	31.6	51.8
e. Procurement or marketing contract		1.2	<0	3.5		39.1	26.4	51.8		10.2	6.8	13.7
f. Production contract		2.0	<0	5.9		2.2	<0	5.1		2.0	<0	5.1
g. Forward contract		0.0	0.0	0.0		7.6	3.3	11.9		1.8	0.8	2.8
h. Marketing agreement		8.1	1.1	15.2		8.6	3.2	14.0		8.2	2.8	13.7
i. Packer owned		3.0	<0	7.4		8.4	0.0	16.7		4.3	0.5	8.1
j. Other		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Total		100.0				100.1†				99.9†		
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
Establishments for which 100% are cash or spot market purchases	41	80.4	69.1	91.7	5	14.7	2.2	27.2	46	64.7	55.7	73.7

† Total does not sum to 100% because of rounding.

(continued)

Table 7-9. Use of Purchase Methods for Pork Packing Plants, by Size (Small = 53, Large = 35) (continued)

	Small				Large				All Plants			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S2.3* What types of pricing methods are used by your plant for purchasing market hogs?												
1. Individually negotiated pricing	31	62.0	48.1	75.9	24	70.6	54.5	86.7	55	64.1	53.0	75.2
2. Public auction	20	40.0	25.9	54.1	6	17.6	4.1	31.1	26	34.6	23.6	45.6
3. Sealed bid	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
4. Formula pricing (using another price as the base)	21	42.0	27.8	56.2	29	85.3	72.8	97.8	50	52.5	41.4	63.5
5. Internal transfer	3	6.0	0.0	12.8	11	32.4	15.8	48.9	14	12.4	5.9	18.8
6. Production contract terms	0	0.0	NA	NA	7	20.6	6.3	34.9	7	5.0	1.6	8.4
7. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
S2.4* For market hogs purchased by your plant during the past year using formula pricing, what was the base price of the formula?												
1. Individual or multiple plant average price	5	19.2	3.0	35.5	10	32.3	14.8	49.7	15	23.9	12.1	35.8
2. Individual or multiple plant average cost of production	D	3.8	0.0	11.8	D	3.2	0.0	9.8	D	3.6	0.0	9.1
3. USDA live quote	15	57.7	37.3	78.0	4	12.9	0.4	25.4	19	41.6	28.2	55.0
4. USDA dressed or carcass quote	7	26.9	8.7	45.2	25	80.6	65.9	95.4	32	46.2	33.7	58.7
5. USDA boxed pork price	0	0.0	NA	NA	5	16.1	2.4	29.8	5	5.8	1.0	10.6
6. Chicago Mercantile Exchange (CME) lean hog futures	D	3.8	0.0	11.8	D	54.8	36.3	73.4	18	22.2	14.0	30.4
7. Retail price	D	3.8	0.0	11.8	0	0.0	NA	NA	D	2.5	0.0	7.4
8. Subscription service price (for example, Urner Barry)	D	3.8	0.0	11.8	0	0.0	NA	NA	D	2.5	0.0	7.4
9. Other market price	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
10. Other	D	3.8	0.0	11.8	0	0.0	NA	NA	D	2.5	0.0	7.4
11. Corn/soybean meal markets *(write-in response)*	0	0.0	NA	NA	D	6.5	0.0	15.6	D	2.3	0.0	5.5
12. Auction price *(write-in response)*	3	11.5	0.0	24.7	0	0.0	NA	NA	3	7.4	0.0	15.6

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-9. Use of Purchase Methods for Pork Packing Plants, by Size (Small = 53, Large = 35) (continued)

		Small				Large				All Plants			
		n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S2.5*	For market hogs received during the past year from another business unit owned by the same company, what was the source of the internal transfer price?												
	1. Price paid for purchased market hogs	D	50.0	0.0	100.0	D	56.3	28.9	83.6	11	54.1	26.7	81.5
	2. Reported market price	D	25.0	0.0	100.0	D	50.0	22.5	77.5	9	41.3	15.9	66.7
	3. Measure of internal production cost with a profit margin	D	25.0	0.0	100.0	0	0.0	NA	NA	D	8.7	0.0	26.9
	4. Measure of internal production cost without a profit margin	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
	5. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
S2.6*	What types of valuation methods are used by your plant for purchasing market hogs?												
	1. Liveweight	40	81.6	70.4	92.9	24	70.6	54.5	86.7	64	78.9	69.7	88.2
	2. Carcass weight, not dependent on merit	10	20.4	8.7	32.1	5	14.7	2.2	27.2	15	19.0	9.8	28.2
	3. Carcass weight, dependent on merit	8	16.3	5.6	27.1	26	76.5	61.4	91.5	34	31.1	22.3	39.9
	4. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
		n	Mean	Lower	Upper	n	Mean	Lower	Upper	n	Mean	Lower	Upper
S2.7	For what percentage of market hogs purchased during the past year did the buyer (your plant) pay for transportation?	48	38.9	25.5	52.3	32	11.5	3.2	19.8	80	32.3	22.1	42.6
S2.8	What percentage of market hogs purchased during the past year were under a written agreement (versus oral)?	48	5.8	<0	12.5	33	59.1	44.4	73.8	81	18.8	12.8	24.9

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 7-10. Terms of Procurement or Marketing Contracts for Pork Packing Plants, by Size (Small = 53, Large = 35)

	Small				Large				All Plants			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S3.1 With how many pork producers did your plant maintain procurement or marketing contracts during the past year?												
1. One	D	66.7	0.0	100.0	0	0.0	NA	NA	D	11.4	0.0	23.0
2. Two	D	33.3	0.0	100.0	D	9.7	0.0	20.7	4	13.7	0.0	28.5
3. Three to five	0	0.0	NA	NA	7	22.6	7.0	38.2	7	18.7	5.8	31.6
4. Six to ten	0	0.0	NA	NA	D	3.2	0.0	9.8	D	2.7	0.0	8.1
5. More than ten	0	0.0	NA	NA	20	64.5	46.7	82.4	20	53.5	38.7	68.3
Total		100.0				100.0				100.0		

	Small (n = 3)			Large (n = 29)			All Plants (n = 32)		
	Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
S3.2 For market hogs purchased under a procurement or marketing contract during the past year, what was the length of the contract (% of head)?	(results suppressed)								
a. Less than 6 months				8.0	0.4	15.6	12.6	<0	26.3
b. 6 to 11 months				18.2	7.0	29.4	14.9	5.7	24.1
c. 1 to 2 years				14.0	3.6	24.5	17.5	2.6	32.5
d. 3 to 5 years				33.0	17.5	48.5	27.0	14.4	39.7
e. 6 to 10 years				1.5	<0	3.1	1.2	<0	2.5
f. More than 10 years or evergreen				25.3	11.4	39.2	26.8	10.0	43.5
Total				100.0			100.0		

D = Results suppressed.
NA = Confidence interval not calculable.

(continued)

Table 7-10. Terms of Procurement or Marketing Contracts for Pork Packing Plants, by Size (Small = 53, Large = 35) (continued)

	Small				Large				All Plants			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S3.3* Which of the following terms were specified in the procurement or marketing contracts used by your plant during the past year?												
1. Number of market hogs to be delivered each specified time period	D	40.0	0.0	100.0	D	89.7	77.9	100.0	28	76.3	60.4	92.2
2. Average weight of market hogs	D	60.0	0.0	100.0	D	62.1	43.3	80.9	21	61.5	42.4	80.6
3. Quality of market hogs	D	60.0	0.0	100.0	D	82.8	68.1	97.4	27	76.7	59.5	93.8
4. Yield percentage of market hogs	D	20.0	0.0	75.5	D	27.6	10.3	44.9	9	25.6	8.9	42.2
5. Producer must sell 100% of production to your plant	0	0.0	NA	NA	14	48.3	28.9	67.6	14	35.3	21.2	49.4
6. Minimum guaranteed price for market hogs	D	40.0	0.0	100.0	D	34.5	16.1	52.9	12	36.0	17.0	54.9
7. Includes a ledger account	0	0.0	NA	NA	12	41.4	22.3	60.4	12	30.3	16.4	44.1
8. Includes a price window	0	0.0	NA	NA	9	31.0	13.1	48.9	9	22.7	9.7	35.7
9. Specifications for production facilities	0	0.0	NA	NA	11	37.9	19.1	56.7	11	27.8	14.1	41.4
10. Breeding/genetics used by producer	0	0.0	NA	NA	15	51.7	32.4	71.1	15	37.8	23.8	51.9
11. Feeding programs used by producer	0	0.0	NA	NA	11	37.9	19.1	56.7	11	27.8	14.1	41.4
12. PSE requirements	0	0.0	NA	NA	D	6.9	0.0	16.7	D	5.0	0.0	12.2
13. Producer must be Pork Quality Assurance (PQA) certified	0	0.0	NA	NA	21	72.4	55.1	89.7	21	53.0	40.4	65.6
14. Allows packer to inspect and monitor production facilities	0	0.0	NA	NA	23	79.3	63.6	95.0	23	58.0	46.6	69.4
15. Allows producer to visit and monitor packing facilities	0	0.0	NA	NA	18	62.1	43.3	80.9	18	45.4	31.7	59.1
16. Allows packer to change carcass pricing grid without producer's consent	0	0.0	NA	NA	15	51.7	32.4	71.1	15	37.8	23.8	51.9
17. Includes definition of viable or acceptable hog	0	0.0	NA	NA	20	69.0	51.1	86.9	20	50.5	37.4	63.5
18. Price adjustment for single or multiple source hogs	D	40.0	0.0	100.0	D	10.3	0.0	22.1	5	18.3	2.4	34.2
19. None of the above	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 7-11. Reasons for Using Purchase Methods for Pork Packing Plants, by Size (Small = 53, Large = 35)

	Small				Large				All Plants			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S5.1* What are the three most important reasons why your plant only uses the cash or spot market for procuring market hogs?												
1. Can purchase market hogs at lower prices	D	37.8	21.4	54.2	D	25.0	0.0	100.0	15	37.2	21.5	53.0
2. Reduces risk exposure	D	8.1	0.0	17.3	D	25.0	0.0	100.0	4	8.9	0.0	18.0
3. Reduces costs of activities for buying market hogs	4	10.8	0.3	21.3	0	0.0	NA	NA	4	10.3	0.3	20.2
4. Reduces price variability for market hogs	D	5.4	0.0	13.0	0	0.0	NA	NA	D	5.1	0.0	12.4
5. Reduces potential liability and litigation concerns	D	5.4	0.0	13.0	0	0.0	NA	NA	D	5.1	0.0	12.4
6. Increases supply chain information	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
7. Secures higher quality market hogs	14	37.8	21.4	54.2	0	0.0	NA	NA	14	36.0	20.4	51.6
8. Allows for market access	D	10.8	0.3	21.3	D	25.0	0.0	100.0	5	11.5	1.2	21.8
9. Allows for adjusting operations quickly in response to changes in market conditions	D	32.4	16.6	48.3	D	50.0	0.0	100.0	14	33.3	18.0	48.6
10. Does not require identifying and recruiting long-term contracting partners	D	24.3	9.8	38.8	D	25.0	0.0	100.0	10	24.4	10.4	38.3
11. Does not require managing complex and costly contracts	D	18.9	5.7	32.2	D	25.0	0.0	100.0	8	19.2	6.4	32.0
12. Eliminates possible negative public perceptions about use of contracts	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
13. Allows for independence, complete control, and flexibility of own business	D	62.2	45.8	78.6	D	25.0	0.0	100.0	24	60.4	44.6	76.1
14. Enhances ability to benefit from favorable market conditions	D	16.2	3.8	28.7	D	50.0	0.0	100.0	8	17.8	5.7	30.0
15. Other	D	2.7	0.0	8.2	0	0.0	NA	NA	D	2.6	0.0	7.8
16. Can easily purchase small quantity of market hogs *(write-in response)*	5	9.4	1.3	17.6	0	0.0	NA	NA	5	7.2	1.1	13.3

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-11. Reasons for Using Purchase Methods for Pork Packing Plants, by Size (Small = 53, Large = 35) (continued)

	Small				Large				All Plants			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S5.2* What are the three most important reasons why your plant uses alternative procurement methods for procuring market hogs?												
1. Can purchase market hogs at lower prices	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
2. Reduces risk exposure	0	0.0	NA	NA	8	27.6	10.3	44.9	8	22.6	8.5	36.7
3. Reduces costs of activities for buying market hogs	D	33.3	0.0	100.0	D	20.7	5.0	36.4	7	23.0	5.2	40.7
4. Reduces price variability for market hogs	D	33.3	0.0	100.0	D	6.9	0.0	16.7	3	11.7	0.0	26.3
5. Reduces potential liability and litigation concerns	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
6. Increases supply chain information	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
7. Secures higher quality market hogs	D	33.3	0.0	100.0	D	65.5	47.1	83.9	20	59.7	40.3	79.1
8. Allows for market access	D	33.3	0.0	100.0	D	41.4	22.3	60.4	13	39.9	20.1	59.8
9. Increases flexibility in responding to consumer demand	D	33.3	0.0	100.0	D	3.4	0.0	10.5	D	8.8	0.0	22.4
10. Allows for product branding in retail sales	0	0.0	NA	NA	D	6.9	0.0	16.7	D	5.7	0.0	13.7
11. Allows for food safety and biosecurity assurances	0	0.0	NA	NA	D	6.9	0.0	16.7	D	5.7	0.0	13.7
12. Allows for product traceability	D	33.3	0.0	100.0	D	10.3	0.0	22.1	4	14.5	0.0	30.1
13. Improves week-to-week supply management	0	0.0	NA	NA	22	75.9	59.3	92.4	22	62.2	48.6	75.7
14. Improves efficiency of operations due to animal uniformity	D	66.7	0.0	100.0	D	17.2	2.6	31.9	7	26.2	9.0	43.3
15. Enhances access to credit	D	33.3	0.0	100.0	0	0.0	NA	NA	D	6.0	0.0	18.3
16. Other	0	0.0	NA	NA	D	3.4	0.0	10.5	D	2.8	0.0	8.6

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 7-12. Use of Sales Methods for Pork Packing Plants, by Size (Small = 53, Large = 35)

	Small (n = 50)			Large (n = 33)			All Plants (n = 83)		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
S6.1 What was your plant's percentage of total pork product dollar sales during the past year by type of buyer or recipient?									
a. Meat processors or food manufacturers	12.7	6.0	19.5	33.7	24.3	43.1	17.7	12.2	23.2
b. Wholesalers or distributors	16.2	9.3	23.2	18.2	13.3	23.2	16.7	11.4	22.1
c. Retail establishments	43.3	31.7	54.9	28.9	21.1	36.6	39.9	30.9	48.9
d. Food service establishments	5.6	1.5	9.7	8.1	4.6	11.6	6.2	3.0	9.4
e. Foreign buyers	0.4	<0	1.0	10.9	5.0	16.8	2.9	1.5	4.3
f. Other	0.0	0.0	0.0	0.2	0.0	0.4	0.0	0.0	0.1
g. Directly to consumers *(write-in response)*	21.7	10.5	32.8	0.0	0.0	0.0	16.5	8.1	25.0
Total	99.9†			100.0			99.9†		

	Small (n = 47)			Large (n = 32)			All Plants (n = 79)		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
S6.2 What sales methods were used by your plant during the past year for selling pork products (% of dollar sales)?									
a. Cash or spot market (less than 3 weeks forward)	86.0	76.0	96.0	67.8	56.9	78.8	81.6	73.7	89.5
b. Forward contract	1.5	<0	3.8	7.1	3.9	10.3	2.9	1.0	4.8
c. Marketing agreement	8.1	0.5	15.6	16.9	9.1	24.8	10.2	4.3	16.2
d. Internal company transfer	4.4	<0	10.3	8.1	1.8	14.4	5.3	0.5	10.0
e. Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.0			99.9†			100.0		

	Small				Large				All Plants			
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are cash or spot market sales	38	80.9	69.2	92.5	7	21.9	6.7	37.0	45	66.6	57.1	76.0

† Total does not sum to 100% because of rounding.

(continued)

Table 7-12. Use of Sales Methods for Pork Packing Plants, by Size (Small = 53, Large = 35) (continued)

		Small				Large				All Plants			
		n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S6.5*	For pork products sold by your plant during the past year using formula pricing, what was the base price of the formula?												
	1. Individual or multiple plant average price	4	21.1	0.9	41.2	10	33.3	15.4	51.2	14	26.3	12.9	39.7
	2. Individual or multiple plant average cost of production	D	5.3	0.0	16.3	D	13.3	0.4	26.2	5	8.7	0.6	16.8
	3. USDA publicly reported price	7	36.8	13.0	60.7	29	96.7	89.8	100.0	36	62.3	48.9	75.8
	4. Retail price	8	42.1	17.7	66.6	0	0.0	NA	NA	8	24.2	10.7	37.6
	5. Subscription service price (for example, Urner Barry)	3	15.8	0.0	33.8	4	13.3	0.4	26.2	7	14.7	3.4	26.0
	6. Other market price	D	5.3	0.0	16.3	0	0.0	NA	NA	D	3.0	0.0	9.1
	7. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
S6.6*	What types of pricing methods does your plant expect to use in 3 years for selling pork products?												
	1. Price list	28	59.6	45.0	74.1	17	53.1	34.8	71.4	45	58.0	46.3	69.8
	2. Individually negotiated pricing	20	42.6	27.9	57.2	27	84.4	71.1	97.7	47	52.7	41.3	64.1
	3. Formula pricing (using another price as the base)	16	34.0	20.0	48.1	30	93.8	84.9	100.0	46	48.5	37.8	59.3
	4. Sealed bid	D	2.1	0.0	6.4	D	28.1	11.7	44.6	10	8.4	3.4	13.5
	5. Internal transfer	D	4.3	0.0	10.2	D	40.6	22.6	58.6	15	13.1	6.9	19.3
	6. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

Table 7-13. Terms of Sales Methods for Pork Packing Plants, by Size (Small = 53, Large = 35)

	Small				Large				All Plants			
	n	**Mean**	**Lower**	**Upper**	**n**	**Mean**	**Lower**	**Upper**	**n**	**Mean**	**Lower**	**Upper**
S7.1 For what percentage of pork products sold during the past year did the seller (your plant) pay for transportation?	49	37.1	24.2	50.1	31	66.2	51.4	81.1	80	43.8	33.4	54.3
S7.2 What percentage of pork products sold during the past year were under a written agreement (versus oral)?	47	2.3	<0	5.1	31	20.2	8.9	31.6	78	6.5	3.1	9.9
	Small (n = 41)				**Large** (n = 31)				**All Plants** (n = 72)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
S7.3 For pork products sold during the past year, what was the length of the agreement or contact (oral or written) (% of dollar sales)?												
a. Sales not under agreement or contract		88.8	79.2	98.3		71.6	58.0	85.3		84.3	76.5	92.1
b. Less than 1 month		6.0	<0	13.0		10.2	1.3	19.0		7.1	1.5	12.6
c. 1 to 2 months		0.2	<0	0.7		3.8	1.4	6.2		1.2	0.5	1.9
d. 3 to 5 months		2.6	<0	7.5		0.8	0.2	1.4		2.1	<0	5.7
e. 6 to 11 months		2.4	<0	7.4		0.8	0.2	1.5		2.0	<0	5.6
f. 1 to 2 years		0.0	0.0	0.0		9.6	0.1	19.0		2.5	0.1	4.9
g. 3 to 5 years		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
h. 6 to 10 years		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
i. More than 10 years or evergreen		0.0	0.0	0.0		3.2	<0	6.9		0.8	<0	1.8
Total		100.0				100.0				100.0		

(continued)

Table 7-13. Terms of Sales Methods for Pork Packing Plants, by Size (Small = 53, Large = 35) (continued)

	Small (n = 46)			Large (n = 32)			All Plants (n = 78)		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
S7.4 For pork products sold during the past year, how far in advance of delivery was the delivery scheduled (% of dollar sales)?									
a. Less than 3 days	60.2	47.3	73.0	45.3	31.5	59.1	56.5	46.3	66.7
b. 4 to 6 days	25.0	13.9	36.0	26.9	17.8	36.0	25.4	16.9	33.9
c. 1 to 2 weeks	10.8	3.0	18.7	11.3	4.4	18.1	10.9	4.9	17.0
d. 3 to 4 weeks	4.0	<0	9.4	10.2	3.8	16.5	5.5	1.2	9.9
e. More than 1 month	0.0	0.0	0.1	6.4	2.2	10.6	1.6	0.6	2.6
Total	100.0			100.1†			99.9†		

† Total does not sum to 100% because of rounding.

Table 7-14. Reasons for Using Sales Methods for Pork Packing Plants, by Size (Small = 53, Large = 35)

	Small				Large				All Plants			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S8.1* What are the three most important reasons why your plant only uses the cash or spot market for selling pork products?												
1. Can sell pork products at higher prices	D	25.0	11.0	39.0	D	40.0	0.0	100.0	12	25.8	12.3	39.3
2. Reduces risk exposure	6	15.0	3.4	26.6	3	60.0	0.0	100.0	9	17.5	6.3	28.7
3. Reduces costs of activities for selling pork products	9	22.5	9.0	36.0	0	0.0	NA	NA	9	21.3	8.5	34.0
4. Reduces price variability for pork products	D	5.0	0.0	12.1	0	0.0	NA	NA	D	4.7	0.0	11.4
5. Reduces potential liability and litigation concerns	D	2.5	0.0	7.6	D	20.0	0.0	75.5	D	3.5	0.0	8.7
6. Increases supply chain information	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
7. Allows for sale of higher quality pork products	D	20.0	7.0	33.0	D	20.0	0.0	75.5	9	20.0	7.6	32.4
8. Allows for market access	D	10.0	0.3	19.7	D	20.0	0.0	75.5	5	10.6	1.1	20.0
9. Allows for adjusting operations quickly in response to changes in market conditions	17	42.5	26.5	58.5	D	40.0	0.0	100.0	19	42.4	27.0	57.7
10. Does not require identifying and recruiting long-term contracting partners	D	17.5	5.2	29.8	D	40.0	0.0	100.0	9	18.7	6.8	30.7
11. Does not require managing complex and costly contracts	12	30.0	15.2	44.8	0	0.0	NA	NA	12	28.3	14.4	42.3
12. Eliminates possible negative public perceptions about use of contracts	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
13. Allows for independence, complete control, and flexibility of own business	D	55.0	38.9	71.1	D	20.0	0.0	75.5	23	53.1	37.7	68.4
14. Enhances ability to benefit from favorable market conditions	D	17.5	5.2	29.8	D	40.0	0.0	100.0	9	18.7	6.8	30.7
15. Other	D	2.5	0.0	7.6	0	0.0	NA	NA	D	2.4	0.0	7.1
16. Can easily sell small quantity of pork products *(write-in response)*	D	5.0	0.0	12.1	0	0.0	NA	NA	D	4.7	0.0	11.4
17. No other choice *(write-in response)*	D	5.0	0.0	12.1	0	0.0	NA	NA	D	4.7	0.0	11.4

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 7-14. Reasons for Using Sales Methods for Pork Packing Plants, by Size (Small = 53, Large = 35) (continued)

	Small				Large				All Plants			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
S8.2* What are the three most important reasons why your plant uses alternative sales methods for selling pork products?												
1. Can sell pork products at higher prices	3	50.0	0.0	100.0	12	52.2	30.1	74.3	15	51.4	29.8	73.0
2. Reduces risk exposure	D	16.7	0.0	59.5	D	52.2	30.1	74.3	13	39.5	20.9	58.1
3. Reduces costs of activities for selling pork products	D	16.7	0.0	59.5	4	17.4	0.6	34.2	5	17.1	0.9	33.3
4. Reduces price variability for pork products	D	16.7	0.0	59.5	D	8.7	0.0	21.2	3	11.5	0.0	26.1
5. Reduces potential liability and litigation concerns	D	16.7	0.0	59.5	0	0.0	NA	NA	D	5.9	0.0	18.2
6. Increases supply chain information	0	0.0	NA	NA	3	13.0	0.0	27.9	3	8.4	0.0	17.9
7. Allows for sale of higher quality pork products	D	33.3	0.0	87.5	D	8.7	0.0	21.2	4	17.5	0.1	34.8
8. Allows for market access	D	16.7	0.0	59.5	D	4.3	0.0	13.4	D	8.7	0.0	22.2
9. Increases flexibility in responding to consumer demand	D	16.7	0.0	59.5	D	17.4	0.6	34.2	5	17.1	0.9	33.3
10. Allows for product branding in retail sales	0	0.0	NA	NA	8	34.8	13.7	55.8	8	22.4	9.0	35.8
11. Allows for food safety and biosecurity assurances	D	33.3	0.0	87.5	D	4.3	0.0	13.4	3	14.7	0.0	31.2
12. Allows for product traceability	0	0.0	NA	NA	D	4.3	0.0	13.4	D	2.8	0.0	8.5
13. Improves week-to-week production management	3	50.0	0.0	100.0	15	65.2	44.2	86.3	18	59.8	38.6	80.9
14. Secures a buyer for pork products	D	33.3	0.0	87.5	D	13.0	0.0	27.9	5	20.3	2.2	38.4
15. Enhances access to credit	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA
16. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

7.3 LAMB PACKERS

Table 7-15 provides weighted tabulations for all survey questions for lamb packers (n = 11). Results are not provided by size because few lamb packers responded to the survey. Also, because the number of respondents is small, we cannot make inferences to the population of lamb packers; however, we can draw some general conclusions about the marketing practices of the lamb packers surveyed.

7.3.1 Characteristics of Lamb Packing Plants

Most lamb packers surveyed (85%) purchased fewer than 10,000 lambs during the past year, and 15% purchased between 10,000 and 499,999 lambs. About 48% of plants conducted slaughter and fabrication, but no further processing activities; 31% conducted slaughter only; and 21% conducted slaughter, fabrication, and further processing activities. Most plants surveyed also slaughtered other species: 95% slaughtered goats, 86% slaughtered beef cattle, and 71% slaughtered hogs. Of the plants that performed custom slaughter in the past year, 69% custom slaughtered between 1,000 and 49,999 lambs, and 31% custom slaughtered fewer than 500 lambs. (See Table 7-15, Questions 1.2 through 1.5.)

The maximum slaughter capacity averaged 1,111 head per week, with an average slaughter speed line of 39 head per hour. The maximum breaking and processing capacity averaged 61,208 pounds of lamb product per week. (See Table 7-15, Questions 8.4 through 8.6.)

Of the lambs slaughtered during the past year by the plants surveyed, 61% were classified as standard weight carcasses, 29% were classified as light weight carcasses, and 10% were classified as heavy weight carcasses.[8] On average, carcasses weighing less than 45 pounds were classified as light weight, while carcasses weighing over 76 pounds were considered heavy weight. (See Table 7-15, Question 1.8.)

Of the lambs slaughtered during the past year by the plants surveyed, 62% were Yield Grades 1, 2, and 3; 8% were Yield Grades 4 and 5; and 31% had other or no yield grade. Of the

[8] These values were computed as the mean percentage of head weighted by the number of eligible plants. Other reported means were computed similarly (i.e., weighted by the number of eligible plants).

lambs slaughtered, 53% received a quality grade of USDA Prime or Choice, 13% were Good, and 31% had other or no quality grade. Of the plants surveyed, 76% of total lamb product dollar sales were carcasses or saddles, and 20% were primal cuts. Of the lamb products sold, none were branded. (See Table 7-15, Questions 1.6, 1.7, 1.12, and 1.13.)

More than 57% of respondents reported total gross sales for fresh, frozen, and processed lamb products of less than $500,000, and 43% had sales of $500,000 or more. More than 73% of respondents reported total gross sales for lamb by-products of less than $100,000, and 26% had sales of $100,000 or more. More than 54% of respondents reported total gross sales for all products of less than $1 million, 15% reported sales between $1 million and $2.5 million, and 31% reported sales of more than $5 million. (See Table 7-15, Questions 8.9 through 8.11.)

The majority of plants surveyed can be characterized as independent businesses. None of the plants surveyed were owned by a company that owns other packing or processing plants, and 60% of plants did not own other upstream or downstream businesses. Furthermore, the majority of respondents did not participate in alliances. Eighty-three percent of respondents did, however, participate in certification programs, with more than 50% participating in organic certification programs and 25% participating in Halal certification programs. (See Table 7-15, Questions 1.9 through 1.11 and 8.7.)

7.3.2 Methods for Purchasing or Receiving Lambs by Lamb Packers

Of the lambs received during the past year by the plants surveyed, nearly 94% were owned solely by the operation. No lambs were received by joint ventures or shared ownership. For 94% of plants, all of their lambs were owned solely by the operation during the past year. Respondents reported that lamb ownership arrangements were very similar 3 years ago and are not expected to change within the next 3 years. (See Table 7-15, Question 2.1.)

For about 90% of plants, all of the lambs purchased were from spot market transactions.

Of the lambs purchased during the past year by the plants surveyed, nearly 95% were from spot market transactions. For about 90% of plants, all of the lambs purchased were from spot market transactions. During the past year, 38% of cash market purchases of lambs were through dealers/brokers, 34% through auction barns, and 23% through direct trade. In contrast, less than 6% of lamb purchases were made through marketing agreements. Respondents reported that methods for purchasing lambs were generally similar to those of 3 years ago and are not expected to change much within the next 3 years. (See Table 7-15, Question 2.2.)

Although plants used multiple pricing methods for lamb purchases, the most frequently cited methods were individual negotiations (73% of plants) and public auctions (45%).[9] Ninety percent of plants used liveweight as the valuation method for lamb purchases. Respondents expect little change in valuation methods in the next 3 years. (See Table 7-15, Questions 2.3, 2.4, and 2.6.)

Lamb buyers paid transportation costs in 50% of the transactions. There were few lambs purchased using a written contract (5% of transactions). For lambs purchased under a preexisting agreement, the agreement was typically less than 6 months. Nearly 90% of lambs purchased were scheduled for delivery within 2 weeks, and the remainder were scheduled for delivery 2 to 4 weeks in advance. (See Table 7-15, Questions 3.1 through 3.4.)

Of the lambs purchased during the past year, plants provided information back to the feeder or finisher on about 18% of the total head purchased. For respondents that provided information back to the feeder or finisher, most did so at the request of the seller, for no charge. Most plants (84%) provided information on carcass weight for individual animals. (See Table 7-15, Questions 3.5 through 3.7.)

For packers that used only spot market transactions, the three most frequently cited reasons for doing so were (1) “Can purchase lambs at lower prices” (76%), (2) “Allows for market access” (47%), and (3) “Reduces risk exposure” (42%). Because the number of plants that used AMAs was very small,

[9] Respondents could select multiple responses.

we cannot evaluate plants' reasons for using AMAs. (See Table 7-15, Questions 4.1 and 4.2.)

7.3.3 Methods for Selling and Transferring Lamb Products by Lamb Packers

About 82% of lamb products sold during the past year were through spot market methods, and 17% were through marketing agreements.

For the plants surveyed, most lamb product sales were to retail establishments (58% of total lamb product sales) and wholesalers or distributors (38%). Less than 5% of sales were to food service establishments. About 82% of lamb products sold during the past year were through spot market methods, and 17% were through marketing agreements. Type of sales method did not typically vary by type of recipient, with the exception of a greater reliance on marketing agreements when selling to wholesalers/distributors. Respondents reported that methods for selling lamb products were very similar to those of 3 years ago and are not expected to change much within the next 3 years. (See Table 7-15, Questions 5.1 through 5.3.)

The type of method used to price lamb products varied somewhat by type of recipient. Individually negotiated pricing was used most often for sales to wholesalers/distributors and food service establishments, although some sales were priced using price lists. Products sold to retail establishments were priced using price lists, individually negotiated pricing and, to a lesser extent, formula pricing. (See Table 7-15, Questions 5.4 through 5.6.)

Plants incurred transportation costs for approximately 40% of the lamb products sold. No lamb products were sold under a written agreement. Almost all deliveries were scheduled less than 7 days in advance. (See Table 7-15, Questions 6.1 through 6.4.)

More than 54% of plants chose "Can sell lamb products at higher prices" as an important reason for using only cash markets to sell lamb products. Other reasons for using only cash markets were "Allows for market access" (48%) and "Allows for independence, complete control, and flexibility of own business" (46%). Because the number of plants that used AMAs was very small, we cannot evaluate their reasons for using AMAs. (See Table 7-15, Questions 7.1 and 7.2.)

7.3.4 Lamb Packer Survey Summary

Most of the lamb packers surveyed relied on spot market transactions for purchasing lambs and selling lamb products.

Few of the lamb packers surveyed used AMAs for purchasing lambs or selling lamb products. Most lambs for slaughter were not purchased under a written agreement and were scheduled for delivery within 2 weeks. Most of the lamb packers surveyed sold lamb products to retail establishments, wholesalers, and distributors, using cash market methods and individually negotiated pricing or price lists. No plants reported using written agreements for sales, and all sales were scheduled for delivery within 2 weeks.

Most of those responding were independent businesses and appear to value independence in their marketing choices. Respondents used cash markets for purchasing lambs to get a lower price, gain market access, and reduce risk exposure. Also, respondents relied on cash markets for lamb product sales to sell their product at a higher price, to gain market access, and to maintain greater independence.

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11)

	n	%	Lower	Upper
1.2* What types of livestock did your plant slaughter during the past year?				
1. Lambs	11	100.0	—[a]	—[a]
2. Ewes and/or rams	5	35.9	—	—
3. Goats	10	95.2	—	—
4. Hogs	5	71.0	—	—
5. Beef cattle (including fed Holsteins)	8	85.5	—	—
6. Dairy cattle	3	26.2	—	—
7. Other	0	0.0	—	—
8. Veal *(write-in response)*	D	21.4	—	—
9. Ratites *(write-in response)*	D	16.5	—	—
10. Buffalo *(write-in response)*	D	16.5	—	—
1.3 Which of the following best describes your plant's operations during the past year?				
1. Only conducted slaughter operations	4	31.0	—	—
2. Conducted slaughter and fabrication operations, but no further processing activities	5	47.6	—	—
3. Conducted slaughter operations, fabrication operations, and further processing activities	D	21.4	—	—
Total		100.0		
	n	**Mean**	**Lower**	**Upper**
1.4 How many lambs were purchased by your plant during the past year?	11	21,814.6	—	—
	n	**%**	**Lower**	**Upper**
1–9,999	8	85.5	—	—
10,000–499,999	3	14.5	—	—
500,000 or more	0	0.0	—	—
Total		100.0		

[a] We do not provide the 95% confidence intervals because we cannot make inferences to the population of lamb packers because of the small number of respondents.
D = Results suppressed.
* Respondents could select multiple responses.

(continued)

A description of the notation used in the table headers is provided below.
n = number of respondents
% = estimated proportion weighted by the number of eligible plants
Mean = estimated mean weighted by the number of eligible plants

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

		n	Mean	Lower	Upper
1.5	How many lambs were custom slaughtered by your plant during the past year?	8	1,873.5	—	—
		n	**%**	**Lower**	**Upper**
	1–499	3	30.7	—	—
	500–999	0	0.0	—	—
	1,000–49,999	5	69.3	—	—
	50,000 or more	0	0.0	—	—
	Total		100.0		
			Mean (n = 9)	**Lower**	**Upper**
1.6	What was the carcass yield grade for lambs slaughtered by your plant during the past year (% of head)?				
	a. Yield grades 1, 2, and 3		61.7	—	—
	b. Yield grades 4 and 5		7.7	—	—
	c. Other yield grade or no yield grade		30.6	—	—
	Total		100.0		
			Mean (n = 9)	**Lower**	**Upper**
1.7	What was the carcass quality grade for lambs slaughtered by your plant during the past year (% of head)?				
	a. Prime and choice		53.0	—	—
	b. Good		13.3	—	—
	c. Utility		2.5	—	—
	d. Other quality grade or no quality grade		31.2	—	—
	Total		100.0		

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

		Weight Range (pounds)			Percentage of Head (n = 9)		
	n	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
1.8 What was the carcass weight classification for lambs slaughtered by your plant during the past year?							
a. Standard weight carcasses	—	—	—	—	61.2	—	—
b. Heavy weight carcasses	5	75.9	—	—	9.9	—	—
c. Light weight carcasses	8	45.3	—	—	29.0	—	—
Total					100.1†		

† Total does not sum to 100% because of rounding.

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

		n	%	Lower	Upper
1.9*	What types of certification programs did your plant participate in during the past year?				
	1. None	D	17.4	—	—
	2. Kosher certification	D	10.2	—	—
	3. Halal certification	5	25.4	—	—
	4. Organic certification	3	52.2	—	—
	5. USDA Process Verified certification	D	22.5	—	—
	6. ISO certification	0	0.0	—	—
	7. Third-party certification of breed or livestock quality	0	0.0	—	—
	8. Own-company certification of breed or livestock quality	0	0.0	—	—
	9. Buyer certification of breed or livestock quality	0	0.0	—	—
	10. Other	0	0.0	—	—
1.10*	What levels of production were owned by the same company that owns your plant during the past year?				
	1. None	7	60.2	—	—
	2. Seed stock supplier	0	0.0	—	—
	3. Producer	0	0.0	—	—
	4. Feeder or finisher	D	17.4	—	—
	5. Breaker or meat processor	3	39.8	—	—
	6. Restaurant, hotel, or other food service	D	17.4	—	—
	7. Grocery store, meat market, or other retailer	D	17.4	—	—
	8. Exporter	0	0.0	—	—
	9. Other	0	0.0	—	—
1.11a	What types of alliances did your plant participate in during the past year for purchasing lambs and/or selling lamb products?				
	– Plants participating in an alliance	D	16.5	—	—
	– Respondents with one alliance	D	100.0	—	—

D = Results suppressed.

(continued)

* Respondents could select multiple responses.

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

		n	%	Lower	Upper
1.11b	For packers that participated in alliances, what types of alliances did your plant participate in during the past year for purchasing lambs and/or selling lamb products?		(results suppressed)		
			Mean (n = 10)	**Lower**	**Upper**
1.12	What was your plant's percentage of total lamb product dollar sales during the past year by product category?				
	a. Carcass or saddle		75.5	—	—
	b. Primal cuts		20.0	—	—
	c. Subprimal cuts		0.8	—	—
	d. Ground, including trimmings		0.7	—	—
	e. Portion cuts		0.2	—	—
	f. Case ready		1.8	—	—
	g. Processed, ready-to-eat		0.0	—	—
	h. Processed, not-ready-to-eat		1.0	—	—
	i. Other		0.0	—	—
	Total		100.0	—	—
		n	**Mean**	**Lower**	**Upper**
1.13	What percentage of lamb product sold by your plant during the past year was branded?	9	0.0	—	—

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

	3 Years Ago (n = 8)				During Past Year (n = 9)				Expected in 3 Years (n = 9)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
2.1 For all lambs purchased or received by your operation, what were the ownership arrangements (% of head)?												
a. Sole ownership by your plant		93.5	—	—		93.9	—	—		93.9	—	—
b. Joint venture		0.0	—	—		0.0	—	—		0.0	—	—
c. Shared ownership		0.0	—	—		0.0	—	—		0.0	—	—
d. Other		6.5	—	—		6.1	—	—		6.1	—	—
Total		100.0				100.0				100.0		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are sole ownership	7	93.5	—	—	8	93.9	—	—	8	93.9	—	—
	3 Years Ago (n = 10)				**During Past Year (n = 10)**				**Expected in 3 Years (n = 11)**			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
2.2 What methods are used by your plant for purchasing lambs (% of head)?												
a. Auction barns		40.1	—	—		33.9	—	—		36.6	—	—
b. Video/electronic auctions		0.0	—	—		0.0	—	—		0.0	—	—
c. Dealers or brokers		32.1	—	—		38.1	—	—		36.9	—	—
d. Direct trade		22.5	—	—		22.5	—	—		21.4	—	—
e. Forward contract		0.0	—	—		0.0	—	—		0.0	—	—
f. Marketing agreement		5.3	—	—		5.6	—	—		5.1	—	—
g. Packer fed/owned		0.0	—	—		0.0	—	—		0.0	—	—
h. Other		0.0	—	—		0.0	—	—		0.0	—	—
Total		100.0				100.1†				100.0		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are cash or spot market purchases	8	89.8	—	—	8	89.8	—	—	9	90.3	—	—

† Total does not sum to 100% because of rounding.

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
2.3* What types of pricing methods are used by your plant for purchasing lambs?								
1. Individually negotiated pricing	7	72.5	—	—	6	67.4	—	—
2. Public auction	4	44.9	—	—	6	55.1	—	—
3. Sealed bid	D	5.1	—	—	0	0.0	—	—
4. Formula pricing (using another price as the base)	D	5.1	—	—	D	5.1	—	—
5. Internal transfer	0	0.0	—	—	0	0.0	—	—
6. Other	0	0.0	—	—	0	0.0	—	—
	With Grid				**Without Grid**			
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
2.4* For lambs purchased by your plant during the past year using formula pricing, what was the base price of the formula?	(results suppressed)							
1. Individual or multiple plant average price					0	0.0	—	—
2. Individual or multiple plant average cost of production					D	63.1	—	—
3. USDA live quote					0	0.0	—	—
4. USDA dressed or carcass quote					0	0.0	—	—
5. USDA cutout value					0	0.0	—	—
6. Retail price					D	18.4	—	—
7. Subscription service price (for example, Urner Barry)					0	0.0	—	—
8. Other market price					0	0.0	—	—
9. Other					0	0.0	—	—
10. Auction price *(write-in response)*					D	18.4	—	—

D = Results suppressed.
* Respondents could select multiple responses.

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

	n	%	Lower	Upper
2.5* For lambs received during the past year from another business unit owned by the same company, what was the source of the internal transfer price?				
1. Price paid for purchased lambs	D	100.0	—	—
2. Reported market price	D	77.4	—	—
3. Measure of internal production cost with a profit margin	0	0.0	—	—
4. Measure of internal production cost without a profit margin	0	0.0	—	—
5. Other	0	0.0	—	—

D = Results suppressed.

* Respondents could select multiple responses.

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
2.6* What types of valuation methods are used by your plant for purchasing lambs?								
1. Per head	D	22.5	—	—	D	22.5	—	—
2. Liveweight	8	89.8	—	—	8	89.8	—	—
3. Carcass weight, not dependent on grid value	D	10.2	—	—	D	5.1	—	—
4. Carcass weight, dependent on grid value	D	5.1	—	—	D	5.1	—	—
5. Other	0	0.0	—	—	0	0.0	—	—

D = Results suppressed.
* Respondents could select multiple responses.

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

		n	Mean	Lower	Upper
3.1	For what percentage of lambs purchased during the past year did the buyer (your plant) pay for transportation?	11	50.0	—	—
3.2	What percentage of lambs purchased during the past year were under a written agreement (versus oral)?	11	4.8	—	—
			Mean (n = 11)	**Lower**	**Upper**
3.3	For lambs purchased during the past year, what was the length of the agreement or contract (oral or written) (% of head)?				
	a. Purchases not under agreement or contract		78.6	—	—
	b. Less than 6 months		16.5	—	—
	c. 6 to 11 months		0.0	—	—
	d. 1 to 2 years		0.0	—	—
	e. 3 to 5 years		0.0	—	—
	f. 6 to 10 years		0.0	—	—
	g. More than 10 years or evergreen		4.8	—	—
	Total		99.9†		
			Mean (n = 11)	**Lower**	**Upper**
3.4	For lambs purchased during the past year, how far in advance of slaughter was the delivery scheduled (% of head)?				
	a. Less than 7 days		62.2	—	—
	b. 8 to 14 days		26.8	—	—
	c. 15 to 21 days		10.5	—	—
	d. 22 to 30 days		0.5	—	—
	e. 1 to 2 months		0.0	—	—
	f. More than 2 months		0.0	—	—
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
3.5	For what percentage of lambs purchased during the past year did your plant provide information back to the feeder or finisher?	11	17.9	—	—

† Total does not sum to 100% because of rounding.

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

	n	%	Lower	Upper
3.6* Under what conditions did your plant provide information back to the feeder or finisher?				
1. Requested by seller, no charge	3	84.4	—	—
2. Requested by seller, for a set fee	0	0.0	—	—
3. Cash or spot market purchases	0	0.0	—	—
4. Forward contract	0	0.0	—	—
5. Marketing agreement	D	31.1	—	—
6. Alliance	0	0.0	—	—
7. Joint venture	0	0.0	—	—
8. Shared ownership	0	0.0	—	—
9. Other	0	0.0	—	—
3.7* What types of information did your plant provide back to the feeder or finisher?				
1. USDA carcass quality grade for individual animals	D	53.3	—	—
2. USDA carcass yield grade for individual animals	D	53.3	—	—
3. Carcass weight for individual animals	3	84.4	—	—
4. Price paid for individual carcasses	D	31.1	—	—
5. USDA carcass quality grade by lot	0	0.0	—	—
6. USDA carcass yield grade by lot	D	15.6	—	—
7. Carcass weight by lot	D	15.6	—	—
8. Average dressing percentage by lot	D	15.6	—	—
9. Other	0	0.0	—	—
4.1* What are the three most important reasons why your plant only uses the cash or spot market for purchasing lambs?				
1. Can purchase lambs at lower prices	7	76.3	—	—
2. Reduces risk exposure	3	42.0	—	—
3. Reduces costs of activities for buying lambs	D	23.7	—	—
4. Reduces price variability for lambs	D	5.3	—	—
5. Reduces potential liability and litigation concerns	0	0.0	—	—
6. Increases supply chain information	0	0.0	—	—
7. Secures higher quality lambs	0	0.0	—	—
8. Allows for market access	4	47.3	—	—
9. Allows for adjusting operations quickly in response to changes in market conditions	D	23.7	—	—
10. Does not require identifying and recruiting long-term contracting partners	D	10.7	—	—
11. Does not require managing complex and costly contracts	D	23.7	—	—
12. Eliminates possible negative public perceptions about use of contracts	0	0.0	—	—
13. Allows for independence, complete control, and flexibility of own business	3	29.0	—	—
14. Enhances ability to benefit from favorable market conditions	0	0.0	—	—
15. Other	0	0.0	—	—
16. Can easily purchase small number of lambs *(write-in response)*	D	18.3	—	—

D = Results suppressed.

* Respondents could select multiple responses.

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

		n	%	Lower	Upper
4.2*	What are the three most important reasons why your plant uses alternative purchase methods for purchasing lambs?		(results suppressed)		
	1. Can purchase lambs at lower prices				
	2. Reduces risk exposure				
	3. Reduces costs of activities for buying lambs				
	4. Reduces price variability for lambs				
	5. Reduces potential liability and litigation concerns				
	6. Increases supply chain information				
	7. Secures higher quality lambs				
	8. Allows for market access				
	9. Increases flexibility in responding to consumer demand				
	10. Allows for product branding in retail sales				
	11. Allows for food safety and biosecurity assurances				
	12. Allows for product traceability				
	13. Improves week-to-week supply management				
	14. Improves efficiency of operations due to animal uniformity				
	15. Enhances access to credit				
	16. Other				

		Mean (n = 10)	Lower	Upper
5.1	What was your plant's percentage of total lamb product dollar sales during the past year by type of buyer or recipient?			
	a. Breakers or meat processors	0.0	—	—
	b. Wholesalers or distributors	38.0	—	—
	c. Retail establishments	57.8	—	—
	d. Food service establishments	4.2	—	—
	e. Foreign buyers	0.0	—	—
	f. Other	0.0	—	—
	Total	100.0		

* Respondents could select multiple responses.

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

	3 Years Ago (n = 9)				During Past Year (n = 10)				Expected in 3 Years (n = 10)			
		Mean	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**		**Mean**	**Lower**	**Upper**
5.2 What sales methods are used by your plant for selling lamb products (% of dollar sales)?												
a. Cash or spot market (less than 3 weeks forward)		78.6	—	—		82.1	—	—		79.0	—	—
b. Forward contract		0.3	—	—		0.5	—	—		1.2	—	—
c. Marketing agreement		21.0	—	—		17.4	—	—		19.8	—	—
d. Internal company transfer		0.0	—	—		0.0	—	—		0.0	—	—
e. Other		0.0	—	—		0.0	—	—		0.0	—	—
Total		99.9†				100.0				100.0		
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
Establishments for which 100% are cash or spot market sales	7	72.8	—	—	8	77.5	—	—	7	68.6	—	—

† Total does not sum to 100% because of rounding.

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

	Breakers or Processors				Wholesalers/Distributors				Retail Establishments			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
5.3* What sales methods did your plant use during the past year for selling lamb products to different types of recipients?	(results suppressed)											
1. Cash or spot market (less than 3 weeks forward)					4	65.2	—	—	9	100.0	—	—
2. Forward contract					0	0.0	—	—	0	0.0	—	—
3. Marketing agreement					D	34.8	—	—	0	0.0	—	—
4. Internal company transfer					0	0.0	—	—	0	0.0	—	—
5. Other					0	0.0	—	—	0	0.0	—	—

	Food Service Establishments				Foreign Buyers			
	n	%	Lower	Upper	n	%	Lower	Upper
1. Cash or spot market (less than 3 weeks forward)	4	100.0	—	—	(results suppressed)			
2. Forward contract	0	0.0	—	—				
3. Marketing agreement	0	0.0	—	—				
4. Internal company transfer	0	0.0	—	—				
5. Other	0	0.0	—	—				

D = Results suppressed.
* Respondents could select multiple responses.

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

		Breakers or Processors				Wholesalers/Distributors				Retail Establishments			
		n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
5.4*	What types of pricing methods did your plant use during the past year for selling lamb products to different types of recipients?	(results suppressed)											
	1. Price list					D	20.3	—	—	5	45.6	—	—
	2. Individually negotiated pricing					4	89.8	—	—	3	33.3	—	—
	3. Formula pricing (using another price as the base)					0	0.0	—	—	D	21.0	—	—
	4. Sealed bid					0	0.0	—	—	0	0.0	—	—
	5. Internal transfer					0	0.0	—	—	0	0.0	—	—
	6. Other					0	0.0	—	—	0	0.0	—	—

		Food Service Establishments				Foreign Buyers			
		n	%	Lower	Upper	n	%	Lower	Upper
	1. Price list	3	46.7	—	—	(results suppressed)			
	2. Individually negotiated pricing	D	68.9	—	—				
	3. Formula pricing (using another price as the base)	0	0.0	—	—				
	4. Sealed bid	0	0.0	—	—				
	5. Internal transfer	0	0.0	—	—				
	6. Other	0	0.0	—	—				

D = Results suppressed.

* Respondents could select multiple responses.

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

	n	%	Lower	Upper
5.5* For lamb products sold by your plant during the past year using formula pricing, what was the base price of the formula?				
1. Individual or multiple plant average price	D	63.1	—	—
2. Individual or multiple plant average cost of production	D	18.4	—	—
3. USDA publicly reported price	0	0.0	—	—
4. Retail price	D	18.4	—	—
5. Subscription service price (for example, Urner Barry)	0	0.0	—	—
6. Other market price	0	0.0	—	—
7. Other	0	0.0	—	—
5.6* What types of pricing methods does your plant expect to use in 3 years for selling lamb products?				
1. Price list	4	32.6	—	—
2. Individually negotiated pricing	8	65.2	—	—
3. Formula pricing (using another price as the base)	D	17.4	—	—
4. Sealed bid	0	0.0	—	—
5. Internal transfer	0	0.0	—	—
6. Other	0	0.0	—	—

D = Results suppressed.

* Respondents could select multiple responses.

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

		Breakers or Processors				Wholesalers / Distributors				Retail Establishments			
		n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
5.7*	Which of the following marketing practices did your plant use during the past year for the sale of lamb products?	(results suppressed)											
	1. Two-part pricing					0	0.0	—	—	D	16.9	—	—
	2. Volume discounts					D	50.0	—	—	D	37.3	—	—
	3. Exclusive dealings					0	0.0	—	—	0	0.0	—	—
	4. Bundling					0	0.0	—	—	0	0.0	—	—
	5. None of the above					D	50.0	—	—	3	45.8	—	—

		Food Service Establishments				Foreign Buyers			
		n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
	1. Two-part pricing	D	15.6	—	—	(results suppressed)			
	2. Volume discounts	D	15.6	—	—				
	3. Exclusive dealings	0	0.0	—	—				
	4. Bundling	0	0.0	—	—				
	5. None of the above	D	68.9	—	—				

D = Results suppressed.

* Respondents could select multiple responses.

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

		n	Mean	Lower	Upper
6.1	For what percentage of lamb products sold during the past year did the seller (your plant) pay for transportation?	11	40.1	—	—
6.2	What percentage of lamb products sold during the past year were under a written agreement (versus oral)?	11	0.0	—	—

		Mean (n = 11)	Lower	Upper
6.3	For lamb products sold during the past year, what was the length of the agreement or contract (oral or written) (% of dollar sales)?			
	a. Sales not under agreement or contract	81.0	—	—
	b. Less than 1 month	19.0	—	—
	c. 1 to 2 months	0.0	—	—
	d. 3 to 5 months	0.0	—	—
	e. 6 to 11 months	0.0	—	—
	f. 1 to 2 years	0.0	—	—
	g. 3 to 5 years	0.0	—	—
	h. 6 to 10 years	0.0	—	—
	i. More than 10 years or evergreen	0.0	—	—
	Total	100.0		

		Mean (n = 11)	Lower	Upper
6.4	For lamb products sold during the past year, how far in advance of delivery was the delivery scheduled (% of dollar sales)?			
	a. Less than 3 days	62.8	—	—
	b. 4 to 6 days	36.7	—	—
	c. 1 to 2 weeks	0.5	—	—
	d. 3 to 4 weeks	0.0	—	—
	e. More than 1 month	0.0	—	—
	Total	100.0		

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

	n	%	Lower	Upper
7.1* What are the three most important reasons why your plant only uses the cash or spot market for selling lamb products?				
1. Can sell lamb products at higher prices	4	54.4	—	—
2. Reduces risk exposure	3	18.4	—	—
3. Reduces costs of activities for selling lamb products	3	33.3	—	—
4. Reduces price variability for lamb products	D	6.1	—	—
5. Reduces potential liability and litigation concerns	0	0.0	—	—
6. Increases supply chain information	0	0.0	—	—
7. Allows for sale of higher quality lamb products	D	6.1	—	—
8. Allows for market access	3	48.2	—	—
9. Allows for adjusting operations quickly in response to changes in market conditions	D	27.2	—	—
10. Does not require identifying and recruiting long-term contracting partners	D	27.2	—	—
11. Does not require managing complex and costly contracts	D	6.1	—	—
12. Eliminates possible negative public perceptions about use of contracts	0	0.0	—	—
13. Allows for independence, complete control, and flexibility of own business	5	45.6	—	—
14. Enhances ability to benefit from favorable market conditions	D	6.1	—	—
15. Other	0	0.0	—	—
16. Can easily sell small quantity of lamb products *(write-in response)*	D	21.0	—	—

D = Results suppressed.

* Respondents could select multiple responses.

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

		n	%	Lower	Upper
7.2*	What are the three most important reasons why your plant uses alternative sales methods for selling lamb products?		(results suppressed)		
	1. Can sell lamb products at higher prices				
	2. Reduces risk exposure				
	3. Reduces costs of activities for selling lamb products				
	4. Reduces price variability for lamb products				
	5. Reduces potential liability and litigation concerns				
	6. Increases supply chain information				
	7. Allows for sale of higher quality lamb products				
	8. Allows for market access				
	9. Increases flexibility in responding to consumer demand				
	10. Allows for product branding in retail sales				
	11. Allows for food safety and biosecurity assurances				
	12. Allows for product traceability				
	13. Improves week-to-week production management				
	14. Secures a buyer for lamb products				
	15. Enhances access to credit				
	16. Other				
8.1	How many days per week did your plant usually slaughter lambs?				
	1. Less frequently than once a week	0	0.0	—	—
	2. 1 or 2 days per week	4	66.2	—	—
	3. 3 or 4 days per week	4	19.3	—	—
	4. 5 or 6 days per week	3	14.5	—	—
	Total		100.0		
8.2	How many lamb slaughter shifts did your plant usually operate per day?				
	1. One	11	100.0	—	—
	2. Two	0	0.0	—	—
	3. Three	0	0.0	—	—
	Total		100.0		
8.3	How many lamb breaking and processing shifts did your plant usually operate per day?				
	1. None	7	57.2	—	—
	2. One	4	42.8	—	—
	3. Two	0	0.0	—	—
	4. Three	0	0.0	—	—
	Total		100.0		

* Respondents could select multiple responses.

(continued)

Table 7-15. Weighted Responses for the Lamb Packer Survey (n = 11) (continued)

		n	Mean	Lower	Upper
8.4	What is your plant's maximum slaughter capacity (head per week) for lambs?	10	1,110.6	—	—
8.5	What is your plant's maximum breaking and processing capacity (pounds per week) for lamb products?	7	61,208.1	—	—
8.6	What was the slaughter line speed (head per hour) for lambs?	5	39.0	—	—
		n	**%**	**Lower**	**Upper**
8.7	How many meat slaughter and processing plants, including this one, are owned by the company that owns your plant?				
	1. One	11	100.0	—	—
	2. 2 to 5	0	0.0	—	—
	3. 6 to 10	0	0.0	—	—
	4. 11 to 20	0	0.0	—	—
	5. 21 or more	0	0.0	—	—
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
8.8	Approximately how many people were employed at your plant during the past year?				
	a. Full time	11	15.1	—	—
	b. Part time or seasonal	3	4.8	—	—
		n	**%**	**Lower**	**Upper**
8.9	What were your plant's approximate total gross sales for fresh, frozen, and processed lamb products during the past year?				
	1. Under $499,999	4	57.2	—	—
	2. $500,000 or more	6	42.8	—	—
	Total		100.0		
8.10	What were your plant's approximate total gross sales for lamb by-products during the past year?				
	1. Under $99,999	8	73.8	—	—
	2. $100,000 to $4,999,999	3	26.2	—	—
	3. $5,000,000 or more	0	0.0	—	—
	Total		100.0		
8.11	What were your plant's approximate total gross sales for all products during the past year?				
	1. Under $999,999	4	54.5	—	—
	2. $1,000,000 to $2,499,999	3	14.5	—	—
	3. $2,500,000 to $4,999,999	0	0.0	—	—
	4. $5,000,000 or more	4	31.0	—	—
	Total		100.0		

8 Survey Results: Meat Processors

This section presents the weighted tabulations for meat processors. Table 8-1 provides weighted tabulations for all survey questions for meat processors (n = 125). We do not provide results by size because of the small number of respondents.

For weighted proportions, the tables provide the number of respondents (n), the estimated proportion weighted by the number of eligible plants (%), and the corresponding 95% confidence interval (lower and upper) for each response item. For questions for which respondents could select only one response, the sum of the responses equals 100%. For questions for which respondents could select more than one response, the total may sum to more than 100%. These questions are noted with an asterisk (*).

For weighted means, the tables provide the number of respondents used in the mean calculation (n), the estimated mean weighted by the number of eligible plants (mean), and the corresponding 95% confidence interval (lower and upper).

In reporting the survey findings, we make comparisons between marketing practices during the past year and expected changes within the next 3 years. These comparisons are based on the magnitude of the point estimates and not on statistical testing. The confidence intervals provided in Table 8-1 can be used to make comparisons between survey estimates. That is, overlapping confidence intervals suggest that the difference between the corresponding point estimates is not statistically significant.

8.1 PLANT CHARACTERISTICS

> Meat processing plants receive meat inputs and produce a variety of products. These plants do not slaughter.

The meat processors responding to the survey operated plants that processed beef, pork, lamb, and combination meats (e.g., products made with beef and pork). Most plants (80%) are small, independently owned businesses and are not part of a company that owns another slaughter or processing plant. Most operated one shift and operated 3 or more days per week. In the past year, approximately 40% of plants had processed meat sales of less than $1 million, nearly 30% had sales between $1 million and $5 million, 14% had sales between $5 million and $50 million, 13% between $50 million and $1 billion, and nearly 4% with more than $1 billion of processed meat sales. The majority of processors did not sell any by-products. For plants with beef sales, average sales were $15 million during the past year; for plants with pork sales, average sales were $5.5 million; for plants with lamb sales, average sales were about $20,000; and for plants with sales of combination product, average sales were more than $13 million. (See Table 8-1, Questions 8.1 through 8.8.)

8.2 INPUT PURCHASING METHODS

Of the total value of meat purchased during the past year, a slightly higher percentage was pork (48%), then beef (45%), followed by lamb (1.4%) and combination meats (5.2%).[1] The vast majority of the volume processed was owned by the plant, approximately 85% for pork, beef, and combination meats, with the remainder being custom processing. Lamb had a lower percentage of owned production (72%) because custom (or toll) processing is more common in the lamb industry. (See Table 8-1, Questions 1.2 and 1.3.)

The most common beef products produced at the responding plants were ground beef and trimmings (53%), followed by processed ready-to-eat products (49%). The largest volume of pork products were ready-to-eat (54%) and ground pork and trimmings (44%). Based on the relatively few lamb processor responses received, more than one-half of the lamb products were portion-control products. Despite the level of processing, only approximately 30% of the products sold by processors

[1] These values were computed as the mean value of meat inputs weighted by the number of eligible plants. Other reported means were computed similarly (i.e., weighted by the number of eligible plants).

were branded products. (See Table 8-1, Questions 1.4 and 1.5.)

Approximately two-thirds of plants did not own other upstream or downstream businesses. Fifteen percent of plants were part of a company that also owned meat packing facilities. A comparable amount (13%) were part of a company that owned retail operations or hotel, restaurant, and institution (HRI) operations (10%). Seventy percent of plants did not certify their products. Plants primarily participated in the following certification programs: USDA Process Verified (14%), CAB (8%), other breed-related programs (10%), and Halal processing (5%). Few meat processors reported belonging to an alliance. Alliances were primarily with packers or retailers. (See Table 8-1, Questions 1.6 through 1.8.)

Most plants (98%) solely owned the meat inputs purchased. Few plants used joint venture or shared ownership arrangements to purchase meat inputs. Plants' ownership arrangements are not expected to change in the next 3 years. (See Table 8-1, Question 2.1.)

The most common purchasing method used by processors was the cash or spot market (less than 3 weeks forward).

The most common purchasing method used by processors was the cash or spot market (less than 3 weeks forward). Ninety-one percent of plants used the spot market for purchases, and 63% used it exclusively. Forward contracting was used by nearly 20% of plants, and marketing agreements and internal company transfers were each used by approximately 13% of plants. Purchasing methods are expected to be relatively stable over the next 3 years, with perhaps a slight increase in forward contracting. (See Table 8-1, Question 2.2.)

The most frequently cited methods used to price meat purchases were price lists and individually negotiated prices, with approximately 60% of plants using each method.[2] Formula pricing was used by 32% of plants, and 13% of plants used internal transfers. For plants using formula pricing, 63% used a USDA publicly reported price. (See Table 8-1, Questions 2.3 and 2.4.)

Most of the meat purchased by processors was on the basis of short-term verbal agreements. Only 8% of the dollar volume of meat purchased was covered under a written contract. Twenty-

[2] Respondents could select multiple responses.

eight percent of purchases were under a contract (oral or written), and these were typically less than a year in length. Nearly two-thirds of the meat purchased was scheduled for delivery within a week of the order, 35% within 3 days, 29% within 4 to 6 days, and 20% within 1 to 2 weeks. (See Table 8-1, Questions 3.1 through 3.3,)

The most cited reasons for using only the cash market to purchase meat related to the respondent's business philosophy and the ability to adjust to market conditions. The reasons centered on decision making, flexibility, and price.

Respondents who used only the cash market to purchase meat products were asked to identify the three most important reasons for using the cash market. The most cited reasons related to the respondent's business philosophy and the ability to adjust to market conditions. The reasons centered on decision making, flexibility, and price. More specifically, the reasons were (1) "Allows for independence, complete control, and flexibility of own business" (51%), (2) "Allows for adjusting operations quickly in response to changes in market conditions" (48%), and (3) "Can purchase meat inputs at lower prices" (46%). Other responses included "Enhances ability to benefit from favorable market conditions" (33%), "Does not require managing complex and costly contracts" (26%), and (3) "Reduces risk exposure" (20%). These responses suggest that processors prefer flexibility and simplicity as a way to adjust to changing market conditions and to reduce their risk exposure. (See Table 8-1, Question 4.1.)

Respondents who used alternatives to the cash market were asked to identify the three most important reasons for using AMAs. Their responses focused on price, price stability, and product standards. The three most frequently cited responses were (1) "Can purchase meat inputs at lower prices" (69%), (2) "Reduces price variability for meat inputs" (59%), and (3) "Improves efficiency of operations due to product uniformity" (43%). Other responses included "Improves week-to-week supply management" (28%), "Secures higher quality meat inputs" (23%), and "Reduces risk exposure" (17%). While AMA users were as concerned as cash market purchasers about price, if not more concerned, the AMA users also identified plant efficiency, supply management, and product quality as important reasons for using AMAs. (See Table 8-1, Question 4.2.)

Companies in similar businesses had different perceptions and preferences regarding meat purchases. The cash-only processors value flexibility over plant efficiency and value simplicity over price stability. It is interesting to note that both cash-only processors and users of AMAs thought that their marketing choice allowed them to obtain lower purchase prices and reduce their risk exposure. Thus, there are similar concerns across both groups of processors, although they have different approaches to addressing these concerns in the individual product markets.

8.3 OUTPUT SALES METHODS

About 87% of processors sold products that contained at least 50% meat by weight during the past year. Of these, 41% of sales were to wholesalers and distributors, 29% to food service operators, 21% to retailers, and 8% to other processors and manufacturers. The cash or spot market was used by many processors. Sixty percent or more of plants used the cash or spot market when selling to processors/ manufacturers, wholesalers/distributors, retailers, and food service operators. Forward contracts and marketing agreements were used by fewer plants. Ten percent or more of plants used forward contracts when selling to wholesalers/distributors, retailers, and food service operators. Likewise, 10% or more of plants used marketing agreements when selling to wholesalers/distributors and food service operators. Nine percent of sales to other processors/manufacturers were internal transfers. Because of the small number of responses, we do not discuss the results for sales to foreign buyers. (See Table 8-1, Questions 5.1 through 5.3.)

Processors were asked their views on the types of sales methods they will use 3 years from now. In general, they expect that cash market sales will still be the largest (85% of plants), and forward contracts and marketing agreements are expected to be used by approximately one-fourth of plants. (See Table 8-1, Question 5.4.)

The most frequently cited methods for pricing meat products were price lists and individually negotiated pricing; formula pricing was used to a lesser extent. The type of pricing method used varied depending on the type of buyer or recipient. For other processors, individually negotiated pricing was most often used. For wholesalers and distributors, retail establishments, food service establishments, and foreign buyers, price lists were most often used. In 3 years, 72% of processors plan to use price lists for selling meat products, 61% plan to use individually negotiated pricing, and 23% plan to use formula pricing. For those processors selling products using formula pricing, 49% of plants used USDA-reported prices as the base. (See Table 8-1, Questions 5.5 through 5.7.)

The majority of plants reported using some type of special marketing practices, such as two-part pricing, volume discounts, exclusive dealings, or bundling. The most common of these across all buyers was volume discounts, followed by two-part pricing. (See Table 8-1, Question 5.8.)

Only 10% of meat sales were covered by a written contract, and 77% of sales were transacted without an oral or written agreement or contract. Most contracts were less than 1 month in length. Delivery was scheduled for 3 days or less for one-half of meat sales, and 20% and 22% were scheduled for delivery in 4 to 6 days and 1 to 2 weeks, respectively. (See Table 8-1, Questions 6.1 through 6.3.)

When asked to identify the three most important reasons for using only the cash market for meat sales, two items were chosen more than the other responses. These both focused on the management philosophy and decision-making style of the respondent. The two most cited responses were (1) “Allows for adjusting operations quickly in response to changes in market conditions” (51%) and (2) “Allows for independence, complete control, and flexibility of own business” (39%). Five other items received a similar number of responses and reflect simplicity, price level, and risk exposure: “Does not require managing complex and costly contracts” (29%), “Reduces costs of activities for selling meat products” (29%), “Reduces risk exposure” (28%), “Can sell meat products at higher prices” (24%), and “Does not require identifying and recruiting long-term contracting partners” (22%). (See Table 8-1, Question 7.1.)

Respondents that used alternatives to the cash market were asked to identify the three most important reasons for using AMAs for meat sales (Table 7-2). One response, “Reduces risk exposure,” was selected by 40% of plants. Several others had responses between 24% and 31% and included, “Allows for sale of higher quality meat products,” “Improves week-to-week production management,” “Reduces price variability for meat products,” “Can sell meat products at higher prices,” “Increases flexibility in responding to consumer demand," and "Reduces costs of activities for selling meat products." The reasons for using AMAs are more diverse than identified on the purchasing side, but still tend to focus on reducing risks, costs, and price variability and emphasized quality and production management. (See Table 8-1, Question 7.2.)

8.4 SUMMARY

The survey of meat processors reflects an industry largely composed of independent companies that buy meat inputs and sell meat products, often in a short time frame. Only some processors sold branded or certified products, and a very small percentage participated in an alliance of any type. The largest share of purchases and sales were conducted in the spot market, although some plants had AMAs with buyers and sellers. Plants do not expect much of a shift in their use of marketing methods 3 years from now. Processors using cash markets exclusively for either meat purchases or meat sales identified operational independence and the flexibility to react to market conditions. These plants also believed that they could achieve better prices with less risk exposure and that AMAs are costly to initiate and maintain. While processors using AMAs to purchase meat inputs identified reducing input prices as an important reason for using AMAs, the most cited reasons for using AMAs on both purchases and sales focused on reducing operating costs and price risk and improving product quality and production efficiency.

The survey results suggest that meat processors have found a combination of cash and AMAs that meets their needs, and they expect little relative change in marketing methods during the next 3 years.

Meat processors face similar challenges because they buy from the same packers and sell to similar customers. In some cases, they indicated similar reasons for using only cash markets or using AMAs. The priorities are different for each plant and the cost and benefit of AMAs are perceived differently by each plant and in relation to the cash market. The survey results suggest that meat processors have found a combination of cash markets and AMAs that meets their needs, and they expect little relative change in marketing methods during the next 3 years.

Table 8-1. Weighted Responses for the Meat Processor Survey (n = 125)

		Mean (n = 108)	Lower	Upper
1.2	What was your plant's percentage of total dollar value of meat inputs during the past year by type of meat?			
	a. Beef	45.2	37.6	52.8
	b. Pork	48.2	40.4	56.0
	c. Lamb	1.4	0.4	2.5
	d. Combination	5.2	1.9	8.5
	Total	100.0		

		Beef (n = 88)			Pork (n = 97)			Lamb (n = 25)		
		Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
1.3	What percentage of your plant's total volume (weight) of meat products during the past year was for your own production and for custom processing or co-packing?									
	a. Own production	86.5	80.3	92.6	84.8	78.5	91.1	71.9	52.3	91.5
	b. Custom processed or co-packed	13.5	7.4	19.7	15.2	8.9	21.5	28.1	8.5	47.7
	Total	100.0			100.0			100.0		

		Combination (n = 41)		
		Mean	Lower	Upper
	a. Own production	84.5	74.6	94.4
	b. Custom processed or co-packed	15.5	5.6	25.4
	Total	100.0		

(continued)

A description of the notation used in the table headers is provided below.
n = number of respondents
% = estimated proportion weighted by the number of eligible plants
Mean = estimated mean weighted by the number of eligible plants
Lower = lower bound of the 95% confidence interval for the weighted proportion or mean
Upper = upper bound of the 95% confidence interval for the weighted proportion or mean

Table 8-1. Weighted Responses for the Meat Processor Survey (n = 125) (continued)

	Beef				Pork				Lamb			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
1.4* What types of meat products did your plant sell or ship during the past year?												
1. Primal cuts	26	30.5	20.6	40.4	28	31.0	21.3	40.7	10	46.6	24.0	69.3
2. Subprimal cuts	34	38.8	28.3	49.3	30	32.2	22.5	42.0	10	46.6	24.0	69.3
3. Ground, including trimmings	46	52.9	42.2	63.6	41	44.4	34.0	54.8	9	42.0	19.6	64.4
4. Portion cuts	35	40.0	29.4	50.5	30	32.2	22.5	42.0	11	51.3	28.7	73.9
5. Case ready	15	16.5	8.5	24.5	16	16.7	8.9	24.5	5	23.3	4.0	42.6
6. Processed, ready-to-eat	51	49.3	38.6	60.1	58	54.4	44.0	64.8	8	20.7	2.9	38.5
7. Processed, not-ready-to-eat	24	27.1	17.5	36.7	37	39.0	28.8	49.2	3	14.0	0.0	29.8
8. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 8-1. Weighted Responses for the Meat Processor Survey (n = 125) (continued)

		Combination			
		n	**Mean**	**Lower**	**Upper**
1.5	What percentage of meat products sold by your plant during the past year were branded?	118	30.5	22.2	38.8
		n	**%**	**Lower**	**Upper**
1.6*	What levels of production were owned by the same company that owns your plant during the past year?				
	1. None	74	65.7	56.6	74.9
	2. Feed company	6	3.2	0.0	6.5
	3. Livestock producer or feeder	9	2.7	0.0	5.4
	4. Packer	21	15.0	8.2	21.8
	5. Restaurant, hotel, or other food service	10	9.6	3.8	15.3
	6. Grocery store, meat market, or other retailer	14	13.4	6.8	20.0
	7. Exporter	6	4.9	0.7	9.1
	8. Other	0	0.0	NA	NA
1.7*	Which of the following types of certification apply for products produced by your plant during the past year?				
	1. None	76	70.3	61.5	79.1
	2. Kosher certification	D	1.9	0.0	4.6
	3. Halal certification	6	4.9	0.7	9.1
	4. Organic certification	8	3.4	0.1	6.7
	5. USDA Process Verified certification	16	13.6	7.0	20.3
	6. ISO certification	D	0.2	0.0	0.5
	7. Certified Angus Beef	11	8.0	2.8	13.2
	8. Other third-party certification of breed or livestock quality (not including Certified Angus Beef)	6	5.8	1.2	10.3
	9. Own-company certification of breed or livestock quality	5	3.9	0.2	7.7
	10. Buyer certification of breed or livestock quality	0	0.0	NA	NA
	11. Other	D	1.0	0.0	2.9
1.8a	What types of alliances did your plant participate in during the past year for purchasing meat inputs and selling meat products?				
	– Plants participating in an alliance	6	5.3	1.1	9.5
	– Number of respondents with one alliance	3	50.0	0.0	100.0
	– Number of respondents with two alliances	D	16.7	0.0	59.5
	– Number of respondents with three alliances	D	16.7	0.0	59.5
	– Number of respondents with five alliances	D	16.7	0.0	59.5
1.8b	For processors that participated in alliances, what types of alliances did your plant participate in during the past year for purchasing meat inputs and selling meat products?				
	1. Packer only	5	38.5	7.9	69.1
	2. Other processor only	D	15.4	0.0	38.1
	3. Retailer only	6	46.2	14.8	77.5
	Total		100.1†		

D = Results suppressed.
NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.
* Respondents could select multiple responses.

(continued)

Table 8-1. Weighted Responses for the Meat Processor Survey (n = 125) (continued)

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
2.1* For all meat inputs purchased or received by your operation, what were the ownership arrangements?								
1. Sole ownership by your plant	115	98.1	95.5	100.0	95	97.7	94.4	100.0
2. Joint venture	4	3.8	0.1	7.5	4	4.7	0.1	9.2
3. Shared ownership	3	2.8	0.0	6.1	4	4.7	0.1	9.2
4. Other	3	2.0	0.0	4.7	3	2.5	0.0	5.7
Establishments that only reported sole ownership	107	91.4	85.9	96.8	86	88.2	81.2	95.1
2.2* What methods are used by your plant for purchasing meat inputs?								
1. Cash or spot market (less than 3 weeks forward)	108	90.7	85.1	96.2	90	89.8	83.4	96.2
2. Forward contract	30	19.5	12.1	26.9	32	25.9	16.8	34.9
3. Marketing agreement	18	13.3	6.9	19.7	16	13.9	6.7	21.1
4. Internal company transfer	21	13.6	7.2	20.1	20	15.4	8.0	22.9
5. Other	3	2.8	0.0	5.9	3	3.4	0.0	7.2
Establishments that only reported cash or spot market purchases	68	62.8	53.6	71.9	52	58.2	47.9	68.5

	During Past Year				Expected in 3 Years			
	n	%	Lower	Upper	n	%	Lower	Upper
2.3* What types of pricing methods are used by your plant for purchasing meat inputs?								
1. Price list	72	59.8	50.6	69.0	55	55.5	45.1	65.9
2. Individually negotiated pricing	79	61.3	52.2	70.4	69	65.2	55.2	75.2
3. Formula pricing (using another price as the base)	45	31.6	22.9	40.3	41	34.9	25.0	44.8
4. Sealed bid	D	1.8	0.0	4.3	D	1.1	0.0	3.3
5. Internal transfer	21	13.3	7.0	19.5	20	15.4	8.0	22.8
6. Other	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 8-1. Weighted Responses for the Meat Processor Survey (n = 125) (continued)

		n	%	Lower	Upper
2.4*	For meat inputs purchased by your plant during the past year using formula pricing, what was the base price of the formula?				
	1. Individual or multiple plant average price	13	18.1	7.0	29.2
	2. Individual or multiple plant average cost of production	7	7.3	0.1	14.5
	3. USDA publicly reported price	37	63.3	49.2	77.4
	4. Retail price	10	13.6	3.8	23.5
	5. Subscription service price (for example, Urner Barry)	16	28.2	15.1	41.4
	6. Other market price	8	9.4	1.2	17.6
	7. Other	5	3.1	0.0	7.4
		n	**Mean**	**Lower**	**Upper**
3.1	What percentage of meat inputs purchased during the past year were under a written agreement (versus oral)?	119	8.3	3.8	12.7
			Mean (n = 110)	**Lower**	**Upper**
3.2	For meat inputs purchased during the past year, what was the length of the agreement or contract (oral or written) (% of meat inputs)?				
	a. Purchases not under agreement or contract		72.4	64.0	80.9
	b. Less than 1 month		9.2	3.7	14.7
	c. 1 to 2 months		6.0	1.8	10.3
	d. 3 to 5 months		2.0	<0	4.3
	e. 6 to 11 months		2.3	<0	5.2
	f. 1 to 2 years		4.9	0.9	9.0
	g. 3 to 5 years		0.2	0.1	0.4
	h. 6 to 10 years		1.0	<0	3.0
	i. More than 10 years or evergreen		1.8	<0	4.3
	Total		99.8†		
			Mean (n = 120)	**Lower**	**Upper**
3.3	For meat inputs purchased during the past year, how far in advance of delivery was the delivery scheduled (% of meat inputs)?				
	a. Less than 3 days		35.3	27.2	43.5
	b. 4 to 6 days		29.4	22.0	36.7
	c. 1 to 2 weeks		20.2	14.0	26.5
	d. 3 to 4 weeks		10.8	5.7	15.9
	e. More than 1 month		4.3	1.5	7.2
	Total		100.0		

* Respondents could select multiple responses.

† Total does not sum to 100% because of rounding.

(continued)

Table 8-1. Weighted Responses for the Meat Processor Survey (n = 125) (continued)

	n	%	Lower	Upper
4.1* What are the three most important reasons why your plant only uses the cash or spot market for purchasing meat inputs?				
1. Can purchase meat inputs at lower prices	32	46.4	34.3	58.4
2. Reduces risk exposure	14	20.3	10.6	30.0
3. Reduces costs of activities for buying meat inputs	5	7.2	1.0	13.5
4. Reduces price variability for meat inputs	7	10.1	2.8	17.5
5. Reduces potential liability and litigation concerns	0	0.0	NA	NA
6. Increases supply chain information	3	4.3	0.0	9.3
7. Secures higher quality meat inputs	10	14.5	6.0	23.0
8. Facilitates or increases market access	D	2.9	0.0	7.0
9. Allows for adjusting operations quickly in response to changes in market conditions	33	47.8	35.7	59.9
10. Does not require identifying and recruiting long-term contracting partners	10	14.5	6.0	23.0
11. Does not require managing complex and costly contracts	18	26.1	15.5	36.7
12. Eliminates possible negative public perceptions about use of contracts	0	0.0	NA	NA
13. Allows for independence, complete control, and flexibility of own business	35	50.7	38.6	62.8
14. Enhances ability to benefit from favorable market conditions	23	33.3	21.9	44.7
15. Other	0	0.0	NA	NA
16. No other choice *(write-in response)*	D	2.9	0.0	7.0
17. Can easily purchase small quantity of meat inputs *(write-in response)*	D	2.9	0.0	7.0
18. Convenience *(write-in response)*	D	1.4	0.0	4.3
4.2* What are the three most important reasons why your plant uses alternative purchase methods for purchasing meat inputs?				
1. Can purchase meat inputs at lower prices	24	68.6	49.0	88.2
2. Reduces risk exposure	11	16.6	2.2	31.1
3. Reduces costs of activities for buying meat inputs	3	9.0	0.0	21.1
4. Reduces price variability for meat inputs	20	59.0	38.4	79.7
5. Reduces potential liability and litigation concerns	D	4.3	0.0	13.0
6. Increases supply chain information	D	8.6	0.0	20.6
7. Secures higher quality meat inputs	9	23.3	5.7	41.0
8. Facilitates or increases market access	0	0.0	NA	NA
9. Increases flexibility in responding to consumer demand	D	4.3	0.0	13.0
10. Allows for product branding in retail sales	0	0.0	NA	NA
11. Allows for food safety and biosecurity assurances	D	8.6	0.0	20.6
12. Allows for product traceability	D	4.8	0.0	13.5
13. Improves week-to-week supply management	11	28.1	9.3	46.8
14. Improves efficiency of operations due to product uniformity	11	43.4	22.5	64.3
15. Enhances access to credit	D	4.3	0.0	13.0
16. Other	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 8-1. Weighted Responses for the Meat Processor Survey (n = 125) (continued)

		n	%	Lower	Upper
5.1	Did your plant sell any products that contain at least 50 percent beef, pork, or lamb by weight during the past year?				
	1. Yes	106	87.2	81.0	93.3
	2. No	19	12.8	6.7	19.0
	Total		100.0		
			Mean (n = 92)	**Lower**	**Upper**
5.2	What was your plant's percentage of total meat product dollar sales during the past year by type of buyer or recipient?				
	a. Meat processors or food manufacturers		8.1	3.7	12.6
	b. Wholesalers or distributors		41.2	33.0	49.3
	c. Retail establishments		21.4	15.3	27.4
	d. Food service establishments		29.3	21.8	36.9
	e. Foreign buyers		0.0	0.0	0.0
	f. Other		0.0	0.0	0.0
	Total		100.0		

(continued)

Table 8-1. Weighted Responses for the Meat Processor Survey (n = 125) (continued)

	Processors/Manufacturers				Wholesalers/Distributors				Retail Establishments			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
5.3* What sales methods did your plant use during the past year for selling meat products to different types of recipients?												
1. Cash or spot market (less than 3 weeks forward)	23	60.5	44.1	76.9	68	81.6	72.9	90.3	57	75.4	65.2	85.6
2. Forward contract	D	2.7	0.0	8.3	12	13.1	5.5	20.7	13	15.8	7.2	24.5
3. Marketing agreement	4	8.5	0.0	17.8	11	13.0	5.4	20.6	9	8.9	2.3	15.6
4. Internal company transfer	4	8.5	0.0	17.8	4	2.9	0.0	6.5	5	3.3	0.0	7.3
5. Other	0	0.0	NA	NA	D	1.3	0.0	3.8	0	0.0	NA	NA
Establishments that only reported cash or spot market sales	20	19.3	11.4	27.2	57	54.0	44.1	64.0	48	46.7	36.8	56.7

	Food Service Establishments				Foreign Buyers			
	n	%	Lower	Upper	n	%	Lower	Upper
1. Cash or spot market (less than 3 weeks forward)	57	70.5	60.1	81.0	6	25.3	2.9	47.8
2. Forward contract	16	17.6	8.9	26.3	3	7.3	0.0	20.0
3. Marketing agreement	12	13.5	5.7	21.3	D	6.7	0.0	19.3
4. Internal company transfer	4	2.9	0.0	6.6	4	13.3	0.0	30.5
5. Other	0	0.0	NA	NA	0	0.0	NA	NA
Establishments that only reported cash or spot market sales	46	44.7	34.8	54.7	5	4.2	0.2	8.1

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 8-1. Weighted Responses for the Meat Processor Survey (n = 125) (continued)

	n	%	Lower	Upper
5.4* What types of sales methods does your plant expect to use in 3 years?				
1. Cash or spot market (less than 3 weeks forward)	84	84.8	77.5	92.0
2. Forward contract	28	25.8	16.9	34.7
3. Marketing agreement	29	26.8	17.8	35.8
4. Internal company transfer	12	9.8	3.8	15.8
5. Other	0	0.0	NA	NA
Establishments that only expect cash or spot market sales	51	52.8	42.6	63.0

NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 8-1. Weighted Responses for the Meat Processor Survey (n = 125) (continued)

	Processors/Manufacturers				Wholesalers/Distributors				Retail Establishments			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
5.5* What types of pricing methods did your plant use during the past year for selling meat products to different types of recipients?												
1. Price list	11	39.9	19.6	60.2	58	73.7	63.4	84.0	44	63.3	51.3	75.3
2. Individually negotiated pricing	16	59.7	39.3	80.0	38	49.8	38.1	61.6	39	56.9	44.5	69.2
3. Formula pricing (using another price as the base)	9	32.0	12.7	51.4	15	18.2	9.2	27.2	10	10.1	2.7	17.4
4. Sealed bid	D	3.9	0.0	12.1	D	1.5	0.0	4.3	D	0.2	0.0	0.5
5. Internal transfer	3	8.3	0.0	19.6	4	4.3	0.0	9.0	5	5.0	0.0	10.4
6. Other	0	0.0	NA	NA	0	0.0	NA	NA	0	0.0	NA	NA

	Food Service Establishments				Foreign Buyers			
	n	%	Lower	Upper	n	%	Lower	Upper
1. Price list	50	66.7	55.4	78.0	4	48.3	0.1	96.5
2. Individually negotiated pricing	38	50.7	38.7	62.7	4	34.5	0.0	80.0
3. Formula pricing (using another price as the base)	17	19.3	9.9	28.7	3	18.9	0.0	55.0
4. Sealed bid	12	14.7	6.2	23.1	D	1.7	0.0	5.7
5. Internal transfer	4	4.5	0.0	9.4	D	17.2	0.0	53.3
6. Other	0	0.0	NA	NA	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 8-1. Weighted Responses for the Meat Processor Survey (n = 125) (continued)

	n	%	Lower	Upper
5.6* For meat products sold by your plant during the past year using formula pricing, what was the base price of the formula?				
1. Individual or multiple plant average price	5	13.0	0.8	25.2
2. Individual or multiple plant average cost of production	7	22.1	6.9	37.3
3. USDA publicly reported price	20	49.1	31.0	67.3
4. Retail price	5	15.8	2.4	29.1
5. Subscription service price (for example, Urner Barry)	8	16.8	3.5	30.2
6. Other market price	0	0.0	NA	NA
7. Other	3	9.5	0.0	20.2
5.7* What types of pricing methods does your plant expect to use in 3 years for selling meat products?				
1. Price list	75	72.1	63.1	81.1
2. Individually negotiated pricing	63	60.7	50.9	70.5
3. Formula pricing (using another price as the base)	28	23.2	14.7	31.6
4. Sealed bid	13	11.5	5.1	17.8
5. Internal transfer	10	8.4	2.9	13.9
6. Other	D	2.0	0.0	4.9

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 8-1. Weighted Responses for the Meat Processor Survey (n = 125) (continued)

	Processors/Manufacturers				Wholesalers/Distributors				Retail Establishments			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
5.8* Which of the following marketing practices did your plant use during the past year for the sale of meat products?												
1. Two-part pricing	6	16.4	3.9	29.0	20	23.4	13.8	32.9	18	22.9	12.9	32.8
2. Volume discounts	9	22.2	8.2	36.2	37	42.9	31.8	54.1	23	26.2	15.8	36.5
3. Exclusive dealings	D	0.3	0.0	0.9	6	7.7	1.7	13.8	5	7.1	1.0	13.2
4. Bundling	0	0.0	NA	NA	3	3.9	0.0	8.2	D	2.8	0.0	6.8
5. None of the above	17	39.2	22.8	55.6	26	30.0	19.6	40.3	27	34.3	23.1	45.6

	Food Service Establishments				Foreign Buyers			
	n	%	Lower	Upper	n	%	Lower	Upper
1. Two-part pricing	14	17.3	8.6	26.0	D	12.0	0.0	29.1
2. Volume discounts	27	30.9	20.4	41.5	5	19.3	0.0	39.6
3. Exclusive dealings	6	7.9	1.7	14.1	0	0.0	NA	NA
4. Bundling	3	4.0	0.0	8.4	0	0.0	NA	NA
5. None of the above	30	36.1	25.1	47.1	14	68.0	44.0	92.1

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 8-1. Weighted Responses for the Meat Processor Survey (n = 125) (continued)

		n	Mean	Lower	Upper
6.1	What percentage of meat products sold during the past year were under a written agreement (versus oral)?	99	10.2	5.2	15.2
			Mean (n = 97)	**Lower**	**Upper**
6.2	For meat products sold during the past year, what was the length of the agreement or contract (oral or written) (% of meat products)?				
	a. Sales not under agreement or contract		77.3	69.8	84.8
	b. Less than 1 month		9.8	4.2	15.4
	c. 1 to 2 months		0.7	0.0	1.4
	d. 3 to 5 months		1.0	<0	2.1
	e. 6 to 11 months		3.1	0.2	5.9
	f. 1 to 2 years		6.2	1.4	11.0
	g. 3 to 5 years		0.0	0.0	0.1
	h. 6 to 10 years		0.0	0.0	0.0
	i. More than 10 years or evergreen		1.8	<0	4.3
	Total		99.9†		
			Mean (n = 104)	**Lower**	**Upper**
6.3	For meat products sold during the past year, how far in advance of delivery was the delivery scheduled (% of meat products)?				
	a. Less than 3 days		50.0	41.2	58.8
	b. 4 to 6 days		20.1	13.9	26.3
	c. 1 to 2 weeks		21.8	15.0	28.6
	d. 3 to 4 weeks		6.4	2.2	10.5
	e. More than 1 month		1.7	<0	4.0
	Total		100.0		

† Total does not sum to 100% because of rounding.

(continued)

Table 8-1. Weighted Responses for the Meat Processor Survey (n=125) (continued)

	n	%	Lower	Upper
7.1* What are the three most important reasons why your plant only uses the cash or spot market for selling meat products?				
1. Can sell meat products at higher prices	13	23.7	11.7	35.7
2. Reduces risk exposure	15	27.6	15.0	40.3
3. Reduces costs of activities for selling meat products	15	29.3	16.4	42.3
4. Reduces price variability for meat products	10	19.6	8.3	30.8
5. Reduces potential liability and litigation concerns	D	2.2	0.0	6.1
6. Increases supply chain information	0	0.0	NA	NA
7. Allows for sale of higher quality meat products	10	19.6	8.3	30.8
8. Facilitates or increases market access	D	2.0	0.0	5.9
9. Allows for adjusting operations quickly in response to changes in market conditions	26	50.9	36.7	65.0
10. Does not require identifying and recruiting long-term contracting partners	11	21.5	9.9	33.2
11. Does not require managing complex and costly contracts	15	29.3	16.4	42.3
12. Eliminates possible negative public perceptions about use of contracts	D	2.0	0.0	5.9
13. Allows for independence, complete control, and flexibility of own business	20	39.1	25.3	53.0
14. Enhances ability to benefit from favorable market conditions	9	17.6	6.8	28.4
15. Other	D	3.9	0.0	9.4
7.2* What are the three most important reasons why your plant uses alternative sales methods for selling meat products?				
1. Can sell meat products at higher prices	8	27.7	9.4	46.0
2. Reduces risk exposure	13	40.3	20.3	60.2
3. Reduces costs of activities for selling meat products	8	24.2	6.8	41.6
4. Reduces price variability for meat products	10	28.6	10.3	46.9
5. Reduces potential liability and litigation concerns	0	0.0	NA	NA
6. Increases supply chain information	5	19.5	3.2	35.8
7. Allows for sale of higher quality meat products	8	31.2	12.2	50.1
8. Facilitates or increases market access	5	12.5	0.0	25.8
9. Increases flexibility in responding to consumer demand	7	27.3	9.0	45.5
10. Allows for product branding in retail sales	4	12.1	0.0	25.4
11. Allows for food safety and biosecurity assurances	D	3.9	0.0	11.9
12. Allows for product traceability	D	3.9	0.0	11.9
13. Improves week-to-week production management	11	29.0	10.7	47.3
14. Secures a buyer for meat products	7	20.3	4.0	36.7
15. Enhances access to credit	0	0.0	NA	NA
16. Other	D	7.8	0.0	18.8

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 8-1. Weighted Responses for the Meat Processor Survey (n=125) (continued)

		n	%	Lower	Upper
8.1	How many days per week did your plant usually produce meat products?				
	1. Less frequently than once a week	3	2.7	0.0	5.7
	2. 1 or 2 days per week	10	8.9	3.6	14.3
	3. 3 or 4 days per week	29	25.9	17.7	34.1
	4. 5 or 6 days per week	78	62.5	53.4	71.6
	Total		100.0		
8.2	How many meat processing shifts did your plant usually operate per day?				
	1. One	93	83.8	77.0	90.6
	2. Two	26	16.2	9.4	23.0
	3. Three	0	0.0	NA	NA
	Total		100.0		
8.3	How many meat slaughter and processing plants, including this one, are owned by the company that owns your plant?				
	1. One	83	79.9	72.2	87.6
	2. 2 to 5	11	10.6	4.6	16.6
	3. 6 to 10	3	2.0	0.0	4.7
	4. 11 to 20	5	4.0	0.2	7.7
	5. 21 or more	9	3.5	0.2	6.8
	Total		100.0		

		n	Mean	Lower	Upper
8.4	Approximately how many people were employed at your plant during the past year?				
	a. Full time	116	57.8	39.3	76.4
	b. Part time or seasonal	55	8.8	4.8	12.9

		n	Mean	Lower	Upper
8.5	What were your plant's total dollar sales during the past year for each type of meat?				
	a. Beef	63	14,945,163.1	<0	31,914,029.7
	b. Pork	77	5,464,804.2	2,557,763.0	8,371,845.5
	c. Lamb	16	20,283.9	9,889.3	30,678.4
	d. Combination	27	13,044,592.7	2,622,270.8	23,466,914.6

NA = Confidence interval not calculable.

(continued)

Table 8-1. Weighted Responses for the Meat Processor Survey (n=125) (continued)

		n	%	Lower	Upper
8.6	What were your plant's approximate total gross sales for fresh, frozen, and processed beef, pork, and lamb products during the past year?				
	1. Under $99,999	10	8.6	3.2	14.0
	2. $100,000 to $499,999	22	20.8	12.9	28.6
	3. $500,000 to $999,999	11	10.4	4.5	16.3
	4. $1,000,000 to $2,499,999	19	17.9	10.5	25.3
	5. $2,500,000 to $4,999,999	12	11.3	5.2	17.4
	6. $5,000,000 to $9,999,999	7	6.6	1.8	11.4
	7. $10,000,000 to $19,999,999	6	5.7	1.2	10.1
	8. $20,000,000 to $49,999,999	3	2.0	0.0	4.6
	9. $50,000,000 to $99,999,999	6	4.8	0.7	8.9
	10. $100,000,000 to $999,999,999	14	8.2	3.1	13.3
	11. $1,000,000,000 or more	4	3.8	0.1	7.5
	Total		100.1†		
8.7	What were your plant's approximate total gross sales for meat by-products during the past year?				
	1. Do not sell by-products	84	74.1	65.6	82.6
	2. Under $99,999	16	15.2	8.3	22.2
	3. $100,000 to $499,999	4	3.8	0.1	7.5
	4. $500,000 to $999,999	0	0.0	NA	NA
	5. $1,000,000 to $2,499,999	5	3.9	0.2	7.6
	6. $2,500,000 to $999,999,999	4	3.0	0.0	6.2
	7. 1,000,000,000 or more	0	0.0	NA	NA
	Total		100.0		
8.8	What were your plant's approximate total gross sales for all products during the past year?				
	1. Under $99,999	4	3.9	0.1	7.8
	2. $100,000 to $499,999	11	10.8	4.7	16.9
	3. $500,000 to $999,999	9	8.8	3.2	14.4
	4. $1,000,000 to $2,499,999	21	20.6	12.6	28.6
	5. $2,500,000 to $4,999,999	15	14.7	7.7	21.7
	6. $5,000,000 to $9,999,999	10	9.8	3.9	15.7
	7. $10,000,000 to $19,999,999	6	5.9	1.2	10.5
	8. $20,000,000 to $49,999,999	6	5.0	0.7	9.3
	9. $50,000,000 to $99,999,999	6	5.0	0.7	9.3
	10. $100,000,000 to $499,999,999	15	9.5	3.9	15.1
	11. $500,000,000 to $999,999,999	4	3.0	0.0	6.4
	12. $1,000,000,000 or more	3	2.9	0.0	6.3
	Total		99.9†		

NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.

9 Survey Results: Downstream Market Participants

This section presents the weighted tabulations for the downstream market participants. We do not provide results by size of company (small versus large) because of the small number of respondents.

For weighted proportions, the tables provide the number of respondents (n), the estimated proportion weighted by the number of eligible business units (%), and the corresponding 95% confidence interval (lower and upper) for each response item. For questions for which respondents could select only one response, the sum of the responses equals 100%. For questions for which respondents could select more than one response, the total may sum to more than 100%. These questions are noted with an asterisk (*).

For weighted means, the tables provide the number of respondents used in the mean calculation (n), the estimated mean weighted by the number of eligible business units (mean), and the corresponding 95% confidence interval (lower and upper).

9.1 WHOLESALERS

Table 9-1 provides weighted tabulations for all survey questions for meat wholesalers (n = 142). These results are described briefly in this section.

9.1.1 Company Characteristics

Forty percent of wholesalers did not own a warehouse or distribution center, 56% owned one warehouse or distribution center, and 4% owned two or more. Thirty-eight percent of the companies had annual gross sales of beef, pork, and lamb products of less than $1 million, 30% had sales between $1 million and $5 million, and 31% had sales of more than $5 million a year. On average, these companies had 142 full-time employees and 12 part-time employees. (See Table 9-1, Questions 4-1 through 4.3.)

9.1.2 Meat Purchases by Wholesalers

The majority of meat purchased by wholesalers was fresh or frozen product. Beef purchases by wholesalers were made up of 81% fresh or frozen product, 15% processed, and 5% variety meats.[1] Pork purchases were 75% fresh or frozen, 21% processed, and 5% variety meats. Lamb purchases were 95% fresh or frozen and 4% processed, with very little variety meats. For purchases of product that was a combination of meats (e.g., beef and pork), 49% was processed, 40% was fresh or frozen, and 11% was variety meats. Nearly all companies purchased some case-ready beef, pork, and lamb, but the percentage was relatively small. Beef and pork case-ready purchases averaged 17% to 18% of total dollar purchases, while lamb was 8%. (See Table 9-1, Questions 1.2 through 1.5.)

More than 70% of the beef and pork and two-thirds of the lamb purchases had national or regional brand labels.

Nearly two-thirds of wholesalers purchased or received meat products that had some type of certification. The most frequently cited type of certification was USDA Process Verified (47% of companies).[2] Other certification programs included CAB (20%), other breed or livestock quality certification (19%), organic (10%), and Halal (9%). More than 70% of the beef and pork and two-thirds of the lamb purchases had national or regional brand labels. Private-label brand volumes were less in comparison with commodity products (i.e., no brand) for pork

[1] These values were computed as the mean value of purchases of meat products weighted by the number of eligible business units. Other reported means were computed similarly (i.e., weighted by the number of eligible business units).

[2] The percentage of wholesalers that reported purchasing USDA Process Verified meat is high relative to the amount of meat that we believe is USDA Process Verified; however, USDA does not track process verified product volume. Respondents may have been confusing this with USDA inspection.

and particularly for lamb, but were comparable for beef. The national or regional brand most often was a brand name used by a packer or processor. (See Table 9-1, Questions 1.6 through 1.8.)

Wholesalers purchased 40% of their beef, pork, and lamb from packers and 38% from another wholesaler. To a lesser extent, further processors and dealers supplied 9% each, and importers and others provided 2% or less each. Wholesalers were asked to identify the three most important reasons for purchasing meat products from a chosen supplier. The most often cited reason was “Has provided good quality product in the past” (64% of companies). Other reasons given included “Provides product quality guarantees” (33%), “Offers lower prices for given product specifications” (32%), and “Can meet all my product needs” (30%). Of lesser importance were issues of source, delivery time, exact specifications, traceability, and certification. (See Table 9-1, Questions 2.1 and 2.2.)

Wholesalers identified specific terms that were included in purchase transactions during the past year. Most often identified, but by less than one-half of companies, was product quality specifications. Other terms included maximum or minimum purchase quantities, volume discounts, and delivery lead times (32% to 36%). One-third of companies did not specify any terms in their purchase transactions. (See Table 9-1, Question 2.3.)

For companies that purchased meat products under an ongoing arrangement, 35% had agreements that were less than 1 month in length, 35% had agreements that were more than 10 years or evergreen, and the rest had agreements between 1 month and 10 years. Regardless of the length of the purchasing agreement, delivery was typically scheduled only days before delivery: 56% of companies scheduled delivery 3 days or less in advance, and 42% scheduled delivery within 4 to 6 days. (See Table 9-1, Questions 2.4 and 2.5.)

The most common type of pricing method used by wholesalers was flat pricing (56% of total dollar purchases), followed by formula pricing (27%), and then or-better pricing (12%). Few companies used floor and ceiling pricing or other methods. For companies using flat pricing, most did not include a premium (or overage) relative to the market price. For companies that purchased product under an ongoing arrangement, the purchase price was usually benchmarked relative to a market-reported price. For companies using formula pricing, many (61%) used a USDA publicly reported price as the base and the current market (82%) or an average of the previous week (24%) as the timing for the base price; relatively few companies received premiums or discounts in formula price agreements. Of those that did, the premiums or discounts most often were based on brand name, USDA quality grade, or availability or timing of product. (See Table 9-1, Questions 2.6 through 2.11.)

9.1.3 Meat Sales by Wholesalers

Sales by wholesalers most often were to domestic HRI and to retail food stores (e.g., grocery stores, meat markets, warehouse clubs), representing 46% and 39% of sales, respectively. Direct to consumers (6%), foreign buyers (4%), and other wholesalers (4%) were other lesser markets for wholesalers. While wholesalers reported purchasing 38% of their meat needs from other wholesalers, they reported selling only 4% of their meat products to other wholesalers, thus suggesting the survey responses tend to represent smaller wholesalers. While companies specified a variety of terms in sales transactions, there was no dominate term identified. Between 22% and 32% of companies specified volume discounts, maximum or minimum quantities, delivery lead times, and/or retail price maintenance. Of lesser importance were maximum or minimum pricing requirements, inventory management, and advertising requirements. Nearly 40% of companies did not specify any terms in sales transactions. (See Table 9-1, Questions 3.1 and 3.2.)

The ongoing arrangements used to sell meat products varied widely in length. Forty-two percent of companies had agreements that were less than 1 month, and 30% had agreements that were more than 10 years in length or evergreen. Delivery time, however, was usually short term. Nearly 76% of companies specified delivery within 3 days, 26% specified delivery 4 to 6 days in advance, and 31% specified delivery 1 to 2 weeks in advance. (See Table 9-1, Questions 3.3 and 3.4.)

Flat pricing was also the most commonly used method for pricing meat sold by wholesalers. Flat pricing was used for 63% of meat sales compared with 24% for formula pricing. Other pricing methods were used less frequently. Relatively few wholesalers made an adjustment to flat pricing agreements that reflected market conditions. When formula pricing was used, companies most often used USDA-reported prices (52% of companies) or retail prices (36%) as the base price. The timing for the base price was most often based on the current market (80%) or an average of the previous week (30%). Relatively few companies offered premiums or discounts in formula price agreements. Of those that did, half based their premiums and discounts on brand name. To a lesser extent, but of nearly equal weight, were customer service, availability, and quality grade. (See Table 9-1, Questions 3-5 through 3-9.)

9.1.4 Wholesaler Survey Summary

Wholesalers handled primarily fresh or frozen meat products rather than processed products. Sixty-five percent of companies purchased meat products that were certified. While packers were the largest supplier to wholesalers, the second largest supplier to wholesalers was another wholesaler. Wholesalers selected suppliers that had a good history of quality product and that provided guarantees on product quality. There was greater use of long-term agreements compared with other types of downstream companies, but short-term agreements were used as well.

Flat pricing was the most common method of meat pricing for wholesalers on both purchases and sales.

Flat pricing was the most common method of meat pricing for wholesalers on both purchases and sales. If formula pricing was used it was most often tied to a USDA-reported price, typically for the current or previous week. If premiums or discounts were paid in formula pricing agreements, they were most often for brand name.

Table 9-1. Weighted Responses for the Food Wholesaler Survey (n = 142)

		Beef (n = 125)			Pork (n = 118)			Lamb (n = 64)		
		Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
1.2	What was your company's percentage of total dollar purchases of meat products during the past year by type of product category for each type of meat?									
	a. Fresh or frozen	80.7	75.7	85.8	74.5	68.4	80.5	94.9	90.3	99.6
	b. Processed	14.7	10.0	19.5	20.9	15.1	26.6	4.4	<0	9.0
	c. Variety meats and edible by-products	4.5	2.9	6.2	4.7	2.8	6.6	0.7	0.2	1.2
	Total	99.9†			100.1†			100.0		
		Combination of Meat (n = 81)								
		Mean	**Lower**	**Upper**						
	a. Fresh or frozen	40.0	30.7	49.4						
	b. Processed	49.2	39.9	58.5						
	c. Variety meats and edible by-products	10.8	5.3	16.3						
	Total	100.0								

(continued)

A description of the notation used in the table headers is provided below.
n = number of respondents
% = estimated proportion weighted by the number of eligible business units
Mean = estimated mean weighted by the number of eligible business units
Lower = lower bound of the 95% confidence interval for the weighted proportion or mean
Upper = upper bound of the 95% confidence interval for the weighted proportion or mean

† Total does not sum to 100% because of rounding.

Table 9-1. Weighted Responses for the Food Wholesaler Survey (n = 142) (continued)

		n	Mean	Lower	Upper
1.3	What percentage of total dollar purchases of beef products during the past year were case ready?	132	17.3	10.9	23.7
1.4	What percentage of total dollar purchases of pork products during the past year were case ready?	134	17.7	11.5	23.9
1.5	What percentage of total dollar purchases of lamb products during the past year were case ready?	131	8.3	3.7	12.9
		n	**%**	**Lower**	**Upper**
1.6*	Which of the following types of certification apply for meat products purchased or received by your company?				
	1. None	42	35.0	26.1	44.0
	2. Kosher certification	9	5.9	1.6	10.3
	3. Halal certification	11	9.2	3.8	14.6
	4. Organic certification	15	9.9	4.4	15.4
	5. USDA Process Verified certification	56	46.9	37.6	56.3
	6. ISO certification	5	3.8	0.2	7.3
	7. Certified Angus Beef	28	19.5	12.2	26.7
	8. Other third-party certification of breed or livestock quality (not including Certified Angus Beef)	19	12.1	6.1	18.0
	9. Own-company certification of breed or livestock quality	11	7.0	2.4	11.7
	10. Buyer certification of breed or livestock quality	D	1.1	0.0	2.9
	11. Other	D	1.8	0.0	4.3

D = Results suppressed.

* Respondents could select multiple responses.

(continued)

Table 9-1. Weighted Responses for the Food Wholesaler Survey (n = 142) (continued)

	Beef (n = 123)			Pork (n = 118)			Lamb (n = 65)		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
1.7 What was your company's percentage of total dollar purchases of meat products during the past year by type of label for each type of meat?									
a. National or regional brand	73.0	65.8	80.3	72.7	65.1	80.2	66.9	55.5	78.4
b. Private label brand	12.1	7.0	17.1	10.6	5.8	15.4	9.2	2.3	16.2
c. Commodity product—not branded	14.9	8.9	21.0	16.7	10.0	23.5	23.8	13.2	34.5
Total	100.0			100.0			99.9†		

	Beef				Pork				Lamb			
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
1.8* For meat products purchased during the past year with a national or regional brand label, what was the source of the brand name?												
1. Brand name used by packer or processor	79	95.8	91.4	100.0	76	97.0	93.2	100.0	33	85.6	73.4	97.8
2. Name of livestock producer organization	10	11.0	3.9	18.0	6	7.1	1.2	13.0	7	20.1	6.2	34.1
3. Name of certification organization	12	12.5	5.1	19.9	3	4.1	0.0	8.7	4	11.5	0.4	22.6
4. Other	0	0.0	NA	NA	D	1.4	0.0	4.1	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.
* Respondents could select multiple responses.

(continued)

Table 9-1. Weighted Responses for the Food Wholesaler Survey (n = 142) (continued)

			Mean (n = 137)	Lower	Upper
2.1	What was your company's percentage of total dollar purchases of beef, pork, and lamb products during the past year by type of supplier?				
	a. Packer		40.1	33.1	47.1
	b. Further processor		8.9	5.0	12.8
	c. Wholesaler or distributor		37.9	30.9	44.9
	d. Dealer or broker		9.1	5.4	12.8
	e. Importer		1.2	0.5	1.9
	f. Other		0.8	<0	2.4
	g. Farmer *(write-in response)*		2.0	<0	4.3
	Total		100.0		
		n	**%**	**Lower**	**Upper**
2.2*	What were the three most important reasons for purchasing meat products from your chosen suppliers during the past year?				
	1. Offers portion cut product for repackaging	3	2.4	0.0	5.1
	2. Has product traceability system in operation	14	9.3	4.2	14.3
	3. Is in electronic procurement system	D	0.8	0.0	2.4
	4. Provides product quality guarantees	44	33.3	25.0	41.6
	5. Provides food safety guarantees	36	25.6	17.9	33.3
	6. Has provided good quality product in the past	89	63.5	55.0	72.0
	7. Offers lower prices for given product specifications	45	32.2	23.9	40.4
	8. Offers products from specific packers or processors	28	22.4	15.0	29.8
	9. Offers case-ready product	4	3.2	0.1	6.3
	10. Meets exact product specifications	25	16.8	10.3	23.3
	11. Offers products with certifications (for example, Certified Angus Beef)	9	6.6	2.2	10.9
	12. Offers products from U.S. sources	12	9.6	4.4	14.8
	13. Is on approved list of suppliers	7	5.0	1.1	8.8
	14. Meets delivery time requirements	32	22.4	15.1	29.7
	15. Can meet all meat product needs	40	30.1	22.0	38.2
	16. Other	D	1.6	0.0	3.8
	17. Franchise or exclusive arrangement *(write-in response)*	7	5.0	1.1	8.8

D = Results suppressed.

(continued)

* Respondents could select multiple responses.

Table 9-1. Weighted Responses for the Food Wholesaler Survey (n = 142) (continued)

		n	%	Lower	Upper
2.3*	Which of the following terms were specified in purchase transactions for meat products made by your company during the past year?				
	1. Retail price maintenance	10	8.3	3.3	13.3
	2. Volume discounts	47	34.3	25.8	42.7
	3. Maximum or minimum purchase quantities	46	36.1	27.5	44.7
	4. Maximum or minimum pricing requirements	13	8.8	3.8	13.8
	5. Delivery lead times	46	32.1	23.8	40.4
	6. Product quality specifications	62	44.0	35.1	52.9
	7. Information sharing	11	7.1	2.6	11.6
	8. Slotting fees	D	1.0	0.0	2.7
	9. Inventory management	12	8.6	3.6	13.6
	10. Inventory cost control	8	6.0	1.7	10.2
	11. Advertising requirements	5	4.1	0.5	7.7
	12. Other	D	0.8	0.0	2.5
	13. None of the above	40	32.5	24.1	40.9
2.4*	For meat products purchased under an ongoing arrangement (oral or written) during the past year, what was the length of the arrangement?				
	1. Less than 1 month	27	34.8	23.2	46.5
	2. 1 to 2 months	11	11.8	4.1	19.5
	3. 3 to 5 months	7	6.9	1.0	12.9
	4. 6 to 11 months	7	5.7	0.5	11.0
	5. 1 to 2 years	7	8.2	1.6	14.8
	6. 3 to 5 years	D	3.0	0.0	7.3
	7. 6 to 10 years	4	6.1	0.2	12.0
	8. More than 10 years or evergreen	24	35.2	23.5	46.9
2.5*	For meat products purchased during the past year, how far in advance of delivery was the delivery scheduled?				
	1. Less than 3 days	72	55.5	46.8	64.1
	2. 4 to 6 days	61	41.7	33.1	50.3
	3. 1 to 2 weeks	32	20.8	13.7	27.8
	4. 3 to 4 weeks	10	6.0	1.9	10.0
	5. More than 1 month	17	9.6	4.6	14.6
			Mean (n = 141)	**Lower**	**Upper**
2.6	What types of pricing methods did your company use during the past year for purchasing meat products (% of total dollar purchases)?				
	a. Flat pricing		55.6	47.7	63.5
	b. Formula pricing (using another price as the base)		26.7	19.7	33.8
	c. Or-better pricing		12.2	6.8	17.6
	d. Floor and ceiling pricing		3.1	0.4	5.9
	e. Other		2.3	<0	5.0
	Total		99.9†		

D = Results suppressed.

* Respondents could select multiple responses.

† Total does not sum to 100% because of rounding.

(continued)

Table 9-1. Weighted Responses for the Food Wholesaler Survey (n = 142) (continued)

		n	%	Lower	Upper
2.7	If flat pricing was used during the past year, did the purchase price include a premium (or overage) relative to the market price?				
	1. Did not use flat pricing during the past year	46	36.5	28.0	45.0
	2. Yes, for some meat product purchases (less than 50%)	14	8.0	3.4	12.7
	3. Yes, for most meat product purchases (50% or more)	15	10.8	5.3	16.3
	4. No	61	44.7	35.9	53.5
	Total		100.0		
2.8*	For meat products purchased under an ongoing arrangement during the past year, how was the purchase price or base price benchmarked?				
	1. Did not purchase under an ongoing arrangement	67	56.0	46.9	65.1
	2. Did not benchmark purchase price or base price	10	8.1	3.0	13.1
	3. Relative to market-reported price	45	33.8	25.1	42.5
	4. Relative to internal rates of return	D	0.2	0.0	0.5
	5. Relative to other bids or offers	14	9.5	4.2	14.8
	6. Other	D	0.2	0.0	0.5
2.9*	For meat products purchased during the past year using formula pricing, what was the base price of the formula?				
	1. USDA publicly reported price	36	60.9	46.4	75.5
	2. Futures price or price ratio	9	18.4	6.8	30.1
	3. Retail price	10	22.5	9.9	35.1
	4. Subscription service price (for example, Urner Barry)	12	16.1	5.6	26.5
	5. Other	3	4.9	0.0	11.3
2.10*	For meat products purchased during the past year using formula pricing, what was the timing for the base price?				
	1. Current market	46	81.5	70.5	92.6
	2. Average of the previous week	16	23.5	11.5	35.5
	3. Average of the previous 2 weeks	D	4.2	0.0	10.1
	4. Average of the previous 3 weeks	D	4.2	0.0	10.1
	5. Average of the previous month	5	7.1	0.0	14.3
	6. Average of the previous 2 months or longer	3	4.6	0.0	10.6
	7. Other	0	0.0	NA	NA
2.11*	For meat products purchased during the past year using formula pricing, what was the basis of any premiums or discounts?				
	1. USDA yield grade	4	16.4	0.8	32.1
	2. USDA quality grade	12	39.3	19.1	59.6
	3. Brand name	16	52.4	31.7	73.2
	4. Availability/timing	9	30.3	11.2	49.4
	5. Customer service	3	12.3	0.0	26.2
	6. Other	D	4.9	0.0	13.5

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 9-1. Weighted Responses for the Food Wholesaler Survey (n = 142) (continued)

			Mean (n = 138)	Lower	Upper
3.1	What was your company's percentage of total dollar sales or shipments of beef, pork, and lamb products during the past year by type of buyer or receiver?				
	a. Grocery stores, meat markets, warehouse clubs, or other retail establishments in the United States		39.2	32.4	45.9
	b. Restaurants, hotels, institutions, or other food service establishments in the United States		46.1	39.1	53.0
	c. Foreign distributors, retailers, or food service		4.4	1.4	7.4
	d. Other		0.9	<0	2.3
	e. Other wholesalers, distributors, or food processors *(write-in response)*		3.8	0.8	6.8
	f. Directly to consumer *(write-in response)*		5.7	2.0	9.4
	Total		100.1†		
		n	**%**	**Lower**	**Upper**
3.2*	Which of the following terms were specified in sales transactions for meat products made by your company during the past year?				
	1. Retail price maintenance	29	22.2	14.9	29.5
	2. Volume discounts	50	31.8	23.7	39.8
	3. Maximum or minimum sales quantities	44	28.3	20.5	36.1
	4. Maximum or minimum pricing requirements	16	9.4	4.4	14.4
	5. Delivery lead times	42	27.4	19.6	35.1
	6. Information sharing	10	5.3	1.6	9.1
	7. Slotting fees	4	2.5	0.0	5.2
	8. Inventory management	14	7.8	3.3	12.4
	9. Inventory cost control	5	2.7	0.0	5.4
	10. Advertising requirements	11	7.4	2.9	11.9
	11. Other	5	3.9	0.5	7.4
	12. None of the above	50	39.4	30.9	48.0
3.3*	For meat products sold under an ongoing arrangement (oral or written) during the past year, what was the length of the arrangement?				
	1. Less than 1 month	30	41.9	29.1	54.7
	2. 1 to 2 months	12	16.5	6.9	26.1
	3. 3 to 5 months	7	5.1	0.1	10.0
	4. 6 to 11 months	7	3.7	0.1	7.3
	5. 1 to 2 years	10	11.6	3.5	19.7
	6. 3 to 5 years	3	5.2	0.0	11.0
	7. 6 to 10 years	D	1.7	0.0	5.2
	8. More than 10 years or evergreen	18	29.6	17.6	41.5

D = Results suppressed.
* Respondents could select multiple responses.
† Total does not sum to 100% because of rounding.

(continued)

Table 9-1. Weighted Responses for the Food Wholesaler Survey (n = 142) (continued)

		n	%	Lower	Upper
3.4*	For meat products sold during the past year, how far in advance of delivery was the delivery scheduled?				
	1. Less than 3 days	104	75.6	68.2	83.1
	2. 4 to 6 days	39	26.1	18.5	33.7
	3. 1 to 2 weeks	47	31.1	23.1	39.1
	4. 3 to 4 weeks	16	9.4	4.4	14.3
	5. More than 1 month	12	6.2	2.2	10.3
			Mean (n = 138)	**Lower**	**Upper**
3.5	What types of pricing methods did your company use during the past year for selling meat products (% of total dollar sales)?				
	a. Flat pricing		63.4	55.5	71.2
	b. Formula pricing (using another price as the base)		23.5	16.5	30.5
	c. Or-better pricing		8.7	4.0	13.4
	d. Floor and ceiling pricing		2.0	0.1	4.0
	e. Other		2.4	<0	5.1
	Total		100.0		
		n	**%**	**Lower**	**Upper**
3.6	If flat pricing was used during the past year, did the sales price include a premium (or overage) relative to the market price?				
	1. Did not use flat pricing during the past year	39	32.1	23.7	40.5
	2. Yes, for some meat product sales (less than 50%)	11	7.7	3.0	12.5
	3. Yes, for most meat product sales (50% or more)	10	6.9	2.4	11.4
	4. No	72	53.3	44.4	62.2
	Total		100.0		
3.7*	For meat products sold during the past year using formula pricing, what was the base price of the formula?				
	1. USDA publicly reported price	29	51.9	37.2	66.6
	2. Futures price or price ratio	6	11.2	1.9	20.4
	3. Retail price	19	35.6	21.6	49.7
	4. Subscription service price (for example, Urner Barry)	8	12.0	2.7	21.3
	5. Other	5	10.7	1.5	19.9
3.8*	For meat products sold during the past year using formula pricing, what was the timing for the base price?				
	1. Current market	42	79.9	68.3	91.4
	2. Average of the previous week	19	29.8	16.7	42.8
	3. Average of the previous 2 weeks	D	2.1	0.0	6.3
	4. Average of the previous 3 weeks	D	4.2	0.0	10.1
	5. Average of the previous month	5	8.8	0.6	17.0
	6. Average of the previous 2 months or longer	D	2.5	0.0	6.8
	7. Other	D	2.1	0.0	6.3

D = Results suppressed.
* Respondents could select multiple responses.

(continued)

Table 9-1. Weighted Responses for the Food Wholesaler Survey (n = 142) (continued)

		n	%	Lower	Upper
3.9*	For meat products sold during the past year using formula pricing, what was the basis of any premiums or discounts?				
	1. USDA yield grade	4	14.1	0.0	29.3
	2. USDA quality grade	5	22.1	3.7	40.6
	3. Brand name	13	50.4	28.4	72.5
	4. Availability/timing	6	19.4	2.4	36.5
	5. Customer service	6	23.0	4.5	41.5
	6. Other	D	8.9	0.0	21.5
4.1	How many warehouses or distribution centers were owned by your company during the past year?				
	1. None	54	39.7	31.2	48.2
	2. One	73	55.8	47.2	64.4
	3. 2 to 9	11	4.2	1.1	7.3
	4. 10 to 99	D	0.1	0.0	0.4
	5. 100 to 499	D	0.1	0.0	0.4
	6. 500 to 999	0	0.0	NA	NA
	7. 1,000 or more	0	0.0	NA	NA
	Total		99.9†		

		n	Mean	Lower	Upper
4.2	What was the approximate total number of people employed by your company during the past year?				
	a. Full time	69	141.5	<0	381.3
	b. Part time	58	11.5	<0	25.4

		n	%	Lower	Upper
4.3	What were your company's approximate total gross sales for fresh, frozen, and processed beef, pork, and lamb products during the past year?				
	1. Under $99,999	16	12.8	6.9	18.7
	2. $100,000 to $499,999	15	12.0	6.2	17.8
	3. $500,000 to $999,999	17	13.6	7.5	19.7
	4. $1,000,000 to $2,499,999	24	19.2	12.2	26.2
	5. $2,500,000 to $4,999,999	14	11.2	5.6	16.8
	6. $5,000,000 to $9,999,999	14	11.2	5.6	16.8
	7. $10,000,000 to $19,999,999	11	8.8	3.8	13.8
	8. $20,000,000 to $49,999,999	7	3.7	0.5	6.8
	9. $50,000,000 to $99,999,999	8	3.8	0.6	7.0
	10. $100,000,000 to $499,999,999	6	2.2	0.0	4.5
	11. $500,000,000 or more	5	1.4	0.0	3.1
	Total		99.9†		

D = Results suppressed.
NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.
* Respondents could select multiple responses.

(continued)

Table 9-1. Weighted Responses for the Food Wholesaler Survey (n = 142) (continued)

		n	%	Lower	Upper
4.4	What were your company's approximate total gross sales for all products during the past year?				
	1. Under $99,999	13	11.0	5.3	16.8
	2. $100,000 to $499,999	11	9.3	4.0	14.6
	3. $500,000 to $999,999	13	11.0	5.3	16.8
	4. $1,000,000 to $2,499,999	27	22.2	14.7	29.8
	5. $2,500,000 to $4,999,999	16	13.6	7.3	19.8
	6. $5,000,000 to $9,999,999	11	9.3	4.0	14.6
	7. $10,000,000 to $19,999,999	12	10.2	4.7	15.7
	8. $20,000,000 to $49,999,999	8	5.4	1.4	9.5
	9. $50,000,000 to $99,999,999	7	3.2	0.3	6.1
	10. $100,000,000 to $499,999,999	5	2.2	0.0	4.6
	11. $500,000,000 to $999,999,999	3	0.5	0.0	1.0
	12. $1,000,000,000 or more	4	2.0	0.0	4.4
	Total		99.9†		

† Total does not sum to 100% because of rounding.

9.2 EXPORTERS

Table 9-2 provides weighted tabulations for all survey questions for meat exporters (n = 14).[3] Because the number of respondents is small, we cannot make inferences to the population of meat exporters; however, we can draw some conclusions about the marketing practices of the exporters surveyed. These results are described briefly in this section.

9.2.1 Company Characteristics

Ten companies reported sales of beef, 14 sold pork, and 4 sold lamb. The responding companies handled a large volume of products. Three companies had annual gross meat sales of less than $5 million, eight companies had gross meat sales between $5 million and $100 million, and three companies had gross meat sales of more than $100 million. A majority of companies appear to only play a broker or dealer role because they do not have warehouses (9 of 14 companies). (See Table 9-2, Questions 4-1 through 4-4.)

9.2.2 Meat Purchases by Exporters

> The majority of the meat purchased by the exporters surveyed was fresh or frozen product. There were no case-ready purchases of beef and lamb, and only 7% of pork purchases were case–ready purchases.

The majority of the meat purchased by the exporters surveyed was fresh or frozen product. Beef purchases by exporters were 61% fresh or frozen, 4% processed, and 35% variety meats. Pork purchases by exporters were 74% fresh or frozen, 13% processed, and 13% variety meats. Lamb purchases by exporters were 97% fresh or frozen. Three companies exported combination meats that were approximately two-thirds processed and one-third fresh or frozen; they exported very little variety meats. There were no case-ready purchases of beef and lamb, and only 7% of pork purchases were case-ready purchases. (See Table 9-2, Questions 1.2 through 1.5.)

Four of the 14 exporters purchased no certified products. The most cited type of certification program was USDA Process Verified (43%).[4] More than half of the meat products purchased by exporters were a branded product of some type. Beef exporters reported that 53% of purchases were national or

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[3] The survey population excluded meat packers that also export; such establishments were included in the survey population for meat packers.

[4] The percentage of exporters that reported purchasing USDA Process Verified meat is high relative to the amount of meat that we believe is USDA Process Verified; however, USDA does not track process verified product volume. Respondents may have been confusing this with USDA inspection.

regional brands, 8% were private-label brands, and 39% were commodity products (i.e., no brand). Pork exporters reported that 52% of purchases were national or regional brands, 14% were private-label brands, and 34% were commodity products. Lamb exporters reported that 75% of purchases were national or regional brands and 25% were commodity. In most cases, the brand was that of a packer or processor across all meat types. (See Table 9-2, Questions 1.6 through 1.8.)

Seventy percent of the beef, pork, and lamb purchased by exporters was from packers. Another 13% was from further processors, 9% from dealers or brokers, and 4% from a wholesaler or distributor. Interestingly, 4% of exporter purchases were from an importer, indicating that these companies are sourcing some of their product from outside the United States. (See Table 9-2, Question 2.1.)

Exporters were asked to identify the three most important reasons for selecting a supplier. The most frequently given reasons were "Has provided good quality product in the past" (86%) and "Offers lower prices for given product specifications" (50%). Thus, product quality and specifications are important to exporters. The other responses were selected by less than one-third of respondents. (See Table 9-2, Question 2.2.)

Exporters specified a variety of terms in purchase transactions. The most common terms were product quality specifications and delivery lead times. The length of the agreement varied for meat products purchased under ongoing arrangements, but most exporters reported having agreements less than 6 months in length. However, most deliveries were scheduled within 6 days. (See Table 9-1, Questions 2.3 through 2.5.)

The most common pricing method employed by exporters was flat pricing (76% of purchases). Formula pricing, or-better pricing, and floor and ceiling pricing were used, but to a much lesser extent. When flat pricing was used, six of the companies did not include a premium or overage in the agreement. When formula pricing was used, the USDA publicly reported price was most often used; the current market and an average of the previous week were most often used as the timing for the base price. (See Table 9-1, Questions 2.6 through 2.11.)

9.2.3 Meat Sales by Exporters

Exporter sales of beef, pork, and lamb went through several outlets to reach consumers. The most common was through foreign distributors, retailers, and food service operators (64% of sales). U.S. retail establishments accounted for 16% of sales, and U.S. HRI accounted for 11% of sales. Delivery lead time was the most common term specified in sales agreements. (See Table 9-2, Questions 3.1 and 3.2.)

The length of the agreement varied for meat products sold under ongoing arrangements, but most exporters reported having agreements less than 6 months in length. Likewise, there was a lot of variation as to when delivery was scheduled, with deliveries ranging from less than 3 days ahead to more than 1 month ahead. The majority of meat exports were priced by flat pricing (83% of sales). (See Table 9-2, Questions 3.3 through 3.5.)

9.2.4 Exporter Survey Summary

The small sample of exporters represented companies with a relatively large dollar volume of business. Most of the product purchased was fresh or frozen rather than processed beef, pork, and lamb. Combination product purchases tended to include more processed product. Most fresh and frozen products carried a national or regional brand, and the brand was typically from a packer or processor. Compared with the other downstream companies, exporters purchased more commodity meats. Motivation for choosing a supplier focused on past quality performance, followed by price for the given product specifications. More than half of the exporters specified product quality specifications in the terms of purchase agreements.

Exporters tended to use flat pricing to purchase and sell meat products. Ongoing arrangements were generally short and measured in weeks or months.

Exporters are generally brokers that do not hold the product. Nine of the 14 companies do not have warehouses and yet they did a very large dollar volume of business. Exporters tended to use flat pricing to purchase and sell meat products. Ongoing arrangements were generally short and measured in weeks or months.

Table 9-2. Weighted Responses for the Meat Exporter Survey (n = 14)

	Beef (n = 10)			Pork (n = 14)			Lamb (n = 4)		
	Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
1.2 What was your company's percentage of total dollar purchases of meat products during the past year by type of product category for each type of meat?									
a. Fresh or frozen	61.0	—[a]	—[a]	74.4	—	—	96.5	—	—
b. Processed	4.0	—	—	12.9	—	—	0.5	—	—
c. Variety meats and edible by-products	35.0	—	—	12.7	—	—	3.0	—	—
Total	100.0			100.0			100.0		

	Combination of Meat (n = 3)		
	Mean	Lower	Upper
a. Fresh or frozen	31.7	—	—
b. Processed	65.0	—	—
c. Variety meats and edible by-products	3.3	—	—
Total	100.0		

(continued)

A description of the notation used in the table headers is provided below.
n = number of respondents
% = estimated proportion weighted by the number of eligible business units
Mean = estimated mean weighted by the number of eligible business units

[a] We do not provide the 95% confidence intervals because we cannot make inferences to the population of meat exporters because of the small number of respondents.

Table 9-2. Weighted Responses for the Meat Exporter Survey (n = 14) (continued)

		n	Mean	Lower	Upper
1.3	What percentage of total dollar purchases of beef products during the past year were case ready?	14	0.0	—	—
1.4	What percentage of total dollar purchases of pork products during the past year were case ready?	14	7.1	—	—
1.5	What percentage of total dollar purchases of lamb products during the past year were case ready?	14	0.0	—	—
		n	**%**	**Lower**	**Upper**
1.6*	Which of the following types of certification apply for meat products purchased or received by your company?				
	1. None	4	28.6	—	—
	2. Kosher certification	D	14.3	—	—
	3. Halal certification	3	21.4	—	—
	4. Organic certification	D	14.3	—	—
	5. USDA Process Verified certification	6	42.9	—	—
	6. ISO certification	D	7.1	—	—
	7. Certified Angus Beef	3	21.4	—	—
	8. Other third-party certification of breed or livestock quality (not including Certified Angus Beef)	4	28.6	—	—
	9. Own-company certification of breed or livestock quality	D	7.1	—	—
	10. Buyer certification of breed or livestock quality	D	14.3	—	—
	11. Other	D	14.3	—	—

D = Results suppressed.
* Respondents could select multiple responses.

(continued)

Table 9-2. Weighted Responses for the Meat Exporter Survey (n = 14) (continued)

	Beef (n = 8)			Pork (n = 14)			Lamb (n = 4)		
	Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
1.7 What was your company's percentage of total dollar purchases of meat products during the past year by type of label for each type of meat?									
a. National or regional brand	53.1	—	—	52.1	—	—	75.0	—	—
b. Private label brand	7.5	—	—	13.9	—	—	0.0	—	—
c. Commodity product—not branded	39.4	—	—	33.9	—	—	25.0	—	—
Total	100.0			99.9†			100.0		

	Beef				Pork				Lamb			
	n	%	Lower	Upper	n	%	Lower	Upper	n	%	Lower	Upper
1.8* For meat products purchased during the past year with a national or regional brand label, what was the source of the brand name?												
1. Brand name used by packer or processor	6	100.0	—	—	9	100.0	—	—	3	100.0	—	—
2. Name of livestock producer organization	D	16.7	—	—	D	22.2	—	—	D	33.3	—	—
3. Name of certification organization	D	16.7	—	—	D	22.2	—	—	0	0.0	—	—
4. Other	D	16.7	—	—	0	0.0	—	—	0	0.0	—	—

D = Results suppressed.
† Total does not sum to 100% because of rounding.
* Respondents could select multiple responses.

(continued)

Table 9-2. Weighted Responses for the Meat Exporter Survey (n = 14) (continued)

		Mean (n = 14)	Lower	Upper
2.1	What was your company's percentage of total dollar purchases of beef, pork, and lamb products during the past year by type of supplier?			
	a. Packer	70.0	—	—
	b. Further processor	12.9	—	—
	c. Wholesaler or distributor	4.1	—	—
	d. Dealer or broker	9.1	—	—
	e. Importer	3.9	—	—
	f. Other	0.0	—	—
	Total	100.0		

		n	%	Lower	Upper
2.2*	What were the three most important reasons for purchasing meat products from your chosen suppliers during the past year?				
	1. Offers portion cut product for repackaging	D	7.1	—	—
	2. Has product traceability system in operation	D	14.3	—	—
	3. Is in electronic procurement system	0	0.0	—	—
	4. Provides product quality guarantees	4	28.6	—	—
	5. Provides food safety guarantees	D	14.3	—	—
	6. Has provided good quality product in the past	12	85.7	—	—
	7. Offers lower prices for given product specifications	7	50.0	—	—
	8. Offers products from specific packers or processors	D	14.3	—	—
	9. Offers case-ready product	0	0.0	—	—
	10. Meets exact product specifications	4	28.6	—	—
	11. Offers products with certifications (for example, Certified Angus Beef)	D	7.1	—	—
	12. Offers products from U.S. sources	0	0.0	—	—
	13. Is on approved list of suppliers	5	35.7	—	—
	14. Meets delivery time requirements	0	0.0	—	—
	15. Can meet all meat product needs	D	7.1	—	—
	16. Other	0	0.0	—	—

D = Results suppressed.
* Respondents could select multiple responses.

(continued)

Table 9-2. Weighted Responses for the Meat Exporter Survey (n = 14) (continued)

		n	%	Lower	Upper
2.3*	Which of the following terms were specified in purchase transactions for meat products made by your company during the past year?				
	1. Retail price maintenance	0	0.0	—	—
	2. Volume discounts	3	21.4	—	—
	3. Maximum or minimum purchase quantities	4	28.6	—	—
	4. Maximum or minimum pricing requirements	0	0.0	—	—
	5. Delivery lead times	6	42.9	—	—
	6. Product quality specifications	9	64.3	—	—
	7. Information sharing	D	7.1	—	—
	8. Slotting fees	0	0.0	—	—
	9. Inventory management	D	7.1	—	—
	10. Inventory cost control	0	0.0	—	—
	11. Advertising requirements	0	0.0	—	—
	12. Other	0	0.0	—	—
	13. None of the above	4	28.6	—	—
2.4*	For meat products purchased under an ongoing arrangement (oral or written) during the past year, what was the length of the arrangement?				
	1. Less than 1 month	6	46.2	—	—
	2. 1 to 2 months	7	53.8	—	—
	3. 3 to 5 months	6	46.2	—	—
	4. 6 to 11 months	D	15.4	—	—
	5. 1 to 2 years	D	15.4	—	—
	6. 3 to 5 years	0	0.0	—	—
	7. 6 to 10 years	0	0.0	—	—
	8. More than 10 years or evergreen	D	7.7	—	—
2.5*	For meat products purchased during the past year, how far in advance of delivery was the delivery scheduled?				
	1. Less than 3 days	6	42.9	—	—
	2. 4 to 6 days	6	42.9	—	—
	3. 1 to 2 weeks	4	28.6	—	—
	4. 3 to 4 weeks	4	28.6	—	—
	5. More than 1 month	5	35.7	—	—
			Mean (n = 14)	**Lower**	**Upper**
2.6	What types of pricing methods did your company use during the past year for purchasing meat products (% of total dollar purchases)?				
	a. Flat pricing		76.2	—	—
	b. Formula pricing (using another price as the base)		7.7	—	—
	c. Or-better pricing		8.6	—	—
	d. Floor and ceiling pricing		7.1	—	—
	e. Other		0.4	—	—
	Total		100.0		

D = Results suppressed.

* Respondents could select multiple responses.

(continued)

Table 9-2. Weighted Responses for the Meat Exporter Survey (n = 14) (continued)

	n	%	Lower	Upper
2.7 If flat pricing was used during the past year, did the purchase price include a premium (or overage) relative to the market price?				
1. Did not use flat pricing during the past year	D	15.4	—	—
2. Yes, for some meat product purchases (less than 50%)	3	23.1	—	—
3. Yes, for most meat product purchases (50% or more)	D	15.4	—	—
4. No	6	46.2	—	—
Total		100.1†		
2.8* For meat products purchased under an ongoing arrangement during the past year, how was the purchase price or base price benchmarked?				
1. Did not purchase under an ongoing arrangement	D	9.1	—	—
2. Did not benchmark purchase price or base price	D	9.1	—	—
3. Relative to market-reported price	9	81.8	—	—
4. Relative to internal rates of return	0	0.0	—	—
5. Relative to other bids or offers	3	27.3	—	—
6. Other	0	0.0	—	—
2.9* For meat products purchased during the past year using formula pricing, what was the base price of the formula?				
1. USDA publicly reported price	8	100.0	—	—
2. Futures price or price ratio	D	12.5	—	—
3. Retail price	0	0.0	—	—
4. Subscription service price (for example, Urner Barry)	3	37.5	—	—
5. Other	0	0.0	—	
2.10* For meat products purchased during the past year using formula pricing, what was the timing for the base price?				
1. Current market	5	62.5	—	—
2. Average of the previous week	5	62.5	—	—
3. Average of the previous 2 weeks	D	12.5	—	—
4. Average of the previous 3 weeks	0	0.0	—	—
5. Average of the previous month	0	0.0	—	—
6. Average of the previous 2 months or longer	0	0.0	—	—
7. Other	0	0.0	—	—
2.11* For meat products purchased during the past year using formula pricing, what was the basis of any premiums or discounts?				
1. USDA yield grade	D	25.0	—	—
2. USDA quality grade	D	25.0	—	—
3. Brand name	D	50.0	—	—
4. Availability/timing	D	50.0	—	—
5. Customer service	0	0.0	—	—
6. Other	0	0.0	—	—

D = Results suppressed.
† Total does not sum to 100% because of rounding.
* Respondents could select multiple responses.

(continued)

Table 9-2. Weighted Responses for the Meat Exporter Survey (n = 14) (continued)

			Mean (n = 14)	**Lower**	**Upper**
3.1	What was your company's percentage of total dollar sales or shipments of beef, pork, and lamb products during the past year by type of buyer or receiver?				
	a. Grocery stores, meat markets, warehouse clubs, or other retail establishments in the United States		15.9	—	—
	b. Restaurants, hotels, institutions, or other food service establishments in the United States		11.3	—	—
	c. Foreign distributors, retailers, or food service		63.9	—	—
	d. Other		0.0	—	—
	e. Food manufacturers in the United States *(write-in response)*		8.9	—	—
	Total		100.0		
		n	**%**	**Lower**	**Upper**
3.2*	Which of the following terms were specified in sales transactions for meat products made by your company during the past year?				
	1. Retail price maintenance	D	7.1	—	—
	2. Volume discounts	3	21.4	—	—
	3. Maximum or minimum sales quantities	4	28.6	—	—
	4. Maximum or minimum pricing requirements	D	7.1	—	—
	5. Delivery lead times	7	50.0	—	—
	6. Information sharing	D	7.1	—	—
	7. Slotting fees	0	0.0	—	—
	8. Inventory management	D	14.3	—	—
	9. Inventory cost control	0	0.0	—	—
	10. Advertising requirements	D	7.1	—	—
	11. Other	D	7.1	—	—
	12. None of the above	3	21.4	—	—
3.3*	For meat products sold under an ongoing arrangement (oral or written) during the past year, what was the length of the arrangement?				
	1. Less than 1 month	5	45.5	—	—
	2. 1 to 2 months	7	63.6	—	—
	3. 3 to 5 months	4	36.4	—	—
	4. 6 to 11 months	D	9.1	—	—
	5. 1 to 2 years	0	0.0	—	—
	6. 3 to 5 years	D	9.1	—	—
	7. 6 to 10 years	0	0.0	—	—
	8. More than 10 years or evergreen	D	9.1	—	—

D = Results suppressed.
* Respondents could select multiple responses.

(continued)

Table 9-2. Weighted Responses for the Meat Exporter Survey (n = 14) (continued)

		n	%	Lower	Upper
3.4*	For meat products sold during the past year, how far in advance of delivery was the delivery scheduled?				
	1. Less than 3 days	6	42.9	—	—
	2. 4 to 6 days	3	21.4	—	—
	3. 1 to 2 weeks	6	42.9	—	—
	4. 3 to 4 weeks	5	35.7	—	—
	5. More than 1 month	3	21.4	—	—
			Mean (n = 14)	**Lower**	**Upper**
3.5	What types of pricing methods did your company use during the past year for selling meat products (% of total dollar sales)?				
	a. Flat pricing		82.8	—	—
	b. Formula pricing (using another price as the base)		2.2	—	—
	c. Or-better pricing		7.9	—	—
	d. Floor and ceiling pricing		7.1	—	—
	e. Other		0.0	—	—
	Total		100.0		
		n	**%**	**Lower**	**Upper**
3.6	If flat pricing was used during the past year, did the sales price include a premium (or overage) relative to the market price?				
	1. Did not use flat pricing during the past year	D	18.2	—	—
	2. Yes, for some meat product sales (less than 50%)	4	36.4	—	—
	3. Yes, for most meat product sales (50% or more)	D	9.1	—	—
	4. No	4	36.4	—	—
	Total		100.1†		
3.7*	For meat products sold during the past year using formula pricing, what was the base price of the formula?				
	1. USDA publicly reported price	3	100.0	—	—
	2. Futures price or price ratio	0	0.0	—	—
	3. Retail price	0	0.0	—	—
	4. Subscription service price (for example, Urner Barry)	D	66.7	—	—
	5. Other	0	0.0	—	—
3.8*	For meat products sold during the past year using formula pricing, what was the timing for the base price?				
	1. Current market	D	66.7	—	—
	2. Average of the previous week	3	100.0	—	—
	3. Average of the previous 2 weeks	D	33.3	—	—
	4. Average of the previous 3 weeks	0	0.0	—	—
	5. Average of the previous month	0	0.0	—	—
	6. Average of the previous 2 months or longer	0	0.0	—	—
	7. Other	0	0.0	—	—

D = Results suppressed.

† Total does not sum to 100% because of rounding.

* Respondents could select multiple responses.

(continued)

Table 9-2. Weighted Responses for the Meat Exporter Survey (n = 14) (continued)

		n	%	Lower	Upper
3.9*	For meat products sold during the past year using formula pricing, what was the basis of any premiums or discounts?		(results suppressed)		
	1. USDA yield grade				
	2. USDA quality grade				
	3. Brand name				
	4. Availability/timing				
	5. Customer service				
	6. Other				
4.1	How many warehouses or distribution centers were owned by your company during the past year?				
	1. None	9	64.3	—	—
	2. One	3	21.4	—	—
	3. 2 to 9	D	14.3	—	—
	4. 10 to 99	0	0.0	—	—
	5. 100 to 499	0	0.0	—	—
	6. 500 to 999	0	0.0	—	—
	7. 1,000 or more	0	0.0	—	—
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
4.2	What was the approximate total number of people employed by your company during the past year?				
	a. Full time	10	53.3	—	—
	b. Part time	8	9.5	—	—
		n	**%**	**Lower**	**Upper**
4.3	What were your company's approximate total gross sales for fresh, frozen, and processed beef, pork, and lamb products during the past year?				
	1. Under $4,999,999	3	21.4	—	—
	2. $5,000,000 to $19,999,999	5	35.7	—	—
	3. $20,000,000 to $99,999,999	3	21.4	—	—
	4. $100,000,000 or more	3	21.4	—	—
	Total		99.9†		
4.4	What were your company's approximate total gross sales for all products during the past year?				
	1. Under $4,999,999	3	21.4	—	—
	2. $5,000,000 to $19,999,999	5	35.7	—	—
	3. $20,000,000 to $99,999,999	3	21.4	—	—
	4. $100,000,000 or more	3	21.4	—	—
	Total		99.9†		

D = Results suppressed.
† Total does not sum to 100% because of rounding.
* Respondents could select multiple responses.

9.3 RETAILERS

Table 9-3 provides weighted tabulations for all survey questions for food retailers (n = 136). These results are described briefly in this section.

9.3.1 Company Characteristics

Nearly 84% of companies owned one retail establishment, and 12% owned two to nine establishments. These companies employed an average of 121 full-time and 150 part-time employees in the past year. More than 62% had total sales of all products of less than $1 million, 25% had sales between $1 million and $10 million, and 12% had sales over $10 million. About 80% had total sales from fresh, frozen, and processed beef, pork, and lamb products of less than $1 million, 16% had meat sales between $1 million and $20 million, and the remaining 4% had meat sales over $20 million. Based on these characteristics, most respondents to the retailer survey represent relatively small establishments. (See Table 9-3, Questions 4.1, 4.2, 4.6, and 4.7.)

9.3.2 Meat Purchases by Retailers

The majority of purchases of beef, pork, lamb, and combination meats by retailers were fresh or frozen rather than processed product. Relatively few of the purchases were case-ready product.

The majority of purchases of beef, pork, lamb, and combination meats were fresh or frozen rather than processed product. Eighty-two percent of beef purchases, 79% of pork purchases, and 90% of lamb purchases were fresh. Combination product was 57% fresh or frozen and 43% processed. However, relatively few of the purchases were case-ready product: 15% of purchases each for beef and pork and 6% for lamb. (See Table 9-3, Questions 1.2 through 1.5.)

More than 70% of retailers purchased meat products that were certified. The two most cited types of certification programs were USDA Process Verified (38%)[5] and CAB (38%). Other third-party certification of livestock breed or quality (15%) and organic certification (12%) were used by fewer companies. (See Table 9-3, Question 1.6.)

Eighty-five percent or more of meat products purchased by retailers were a branded product of some type. For beef, 81%

[5] The percentage of retailers that reported purchasing USDA Process Verified meat is high relative to the amount of meat that we believe is USDA Process Verified; however, USDA does not track process verified product volume. Respondents may have been confusing this with USDA inspection.

of purchases were national or regional brands, 9% were private-label brands, and 10% were commodity products (i.e., no brand). For pork, 85% of purchases were national or regional brands, 9% were private-label brands, and 7% were commodity products. For lamb, 72% of purchases were national or regional brands, 13% were private-label brands, and 15% were commodity products. In most cases, the brand was that of a packer or processor. (See Table 9-3, Questions 1.7 and 1.8.)

Because most respondents represented mostly small establishments, more than 80% of meat purchases by retailers were from wholesalers or distributors. Purchases directly from packers represented only 13% of purchases. Dealers, processors, and importers accounted for a small percentage of purchases. Relatively little meat case space received slotting fees from suppliers, but fees were more prevalent for fresh than frozen product. (See Table 9-3, Questions 2.1 through 2.4.)

The three most cited reasons given by retailers for selecting their chosen suppliers were (1) “Has provided good quality product in the past” (63%), (2) “Provides product quality guarantees” (46%), and (3) “Can meet all meat product needs” (45%). Less than 20% of companies selected responses addressing delivery, product specifications, sources, traceability, and other services or features. (See Table 9-3, Question 2.5.)

Retailers specified or were required to include a variety of terms in purchase transactions for meat products. The most common terms were product quality specifications (45%) and retail price maintenance (34%). These terms require the supplier to meet product specifications and help the retailer manage price risk on the product supplied. Nearly one-fourth of companies did not require specific terms on their purchase transactions. (See Table 9-3, Question 2.6.)

Relatively few retailers had ongoing arrangements with their suppliers. For those that did have an ongoing arrangement, the agreements were either long term or very short. About 41% of companies had agreements that were more than 10 years or evergreen, and 35% of companies had agreements that lasted less than 1 month. Delivery of product was primarily scheduled within a short time frame. Nearly 86% of companies scheduled delivery for within 3 days. (See Table 9-3, Questions 2-7 and 2.8.)

The most common pricing method for purchasing meat by retailers was flat pricing.

The most common pricing method for purchasing meat by retailers was flat pricing (53% of purchases). Formula pricing was used for 21% of purchases, and or-better pricing and floor and ceiling pricing were each used for 12% of purchases. Flat pricing arrangements sometimes included a premium (or overage) relative to market prices. For companies that purchased under an ongoing arrangement, the purchase price was generally benchmarked relative to market-reported prices. Formula-priced meat purchases were most often based on retail prices (62% of companies) or USDA-reported prices (35%). Companies using formula prices used the current market price (85% of companies) and the previous week's average price (20%) as the timing for the base period. Formula price premiums or discounts were based on several factors including USDA grades, brand name, availability/timing, and service. (See Table 9-3, Questions 2.9 through 2.14.)

Retailers identified price and appearance as the key factors affecting consumer purchases of beef, pork, and lamb.

Retailers were asked to identify the three most important factors that affect consumer purchases of beef, pork, and lamb. The factors most often cited were price per pound (60% of companies), appearance (56%), fat trim (41%), and cut of meat (37%). (See Table 9-3, Question 3.1.)

Retailers reported selling 23% of fresh beef and pork volume at a discounted or featured price, while only 4% of fresh lamb was discounted. A smaller share of frozen product was sold at a discounted or feature price: 12% for beef, 10% for pork, and 2% for lamb. The three most cited reasons for selling fresh meat at discounted or featured prices tended to be consumer focused and included "Bring new customers into the store" (71%), "Reward loyal customers" (59%), and "Pass on discounts offered by suppliers" (52%). Responses were similar for frozen product. (See Table 9-3, Questions 3.2 through 3.5.)

Retailers' target rate of return or profit on meat sales during the last year ranged from between 1% and 5% to more than 30%. One-half had a target rate of return of 26% or higher, and 23% had a target rate of return of 21% to 25%. Despite their profit targets, retailers reported discarding or discounting a significant amount of the meat they purchased. These companies reported that 8% of meat purchased passed the "sell-by" date or was discarded because of spoilage, and 78%

reported selling meat at a discount to the list price. The discounts on meat products were reported to be 11% to 15% (21% of companies), 6% to 10% (20%), 16% to 20% (14%), more than 20% (14%), and 1% to 5% (9%). (See Table 9-3, Questions 4.3 through 4.5.)

9.3.3 Retailer Survey Summary

The retailers surveyed were predominately small, independent stores where fresh sales of beef, pork, and lamb made up a large portion of their gross sales. The product sold is mostly under a national or regional brand typically belonging to a packer or processor. More than 80% of retailer purchases were from a wholesaler or distributor, and only 13% were directly from the packer.

Retailers purchased meat from their chosen suppliers because the suppliers had a history of good quality product and offered quality product guarantees.

Retailers purchased meat from their chosen suppliers because the suppliers had a history of good quality product and offered product quality guarantees. Common terms of purchase transactions included product specifications and retail price maintenance. There were relatively few marketing agreements, but those that were used were either long term or very short. However, most product was scheduled for delivery within 3 days.

Flat pricing was the most common pricing method used by retailers to purchase meat. When formula pricing was used, it was more often tied to retail prices and, to a lesser extent, to USDA-reported prices. Premiums and discounts were based on USDA grades, brands, and service. Retailers identified price and appearance as the key factors affecting consumer purchases of beef, pork, and lamb. While retailers had target profit margins, a relatively high percentage of meat was sold at discount prices. The reasons given for discounts were to attract new customers and to reward loyal customers.

Table 9-3. Weighted Responses for the Food Retailer Survey (n = 136)

	Beef (n = 125)			Pork (n = 118)			Lamb (n = 59)		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
1.2 What was your company's percentage of total dollar purchases of meat products during the past year by type of product category for each type of meat?									
a. Fresh or frozen	81.8	76.7	87.0	78.6	72.9	84.3	89.9	81.6	98.2
b. Processed	18.2	13.0	23.3	21.4	15.7	27.1	10.1	1.8	18.4
Total	100.0			100.0			100.0		

	Combination of Meat (n = 103)		
	Mean	**Lower**	**Upper**
a. Fresh or frozen	56.8	48.3	65.2
b. Processed	43.2	34.8	51.7
Total	100.0		

(continued)

A description of the notation used in the table headers is provided below.
n = number of respondents
% = estimated proportion weighted by the number of eligible business units
Mean = estimated mean weighted by the number of eligible business units
Lower = lower bound of the 95% confidence interval for the weighted proportion or mean
Upper = upper bound of the 95% confidence interval for the weighted proportion or mean

Table 9-3. Weighted Responses for the Food Retailer Survey (n = 136) (continued)

		n	Mean	Lower	Upper
1.3	What percentage of total dollar purchases of beef products during the past year were case ready?	133	14.6	9.2	20.0
1.4	What percentage of total dollar purchases of pork products during the past year were case ready?	132	14.8	9.3	20.3
1.5	What percentage of total dollar purchases of lamb products during the past year were case ready?	127	6.0	2.1	9.9
		n	**%**	**Lower**	**Upper**
1.6*	Which of the following types of certification apply for meat products purchased or received by your company?				
	1. None	31	27.5	19.2	35.9
	2. Kosher certification	15	6.5	2.0	11.0
	3. Halal certification	6	4.5	0.6	8.3
	4. Organic certification	19	11.8	5.8	17.7
	5. USDA Process Verified certification	50	38.4	29.3	47.5
	6. ISO certification	D	1.8	0.0	4.3
	7. Certified Angus Beef	53	37.7	28.6	46.7
	8. Other third-party certification of breed or livestock quality (not including Certified Angus Beef)	24	14.5	7.9	21.0
	9. Own-company certification of breed or livestock quality	4	2.7	0.0	5.7
	10. Buyer certification of breed or livestock quality	7	3.7	0.2	7.1
	11. Other	D	0.9	0.0	2.7

D = Results suppressed.

* Respondents could select multiple responses.

(continued)

Table 9-3. Weighted Responses for the Food Retailer Survey (n = 136) (continued)

	Beef (n = 120)			Pork (n = 121)			Lamb (n = 58)		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
1.7 What was your company's percentage of total dollar purchases of meat products during the past year by type of label for each type of meat?									
a. National or regional brand	81.1	74.4	87.9	84.8	78.7	90.9	72.0	59.7	84.4
b. Private label brand	9.0	4.3	13.6	8.6	4.1	13.1	13.0	4.0	21.9
c. Commodity product—not branded	9.9	4.5	15.3	6.6	2.2	11.0	15.0	5.0	24.9
Total	100.0			100.0			100.0		

	Beef				Pork				Lamb			
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
1.8* For meat products purchased during the past year with a national or regional brand label, what was the source of the brand name?												
1. Brand name used by packer or processor	81	95.8	91.2	100.0	84	97.2	93.5	100.0	31	88.6	75.7	100.0
2. Name of livestock producer organization	15	15.0	6.7	23.2	10	9.5	2.8	16.3	6	19.2	3.3	35.0
3. Name of certification organization	15	11.1	3.9	18.3	6	5.5	0.2	10.7	D	3.8	0.0	11.5
4. Other	D	2.7	0.0	6.4	3	4.0	0.0	8.6	0	0.0	NA	NA

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 9-3. Weighted Responses for the Food Retailer Survey (n = 136) (continued)

			Mean (n = 128)	Lower	Upper
2.1	What was your company's percentage of total dollar purchases of beef, pork, and lamb products during the past year by type of supplier?				
	a. Packer		13.0	7.6	18.5
	b. Further processor		1.6	<0	3.3
	c. Wholesaler or distributor		82.1	76.0	88.2
	d. Dealer or broker		2.0	0.6	3.4
	e. Importer		0.2	0.0	0.4
	f. Other		0.0	0.0	0.0
	g. Other retailers *(write-in response)*		1.0	<0	2.8
	Total		99.9†		
		n	**Mean**	**Lower**	**Upper**
2.2	During the past year, what percentage of your company's case space for beef products received slotting fees from suppliers?				
	a. Percentage of fresh product case space	130	8.6	3.9	13.3
	b. Percentage of frozen product case space	122	3.4	0.5	6.2
2.3	During the past year, what percentage of your company's case space for pork products received slotting fees from suppliers?				
	a. Percentage of fresh product case space	131	7.9	3.3	12.4
	b. Percentage of frozen product case space	122	3.4	0.6	6.2
2.4	During the past year, what percentage of your company's case space for lamb products received slotting fees from suppliers?				
	a. Percentage of fresh product case space	123	1.1	<0	3.0
	b. Percentage of frozen product case space	115	1.0	<0	2.9

† Total does not sum to 100% because of rounding.

(continued)

Table 9-3. Weighted Responses for the Food Retailer Survey (n = 136) (continued)

		n	%	Lower	Upper
2.5*	What were the three most important reasons for purchasing meat products from your chosen suppliers during the past year?				
	1. Offers portion cut product for repackaging	6	4.2	0.6	7.8
	2. Has product traceability system in operation	10	7.6	2.8	12.4
	3. Is in electronic procurement system	0	0.0	NA	NA
	4. Provides product quality guarantees	63	46.3	37.2	55.3
	5. Provides food safety guarantees	29	21.0	13.7	28.4
	6. Has provided good quality product in the past	80	62.9	54.1	71.6
	7. Offers lower prices for given product specifications	34	26.8	18.8	34.9
	8. Offers products from specific packers or processors	19	15.9	9.3	22.5
	9. Offers case ready product	11	6.0	1.7	10.2
	10. Meets exact product specifications	15	9.3	4.1	14.6
	11. Offers products with certifications (for example, Certified Angus Beef)	29	20.2	13.0	27.5
	12. Offers products from U.S. sources	8	5.9	1.6	10.2
	13. Is on approved list of suppliers	6	5.0	1.1	9.0
	14. Meets delivery time requirements	25	18.5	11.5	25.5
	15. Can meet all meat product needs	61	45.4	36.4	54.4
	16. Other	D	0.8	0.0	2.5
2.6*	Which of the following terms were specified in purchase transactions for meat products made by your company during the past year?				
	1. Retail price maintenance	44	34.2	25.5	42.9
	2. Volume discounts	42	27.6	19.4	35.7
	3. Maximum or minimum purchase quantities	40	28.3	20.1	36.5
	4. Maximum or minimum pricing requirements	13	8.6	3.5	13.7
	5. Delivery lead times	38	24.2	16.4	32.0
	6. Product quality specifications	63	44.6	35.5	53.7
	7. Information sharing	13	9.4	4.1	14.8
	8. Slotting fees	6	1.8	0.0	4.2
	9. Inventory management	9	6.0	1.7	10.4
	10. Inventory cost control	9	6.8	2.2	11.5
	11. Advertising requirements	19	11.3	5.5	17.0
	12. Other	0	0.0	NA	NA
	13. None of the above	29	24.7	16.8	32.6

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 9-3. Weighted Responses for the Food Retailer Survey (n = 136) (continued)

		n	%	Lower	Upper
2.7*	For meat products purchased under an ongoing arrangement (oral or written) during the past year, what was the length of the arrangement?				
	1. Less than 1 month	13	35.1	18.4	51.7
	2. 1 to 2 months	4	8.8	0.0	18.7
	3. 3 to 5 months	D	0.1	0.0	0.3
	4. 6 to 11 months	3	3.1	0.0	9.0
	5. 1 to 2 years	6	9.1	0.0	18.9
	6. 3 to 5 years	0	0.0	NA	NA
	7. 6 to 10 years	3	8.7	0.0	18.6
	8. More than 10 years or evergreen	19	41.3	24.2	58.5
2.8*	For meat products purchased during the past year, how far in advance of delivery was the delivery scheduled?				
	1. Less than 3 days	108	85.6	79.3	91.9
	2. 4 to 6 days	24	15.1	8.7	21.6
	3. 1 to 2 weeks	23	9.5	4.3	14.7
	4. 3 to 4 weeks	14	6.8	2.3	11.3
	5. More than 1 month	6	1.8	0	4.1

		Mean (n = 123)	Lower	Upper
2.9	What types of pricing methods did your company use during the past year for purchasing meat products (% of total dollar purchases)?			
	a. Flat pricing	53.2	44.5	61.9
	b. Formula pricing (using another price as the base)	20.7	13.4	28.0
	c. Or-better pricing	12.4	6.8	18.0
	d. Floor and ceiling pricing	12.3	6.4	18.3
	e. Other	1.4	<0	3.4
	Total	100.0		

		n	%	Lower	Upper
2.10	If flat pricing was used during the past year, did the purchase price include a premium (or overage) relative to the market price?				
	1. Did not use flat pricing during the past year	49	43.0	33.6	52.3
	2. Yes, for some meat product purchases (less than 50%)	22	15.7	8.8	22.6
	3. Yes, for most meat product purchases (50% or more)	12	10.1	4.4	15.8
	4. No	41	31.3	22.5	40.1
	Total		100.1†		

D = Results suppressed.
NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.
* Respondents could select multiple responses.

(continued)

Table 9-3. Weighted Responses for the Food Retailer Survey (n = 136) (continued)

	n	%	Lower	Upper
2.11* For meat products purchased under an ongoing arrangement during the past year, how was the purchase price or base price benchmarked?				
1. Did not purchase under an ongoing arrangement	92	77.3	69.5	85.2
2. Did not benchmark purchase price or base price	6	4.5	0.6	8.4
3. Relative to market-reported price	23	13.7	7.3	20.1
4. Relative to internal rates of return	4	2.7	0.0	5.8
5. Relative to other bids or offers	12	6.4	1.9	11.0
6. Other	D	0.9	0.0	2.7
2.12* For meat products purchased during the past year using formula pricing, what was the base price of the formula?				
1. USDA publicly reported price	23	35.0	18.8	51.2
2. Futures price or price ratio	5	6.0	0.0	13.9
3. Retail price	23	62.1	45.6	78.5
4. Subscription service price (for example, Urner Barry)	4	3.1	0.0	8.8
5. Other	D	2.8	0.0	8.5
2.13* For meat products purchased during the past year using formula pricing, what was the timing for the base price?				
1. Current market	47	85.4	74.4	96.5
2. Average of the previous week	16	20.0	7.6	32.4
3. Average of the previous 2 weeks	D	2.5	0.0	7.3
4. Average of the previous 3 weeks	D	0.1	0.0	0.3
5. Average of the previous month	D	2.5	0.0	7.3
6. Average of the previous 2 months or longer	3	2.6	0.0	7.4
7. Other	0	0.0	NA	NA
2.14* For meat products purchased during the past year using formula pricing, what was the basis of any premiums or discounts?				
1. USDA yield grade	13	35.8	17.2	54.4
2. USDA quality grade	15	42.9	23.7	62.1
3. Brand name	17	43.1	23.9	62.3
4. Availability/timing	12	32.2	14.1	50.4
5. Customer service	5	17.7	2.8	32.5
6. Other	D	0.1	0.0	0.4

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 9-3. Weighted Responses for the Food Retailer Survey (n = 136) (continued)

	n	%	Lower	Upper
3.1* In your opinion, what are the three most important factors that affect consumer purchases of beef, pork, and lamb products in stores owned by your company?				
1. Fat trim	51	41.2	32.3	50.0
2. Recipes or cooking instructions on label	D	0.9	0.0	2.5
3. Case ready packaging	8	5.8	1.6	10.0
4. Cut of meat	52	37.2	28.5	45.9
5. Package size	15	10.8	5.2	16.3
6. Size of cuts	11	9.0	3.9	14.2
7. Featured (discounted) product	32	22.4	14.9	29.8
8. Visual appearance (color, marbling, etc.)	81	56.3	47.4	65.3
9. Food safety assurances on label	10	8.2	3.3	13.2
10. Shelf life (use-by date)	19	12.5	6.5	18.4
11. Produced in United States	9	7.4	2.7	12.1
12. Quality assurances on label	11	8.3	3.3	13.2
13. Brand name of product	17	13.2	7.1	19.3
14. Price per pound	81	59.5	50.7	68.3
15. Resealable packaging	3	2.5	0.0	5.3
16. Other	D	1.6	0.0	3.9
	n	**Mean**	**Lower**	**Upper**
3.2 During the past year, what percentage of your company's total pounds of beef products were sold at a discounted or featured price?				
a. Percentage of fresh product pounds sold	130	23.1	18.1	28.0
b. Percentage of frozen product pounds sold	121	11.5	7.4	15.5
3.3 During the past year, what percentage of your company's total pounds of pork products were sold at a discounted or featured price?				
a. Percentage of fresh product pounds sold	130	23.1	17.9	28.2
b. Percentage of frozen product pounds sold	115	9.5	6.1	12.9
3.4 During the past year, what percentage of your company's total pounds of lamb products were sold at a discounted or featured price?				
a. Percentage of fresh product pounds sold	124	4.3	1.0	7.5
b. Percentage of frozen product pounds sold	111	1.6	<0	3.8

D = Results suppressed.
* Respondents could select multiple responses.

(continued)

Table 9-3. Weighted Responses for the Food Retailer Survey (n = 136) (continued)

		n	%	Lower	Upper
3.5a*	What were the three most important reasons for selling fresh meat products at a discounted or featured price during the past year?				
	a. Bring new customers into the store	75	71.4	61.8	81.0
	b. Reward loyal customers	61	58.7	48.2	69.2
	c. Reduce excess inventory	27	30.8	21.0	40.7
	d. Pass on discounts offered by suppliers	54	51.8	41.2	62.4
	e. Sell product with nearing expiration dates	23	24.1	15.0	33.2
	f. Offer volume discount for larger size packages	29	29.8	20.1	39.6
	g. Other	D	1.1	0.0	3.4
	h. Increase sales	D	1.2	0.0	3.5
3.5b*	What were the three most important reasons for selling frozen meat products at a discounted or featured price during the past year?				
	a. Bring new customers into the store	46	55.1	42.5	67.7
	b. Reward loyal customers	38	46.9	34.3	59.5
	c. Reduce excess inventory	22	33.6	21.7	45.6
	d. Pass on discounts offered by suppliers	32	35.8	23.7	47.9
	e. Sell product with nearing expiration dates	18	27.2	16.0	38.5
	f. Offer volume discount for larger size packages	18	27.2	16.0	38.5
	g. Other	0	0.0	NA	NA
	h. Increase sales	D	1.7	0.0	4.8

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 9-3. Weighted Responses for the Food Retailer Survey (n = 136) (continued)

		n	%	Lower	Upper
4.1	How many retail establishments were owned by your company during the past year?				
	1. One	102	83.9	77.4	90.4
	2. 2 to 9	14	11.5	5.8	17.3
	3. 10 to 99	12	2.8	0.0	5.5
	4. 100 to 499	7	1.0	0.0	2.6
	5. 500 to 999	0	0.0	NA	NA
	6. 1,000 or more	D	0.8	0.0	2.4
	Total		100.0		
		n	**Mean**	**Lower**	**Upper**
4.2	What was the approximate total number of people employed by your company during the past year?				
	a. Full time	122	120.7	28.6	212.8
	b. Part time	110	150.2	<0	313.1
		n	**%**	**Lower**	**Upper**
4.3	What was the average discount on the list price for meat products sold by your company during the past year?				
	1. 0%	27	21.6	14.2	29.0
	2. 1% to 5%	11	9.1	3.9	14.3
	3. 6% to 10%	24	19.9	12.7	27.1
	4. 11% to 15%	28	20.8	13.5	28.2
	5. 16% to 20%	20	14.2	7.9	20.5
	6. More than 20%	25	14.4	8.1	20.6
	Total		100.0		
4.4	What was your company's target rate of return or profit on meat product sales during the past year?				
	1. 1% to 5%	11	9.3	4.0	14.6
	2. 6% to 10%	8	5.9	1.6	10.2
	3. 11% to 15%	8	5.9	1.6	10.2
	4. 16% to 20%	8	5.9	1.6	10.2
	5. 21% to 25%	31	22.9	15.3	30.6
	6. 26% to 30%	50	37.3	28.5	46.1
	7. More than 30%	16	12.7	6.6	18.8
	Total		99.9†		
		n	**Mean**	**Lower**	**Upper**
4.5	What percentage of meat products purchased by your company during the past year passed the sell-by date or were discarded because of spoilage?	133	8.1	4.5	11.8

D = Results suppressed.
NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.

(continued)

Table 9-3. Weighted Responses for the Food Retailer Survey (n = 136) (continued)

		n	%	Lower	Upper
4.6	What were your company's approximate total gross sales for fresh, frozen, and processed beef, pork, and lamb products during the past year?				
	1. Under $99,999	39	33.5	24.8	42.2
	2. $100,000 to $499,999	38	32.6	24.0	41.2
	3. $500,000 to $999,999	16	13.7	7.4	20.1
	4. $1,000,000 to $4,999,999	12	10.3	4.7	15.9
	5. $5,000,000 to $19,999,999	7	6.0	1.6	10.4
	6. $20,000,000 to $49,999,999	3	0.1	0.0	0.2
	7. $50,000,000 to $99,999,999	7	1.1	0.0	2.8
	8. $100,000,000 to $499,999,999	7	2.7	0.0	5.6
	9. $500,000,000 to $999,999,999	0	0.0	NA	NA
	10. $1,000,000,000 or more	0	0.0	NA	NA
	Total		100.0		
4.7	What were your company's approximate total gross sales for all products during the past year?				
	1. Under $99,999	21	17.7	10.8	24.7
	2. $100,000 to $499,999	34	28.7	20.4	36.9
	3. $500,000 to $999,999	19	16.0	9.3	22.7
	4. $1,000,000 to $2,499,999	17	14.3	8.0	20.7
	5. $2,500,000 to $4,999,999	5	4.2	0.6	7.9
	6. $5,000,000 to $9,999,999	8	6.8	2.2	11.3
	7. $10,000,000 to $19,999,999	3	2.5	0.0	5.4
	8. $20,000,000 to $49,999,999	3	1.7	0.0	4.1
	9. $50,000,000 to $99,999,999	4	3.4	0.1	6.7
	10. $100,000,000 to $499,999,999	5	1.8	0.0	4.1
	11. $500,000,000 to $999,999,999	5	1.0	0.0	2.6
	12. $1,000,000,000 or more	7	1.8	0.0	4.2
	Total		99.9†		

NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.

9.4 FOOD SERVICE OPERATORS

Table 9-4 provides weighted tabulations for all survey questions for food service operators (n = 108). Food service operators include restaurants and other institutions that purchase and serve meat products. These survey results are described briefly in this section.

9.4.1 Company Characteristics

About 68% of companies owned 1 food service establishment, 20% owned 2 to 9 establishments, 8% owned 10 to 99 establishments, and 3% owned 100 or more establishments. On average, these companies had 353 full-time and 114 part-time employees. Approximately one-third of companies had beef, pork, and lamb sales of less than $100,000 in the past year. Another one-third had sales between $100,000 and $499,999, and 14% had sales between $500,000 and $999,999 annually. The remaining 17% had meat sales of more than $1 million per year. Based on these characteristics, most respondents to the food service operator survey represent relatively small establishments. (See Table 9-4, Questions 3.1 through 3.3.)

9.4.2 Meat Purchases by Food Service Operators

Food service companies purchased primarily fresh or frozen beef, pork, and lamb rather than processed meat (about 80% of purchases were fresh or frozen and 20% were processed). Purchases of combination meats were about 60% for fresh or frozen product and 40% for processed meat. Nearly 80% of companies purchased meat that was certified under some type of program. The most cited types of certification programs were the USDA Process Verified[6] (49% of companies) and CAB (39%) programs. National or regional brands were the dominate types of products, with 69%, 81%, and 77% for beef, pork, and lamb purchases, respectively. Private-label brands made up 24%, 14%, and 18% of purchases for beef, pork, and lamb, respectively. The source of the national or regional brand was most often a packer or processor (95% to 100% of companies). (See Table 9-4, Questions 1.2 through 1.5.)

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[6] The percentage of food service operators that reported purchasing USDA Process Verified meat is high relative to the amount of meat that we believe is USDA Process Verified; however, USDA does not track process verified product volume. Respondents may have been confusing this with USDA inspection.

Food service companies responding to the survey purchased 81% of their beef, pork, and lamb from a wholesaler or distributor, and 11% of purchases were directly from a packer. Companies' reasons for choosing the suppliers they did were relatively diverse, but mostly related to product quality. The most cited responses were (1) "Has provided good quality product in the past" (57%), (2) "Provides product quality guarantees" (48%), and (3) "Can meet all meat product needs" (34%). The following responses were selected by 18% to 24% of companies: "Offers lower prices for given product specifications," "Provides food safety guarantees," "Offers portion cut product," "Meets delivery time requirements," and "Meets exact product specifications." Thus, price, food safety, and product specifications are also important. (See Table 9-4, Questions 2.1 and 2.2.)

The terms specified in purchase transactions for food service operators were diverse. Product quality specifications (58% of companies), volume discounts (40%), delivery lead times (32%), and maximum and minimum purchase quantities (27%) were the most cited terms. Other responses dealing with pricing, inventory management, and cost were selected by less than 20% of companies. (See Table 9-4, Question 2.3.)

Relatively few food service companies had ongoing purchasing arrangements. Of those that reported having ongoing arrangements, nearly 60% of companies had agreements that were less than 1 year, 24% were 1 to 2 years, 6% were 6 to 10 years, and 29% were long term (more than 10 years or evergreen). Delivery scheduling, however, was short term. Nearly 80% of companies scheduled deliveries for within 3 days, 17% within 4 to 6 days, and 12% within 1 to 2 weeks. (See Table 9-4, Questions 2.4 and 2.5.)

Flat pricing was the most common method of pricing among food service companies, making up 48% of the product purchased.

Flat pricing was the most common method of pricing among food service companies, making up 48% of the product purchased. Or-better (21%), floor and ceiling (16%), and formula (14%) were the next most common pricing methods. For companies that used flat pricing, some purchases included a premium or overage relative to the market price. Without this type of adjustment, the supplier bears more market risk. For companies that purchased products under an ongoing arrangement, most benchmarked the price relative to a market-reported price. Prices were also benchmarked relative to other bids and internal rates of returns, and still others did not benchmark the price. (See Table 9-4, Questions 2.6 through 2.8.)

Formula pricing was used by few food service companies; for most of these companies (61%), the base price was tied to a retail price. From a timing standpoint, most companies (79%) used the current market price. Other time frames were used less often. Few companies reported using premiums or discounts with formula pricing, but those that did based them on USDA quality grade, brand name, or availability/timing of product. (See Table 9-4, Questions 2.9 through 2.11.)

9.4.3 Food Service Operator Survey Summary

Product quality history and guarantees were the primary motivators for food service companies choosing their suppliers, and product specifications and volume discounts were often written into purchase agreements.

Compared with the other downstream segments, food service companies tended to have smaller gross sales but more employees. A relatively high percentage of the meat products purchased were from a certified program and had a national or regional brand. At the same time, food service companies purchased most of their product from wholesalers or distributors, and only slightly more than 10% of product was purchased from packers. Product quality history and guarantees were the primary motivators for food service companies choosing their suppliers, and product specifications and volume discounts were often written into purchase agreements. There were relatively few ongoing arrangements, but the ones that existed tended to be longer than in other downstream segments, with 10 or more years representing nearly 30% of these agreements. Flat pricing was the most common pricing method identified, and many transactions included market adjustment terms. Formula pricing was used less often, but was typically tied to retail prices.

Table 9-4. Weighted Responses for the Food Service Operator Survey (n = 108)

		Beef (n = 101)			Pork (n = 89)			Lamb (n = 27)		
		Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
1.2	What was your company's percentage of total dollar purchases of meat products during the past year by type of product category for each type of meat?									
	a. Fresh or frozen	76.8	69.8	83.7	78.9	71.3	86.4	78.6	61.3	95.9
	b. Processed	23.2	16.3	30.2	21.1	13.6	28.7	21.4	4.1	38.7
	Total	100.0			100.0			100.0		

		Combination of Meat (n = 59)		
		Mean	Lower	Upper
	a. Fresh or frozen	60.3	48.5	72.2
	b. Processed	39.7	27.8	51.5
	Total	100.0		

(continued)

A description of the notation used in the table headers is provided below.
n = number of respondents
% = estimated proportion weighted by the number of eligible business units
Mean = estimated mean weighted by the number of eligible business units
Lower = lower bound of the 95% confidence interval for the weighted proportion or mean
Upper = upper bound of the 95% confidence interval for the weighted proportion or mean

Table 9-4. Weighted Responses for the Food Service Operator Survey (n = 108) (continued)

	n	%	Lower	Upper
1.3* Which of the following types of certification apply for meat products purchased or received by your company?				
1. None	22	21.9	13.1	30.7
2. Kosher certification	6	4.7	0.2	9.1
3. Halal certification	4	3.5	0.0	7.4
4. Organic certification	4	4.6	0.1	9.0
5. USDA Process Verified certification	49	49.4	38.8	60.1
6. ISO certification	7	6.9	1.5	12.3
7. Certified Angus Beef	38	39.1	28.7	49.5
8. Other third-party certification of breed or livestock quality (not including Certified Angus Beef)	8	8.1	2.3	13.8
9. Own-company certification of breed or livestock quality	5	4.6	0.2	9.1
10. Buyer certification of breed or livestock quality	D	1.1	0.0	3.4
11. Other	D	2.3	0.0	5.5

D = Results suppressed.
* Respondents could select multiple responses.

(continued)

Table 9-4. Weighted Responses for the Food Service Operator Survey (n = 108) (continued)

	Beef (n = 105)			Pork (n = 94)			Lamb (n = 28)		
	Mean	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**
1.4 What was your company's percentage of total dollar purchases of meat products during the past year by type of label for each type of meat?									
a. National or regional brand	68.8	60.9	76.8	81.3	74.0	88.7	77.2	62.1	92.2
b. Private label brand	23.8	16.6	31.0	14.4	8.2	20.6	17.5	3.9	31.2
c. Commodity product—not branded	7.4	2.9	11.9	4.3	0.5	8.1	5.3	<0	13.8
Total	100.0			100.0			100.0		

	Beef				Pork				Lamb			
	n	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**	**n**	**%**	**Lower**	**Upper**
1.5* For meat products purchased during the past year with a national or regional brand label, what was the source of the brand name?												
1. Brand name used by packer or processor	79	94.7	89.5	99.9	68	98.4	95.1	100.0	18	100.0	100.0	100.0
2. Name of livestock producer organization	8	9.3	2.6	16.0	4	5.0	0.0	10.5	D	6.2	0.0	19.4
3. Name of certification organization	17	18.7	9.8	27.7	5	3.4	0.0	8.0	D	0.2	0.0	0.7
4. Other	D	0.0	0.0	0.1	D	1.7	0.0	4.9	D	6.2	0.0	19.4

D = Results suppressed.

* Respondents could select multiple responses.

(continued)

Table 9-4. Weighted Responses for the Food Service Operator Survey (n = 108) (continued)

			Mean (n = 108)	Lower	Upper
2.1	What were your company's percentage of total dollar purchases of beef, pork, and lamb products during the past year by type of supplier?				
	a. Packer		10.8	5.5	16.0
	b. Further processor		4.5	1.1	7.9
	c. Wholesaler or distributor		80.7	73.9	87.5
	d. Dealer or broker		2.7	<0	5.6
	e. Importer		0.2	<0	0.5
	f. Other		0.0	0.0	0.0
	g. Grocery stores *(write-in response)*		1.2	<0	3.2
	Total		100.1†		
		n	**%**	**Lower**	**Upper**
2.2*	What were the three most important reasons for purchasing meat products from your chosen suppliers during the past year?				
	1. Offers portion cut product	25	20.9	12.7	29.2
	2. Has product traceability system in operation	9	8.3	2.7	13.9
	3. Is in electronic procurement system	0	0.0	NA	NA
	4. Provides product quality guarantees	50	47.9	37.7	58.0
	5. Provides food safety guarantees	26	23.0	14.4	31.5
	6. Has provided good quality product in the past	59	57.2	47.2	67.2
	7. Offers lower prices for given product specifications	29	24.1	15.4	32.7
	8. Offers products from specific packers or processors	11	11.4	5.0	17.9
	9. Offers case ready product	8	8.3	2.7	13.9
	10. Meets exact product specifications	23	17.9	10.1	25.6
	11. Offers products with certifications (e.g., Certified Angus Beef)	16	14.6	7.4	21.7
	12. Offers products from U.S. sources	6	6.2	1.3	11.1
	13. Is on approved list of suppliers	5	3.2	0.0	6.7
	14. Meets delivery time requirements	19	19.7	11.6	27.8
	15. Can meet all meat product needs	35	34.3	24.7	43.9
	16. Other	0	0.0	NA	NA

NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.
* Respondents could select multiple responses.

(continued)

Table 9-4. Weighted Responses for the Food Service Operator Survey (n = 108) (continued)

		n	%	Lower	Upper
2.3*	Which of the following terms were specified in purchase transactions for meat products made by your company during the past year?				
	1. Volume discounts	42	40.2	30.1	50.4
	2. Maximum or minimum purchase quantities	33	27.4	18.1	36.6
	3. Maximum or minimum pricing requirements	18	14.3	7.0	21.5
	4. Delivery lead times	37	31.7	22.1	41.3
	5. Product quality specifications	64	57.8	47.5	68.0
	6. Information sharing	14	9.9	3.8	16.1
	7. Inventory management	16	14.2	7.0	21.4
	8. Inventory cost control	17	15.3	7.8	22.7
	9. Advertising requirements	5	4.4	0.1	8.6
	10. Other	D	2.2	0.0	5.2
	11. None of the above	16	17.3	9.5	25.2
2.4*	For meat products purchased under an ongoing arrangement (oral or written) during the past year, what was the length of the arrangement?				
	1. Less than 1 month	6	17.4	4.2	30.7
	2. 1 to 2 months	8	14.8	2.6	27.1
	3. 3 to 5 months	8	14.8	2.6	27.1
	4. 6 to 11 months	8	12.0	0.9	23.2
	5. 1 to 2 years	16	24.1	9.4	38.8
	6. 3 to 5 years	D	0.1	0.0	0.3
	7. 6 to 10 years	D	5.8	0.0	14.0
	8. More than 10 years or evergreen	10	29.1	13.3	44.9
2.5*	For meat products purchased during the past year, how far in advance of delivery was the delivery scheduled?				
	1. Less than 3 days	78	78.7	70.4	87.0
	2. 4 to 6 days	18	16.8	9.2	24.5
	3. 1 to 2 weeks	20	11.9	5.3	18.4
	4. 3 to 4 weeks	D	0.1	0.0	0.2
	5. More than 1 month	D	0.0	0.0	0.1
			Mean (n = 104)	**Lower**	**Upper**
2.6	What types of pricing methods did your company use during the past year for purchasing meat products (% of total dollar purchases)?				
	a. Flat pricing		47.6	37.8	57.3
	b. Formula pricing (using another price as the base)		14.3	7.9	20.8
	c. Or-better pricing		21.1	13.3	29.0
	d. Floor and ceiling pricing		15.9	8.8	23.0
	e. Other		1.1	<0	3.2
	Total		100.0		

D = Results suppressed.

* Respondents could select multiple responses.

(continued)

Table 9-4. Weighted Responses for the Food Service Operator Survey (n = 108) (continued)

		n	%	Lower	Upper
2.7	If flat pricing was used during the past year, did the purchase price include a premium (or overage) relative to the market price?				
	1. Did not use flat pricing during the past year	43	45.0	34.8	55.2
	2. Yes, for some meat product purchases (less than 50%)	11	10.7	4.4	17.1
	3. Yes, for most meat product purchases (50% or more)	14	15.0	7.6	22.3
	4. No	37	29.3	19.9	38.6
	Total		100.0		
2.8*	For meat products purchased under an ongoing arrangement during the past year, how was the purchase price or base price benchmarked?				
	1. Did not purchase under an ongoing arrangement	63	65.7	56.0	75.4
	2. Did not benchmark purchase price or base price	6	5.3	0.7	9.9
	3. Relative to market-reported price	35	26.9	17.8	35.9
	4. Relative to internal rates of return	3	3.2	0.0	6.8
	5. Relative to other bids or offers	11	7.6	2.2	12.9
	6. Other	D	0.0	0.0	0.1
2.9*	For meat products purchased during the past year using formula pricing, what was the base price of the formula?				
	1. USDA publicly reported price	13	33.9	12.5	55.2
	2. Futures price or price ratio	7	19.3	1.5	37.1
	3. Retail price	13	61.1	39.1	83.1
	4. Subscription service price (for example, Urner Barry)	4	5.2	0.0	14.8
	5. Other	D	4.7	0.0	14.3
2.10*	For meat products purchased during the past year using formula pricing, what was the timing for the base price?				
	1. Current market	21	78.5	61.4	95.6
	2. Average of the previous week	5	12.6	0.0	26.6
	3. Average of the previous 2 weeks	0	0.0	NA	NA
	4. Average of the previous 3 weeks	3	12.4	0.0	26.3
	5. Average of the previous month	6	4.8	0.0	13.3
	6. Average of the previous 2 months or longer	D	4.3	0.0	12.7
	7. Other	0	0.0	NA	NA
2.11*	For meat products purchased during the past year using formula pricing, what was the basis of any premiums or discounts?				
	1. USDA yield grade	D	0.3	0.0	1.0
	2. USDA quality grade	7	54.3	20.4	88.3
	3. Brand name	6	45.3	11.4	79.3
	4. Availability/timing	5	36.3	3.5	69.2
	5. Customer service	D	9.3	0.0	29.0
	6. Other	D	0.3	0.0	1.0

D = Results suppressed.
NA = Confidence interval not calculable.
* Respondents could select multiple responses.

(continued)

Table 9-4. Weighted Responses for the Food Service Operator Survey (n = 108) (continued)

		n	%	Lower	Upper
3.1	How many food service establishments were owned by your company during the past year?				
	1. One	66	68.4	59.1	77.8
	2. 2 to 9	20	19.7	11.7	27.8
	3. 10 to 99	12	8.4	2.8	14.0
	4. 100 to 499	7	3.3	0.0	6.8
	5. 500 to 999	0	0.0	NA	NA
	6. 1,000 or more	3	0.1	0.0	0.2
	Total		99.9†		
		n	**Mean**	**Lower**	**Upper**
3.2	What was the approximate total number of people employed by your company during the past year?				
	a. Full time	99	352.6	95.6	609.5
	b. Part time	85	114.4	61.8	166.9
		n	**%**	**Lower**	**Upper**
3.3	What were your company's approximate total gross sales for fresh, frozen, and processed beef, pork, and lamb products during the past year?				
	1. Under $99,999	33	35.7	25.8	45.6
	2. $100,000 to $499,999	31	33.5	23.8	43.3
	3. $500,000 to $999,999	13	14.1	6.9	21.3
	4. $1,000,000 to $2,499,999	5	5.4	0.7	10.1
	5. $2,500,000 to $4,999,999	0	0.0	NA	NA
	6. $5,000,000 to $9,999,999	7	5.5	0.8	10.2
	7. $10,000,000 to $19,999,999	3	3.2	0.0	6.9
	8. $20,000,000 to $49,999,999	5	2.3	0.0	5.3
	9. $50,000,000 to $99,999,999	0	0.0	NA	NA
	10. $100,000,000 to $499,999,999	3	0.1	0.0	0.2
	11. $500,000,000 or more	4	0.2	0.0	0.3
	Total		100.0		
3.4	What were your company's approximate total gross sales for all products during the past year?				
	1. Under $99,999	13	14.2	6.9	21.5
	2. $100,000 to $499,999	28	30.6	21.0	40.2
	3. $500,000 to $999,999	23	25.2	16.1	34.2
	4. $1,000,000 to $2,499,999	11	12.0	5.2	18.8
	5. $2,500,000 to $9,999,999	6	5.5	0.8	10.3
	6. $10,000,000 to $19,999,999	3	3.3	0.0	7.0
	7. $20,000,000 to $49,999,999	5	4.4	0.1	8.7
	8. $50,000,000 to $99,999,999	3	2.2	0.0	5.3
	9. $100,000,000 to $999,999,999	7	2.4	0.0	5.4
	10. $1,000,000,000 or more	4	0.2	0.0	0.3
	Total		100.0		

NA = Confidence interval not calculable.
† Total does not sum to 100% because of rounding.

10 Sample Design for the Transactions Data Collection

This section describes the sample design for the transactions data collection. We limited the transactions data collection to the largest companies because these businesses represent the majority of purchases of livestock and sales of meat products and these businesses are likely to use a variety of AMAs. The transactions data collection also included collection of P&L statements.

10.1 MEAT PACKERS AND PROCESSORS

We limited the transactions data collection to the largest companies because these businesses represent the majority of purchases of livestock and sales of meat products and these businesses are likely to use a variety of AMAs.

As described in Section 2.1, we used the USDA, FSIS EFD to construct the sampling frames for meat packers and meat processors (USDA, FSIS, 2005). The sampling unit for meat packers and processors was the establishment because establishment-level transactions data were needed for the analysis. Using the EFD, we constructed separate sampling frames for beef packers, pork packers, lamb packers, and meat processors. Establishments that slaughter and process were included in the sampling frame for packers. We stratified each industry segment by small and large establishments and then took a census of the largest establishments from each industry segment. We used annual slaughter volume as the size criterion for packers and annual revenues as the size criterion for processors.

Table 10-1 shows the initial sample design for meat packers and processors. The large sample was the same sample used for the industry survey and initially included the 60 largest beef packers, 60 largest pork packers, 30 largest lamb packers, and

50 largest meat processors.[1,2] While administering the industry survey, we found that some large establishments were not eligible for the survey (e.g., packers that only do custom slaughter). If additional establishments were available in the sampling frame, we replaced these ineligible establishments with the plant next in rank size to achieve the specified sample sizes.

After the start of data collection, GIPSA decided to limit data collection to a subset of packing establishments to minimize the burden on smaller entities, while still including the entities representing the vast majority of product volume in the industry. After these adjustments,

- the top 37 beef packers establishments, representing 97% of total industry slaughter volume, were required to provide transactions data;
- the top 39 pork packers establishments, representing 96% of total industry slaughter volume, were required to provide transactions data; and
- the top 15 lamb packers establishments, representing 84% of total industry slaughter volume, were required to provide transactions data.

GIPSA did not modify the sample size for meat processors and thus the largest 50 meat processors were retained in the sample.

10.2 DOWNSTREAM MARKET PARTICIPANTS

> We made an attempt to obtain transactions data from downstream market participants, but ultimately were not successful.

As described in Section 2.1, we used the D&B database to construct the sampling frames for wholesalers, retailers, and food service operators. The sampling unit for the downstream market participants was the firm or company (single-location businesses or the headquarters for multilocation businesses), because firm-level transactions data were needed for the analysis. Using the D&B database, we constructed sampling frames for each industry segment on the basis of the

[1] To ensure adequate representation of lamb processors (i.e., breakers) in the sample for large processing plants, we replaced 10 of the plants with lamb breakers.

[2] Two plants selected for the large sample slaughtered more than one species. To minimize burden on individual entities to the extent possible, these plants were only required to provide transactions data for their highest volume species. To achieve the specified sample sizes, another plant was substituted for the species with the smaller volume, determined by the plant next in size rank.

company's primary SIC code. We stratified each industry segment by small and large companies and then took a census of the largest companies from each industry segment. We used annual revenue as the size criterion for selecting the largest companies from each industry segment.[3] After selecting the sample, we compared the large sample with industry lists of the largest companies to identify and add companies not included in the sample. Finally, we used the USMEF membership list as the sampling frame for meat exporters because meat exporters are not specifically identified in the D&B database. We took a census of all meat exporters (n = 46).

Because the transactions data collection was voluntary for the downstream market participants, in consultation with GIPSA, we limited the data collection to eligible companies that completed the industry survey or agreed to be sent the survey packet. We assumed that companies that were not responsive to the industry survey would not provide transactions data. Table 10-1 shows the initial and revised sample sizes for each industry segment.

[3] Our target sample size for large companies was 50 companies from each segment; however, because revenue is reported as categories in the D&B database, it was necessary to select more than 50 companies.

Table 10-1. Sample Design for the Transactions Data Collection

Industry Segment	NAICS Codes	SIC Codes	Universe Size	Initial Sample Size	Percentage of Total Industry Volume	Revised Sample Size[a]	Percentage of Total Industry Volume
Packers	311611[b]	2011[b]					
Fed cattle			300	60	99%	37	97.0%
Hogs			309	60	99%	39	96.0%
Lambs			120	30	96%	15	84.0%
Processors	311612[b]	2013[b]	4,050	50	N/A	45	N/A
Wholesalers	42242, 42247	5142[c], 5147[d]	3,562	72	N/A	35	N/A
Exporters	N/A	N/A	46	46	N/A	31	N/A
Retailers	44511, 44512, 44521, 45291	5411[e], 5421[f], 5399[g]	28,559	91	N/A	44	N/A
Food service operators	72211, 722211, 722212, 72231, 72111, 72112	5812[h], 7011[i]	44,246	122	N/A	36	N/A

Sources: Dun and Bradstreet (D&B). <http:\www.dnb.com>.
U.S. Department of Agriculture, Food Safety and Inspection Service (USDA, FSIS). 2005. Enhanced Facilities Database. Washington, DC: USDA.
U.S. Meat Export Federation. 2005. *2005 Membership Directory*. Denver, CO: Meat Export Federation.

N/A = Not available.

[a] Excludes plants that were determined to be ineligible for the data collection.

[b] NAICS and SIC codes were not used to identify the respondent universe for packers and processors but are included in the table for completeness.

[c] For SIC code 5142 (packaged frozen foods), the following subcategories were included in the sampling frame: frozen meat, frozen meat pies, and packaged frozen meat.

[d] For SIC code 5147 (meats and meat products), the following subcategories were included in the sampling frame: meats and meat products, excluding lard.

[e] For SIC code 5411 (grocery stores), the following subcategories were included in the sampling frame: supermarkets (chains and independents) and grocery stores (chains and independents).

[f] For SIC code 5421 (meat and fish markets), the following subcategories were included in the sampling frame: meat markets, including freezer provisioners.

[g] For SIC code 5399 (miscellaneous general merchandise stores), the following subcategories were included in the sampling frame: warehouse club stores.

[h] For SIC code 5812 (eating places), the following subcategories were included in the sampling frame: fast-food restaurants (chains and independents), family restaurants (chains and independents), steak and barbecue restaurants, and contract food services.

[i] For SIC code 7011 (hotels and motels), the following subcategories were included in the sampling frame: hotels (franchised and independents), casino hotels, and resort hotels (franchised and independents).

11 Study Design and Procedures for the Transactions Data Collection

This section describes the data specifications for the transactions data collection, our pretest procedures for testing the instruction booklets for the transactions data collection, and our data collection procedures for the mandatory and voluntary components of the data collection.

11.1 DATA SPECIFICATIONS

> We developed instruction booklets that provided detailed information on how to provide the transactions data. We also provided electronic templates for preparing the files in the specified format and for preparing a data dictionary (if an alternative format was used). Companies could provide electronic or hard copy data.

We developed instruction booklets (eight versions, a different version for each industry segment) that provided detailed information on how to provide the transactions data. Appendix D in Volume 2 provides the instruction booklets for each industry segment. Each instruction booklet provided tables with file specifications that described each data element or data field required (e.g., carcass quality grade) and the preferred format for providing the data (e.g., 1 = prime, 2 = choice). If a plant or company chose to use an alternative format, the data could be provided in the format used by the respondent; however, the respondent was asked to provide a data dictionary (i.e., variable name, description, unit of measure, and description of any coding system used). We also provided a CD with templates in Microsoft Excel for preparing the files in the specified format and for preparing a data dictionary (if an alternative format was used). Companies could provide electronic or hard copy data. Companies were instructed to send electronic data files to RTI and hard copy data to GIPSA.

11.1.1 Meat Packers

Beef, pork, and lamb packers were required to provide the following types of information for the 2.5-year period from October 6, 2002, through March 31, 2005:

- daily transactions data for purchases/procurement of livestock
- contract settlement data for production contracts (pork packers only)
- daily transactions data for sales of meat products
- weekly P&L statements for each production stage

Pork packers also were asked to provide procurement transactions data and contract settlement data for weaner and feeder pigs on a voluntary basis.

For purchases/procurement of livestock, a transaction was defined as the purchase or procurement of a pen or lot of fed cattle, lambs, or finished hogs.

For contract settlement data for hog production contracts, pork packers were required to provide a copy of the contract form (electronic or hard copy) for each hog production contract and contract settlement data or to provide settlement sheets for each payment made to the grower during the requested time period.

For sales of meat products, a transaction was defined as the sale of a specific type of raw or processed meat product based on the Institutional Meat Purchase Specification (IMPS) item numbers or other coding system; thus, each transaction is equivalent to an individual line item on the respondent's invoices.[1]

Packing establishments were also required to provide weekly P&L statements for each production stage (i.e., slaughter, fabrication, and processing) operated by the establishment. If establishments did not prepare weekly P&L statements but did prepare monthly P&L statements, they were asked to provide monthly P&L statements.

[1] The IMPS system is not commonly used by pork packers.

11.1.2 Processors

Meat processors were required to provide the following types of information for the 2.5-year period from October 6, 2002, through March 31, 2005:

- detailed transactions data for purchases of meat inputs
- detailed transactions data for sales of meat products
- weekly P&L statements

A transaction was defined as the purchase or sale of a specific type of raw or processed meat product based on the IMPS item numbers or other coding system. For sales of meat products, meat processors were only required to provide information on products that contained at least 50% meat by weight.

Processors were also required to provide weekly P&L statements. If establishments did not prepare weekly P&L statements but did prepare monthly P&L statements, they were asked to provide monthly P&L statements. Processors were not required to provide P&L statements if they only sold meat products that contained less than 50% meat by weight.

11.1.3 Downstream Market Participants

To minimize respondent burden, downstream market participants were asked to provide weekly summaries of purchase and sales transactions by type of meat for the 2.5-year period from October 6, 2002, through March 31, 2005. Some market participants at these levels frequently handled many nonmeat items; thus, they were asked to provide information on products that contained at least 50% meat by weight.

The following types of data were requested from downstream market participants:

- weekly summaries of purchase or receipt of meat products, by type of meat
- weekly summaries of sales or transfers of meat products to other market entities, by type of meat

Companies that purchased or sold more than one type of meat were asked to provide separate data files for each type of meat (i.e., beef, pork, and lamb). The requested data elements for downstream market participants were substantially fewer because data on product attributes should mirror those for meat product sales from packers and processors. Furthermore, the data collection did not seek to obtain data on final sales to consumers by retailers and food service operators.

11.2 PRETEST PROCEDURES

To test the usability and respondent's understanding of the instructions and format specifications provided in the instruction booklets, we conducted interviews with GIPSA field staff, conducted interviews with individuals from the target population, and met with industry representatives. Additionally, we reviewed the comments from the study's peer reviewers on the draft instruction booklets. Our pretest procedures are described below.

We conducted telephone interviews with three GIPSA field staff to obtain feedback on the draft instruction booklets for beef packers and pork packers. These individuals are very knowledgeable about the meat packing industry and frequently interact with packers. Based on the interviews with the GIPSA field staff and the written comments from the peer reviewers, we revised the eight versions of the draft instruction booklets.

Next, we conducted interviews with 13 respondents representing the different industry segments (Table 11-1). We sent the pretest respondents the instruction booklet and then conducted telephone interviews to obtain their feedback on the instructions, format specifications, and burden estimate. In November 2004, we met with representatives from the American Meat Institute (AMI), several of its member companies, and representatives for the National Meat Association (NMA) at AMI's offices in Washington, D.C. The primary purpose of this meeting was to obtain feedback on the draft instruction booklets. Subsequent to this meeting, we sent AMI a template on which member companies could indicate which of the requested data items were available, which were available but would be difficult to provide, and which were not available. AMI received 11 completed templates (see Table 11-1), which they forwarded to RTI.

We reviewed the templates and the findings from the pretest interviews and revised the eight versions of the instruction booklets. The instruction booklets were revised to clarify instructions that were confusing to respondents; to clarify the definitions provided for the different types of purchase and sales methods, pricing methods, and other terms used; and to

Table 11-1. Pretest Respondents for the Transactions Data Collection

Industry Segment/Size	Number of Pretest Interviews	Number of Completed Templates
Beef packers	3	1
Lamb packers	2	0
Pork packers[a]	0	5
Processors	2	5
Wholesalers	2	–
Exporters	2	–
Retailers	1	–
Food service operators	1	–
Total	13	11

[a] Although several pork packers were contacted, we were unable to schedule a pretest interview with a pork packer. However, feedback was obtained from pork packers in the meeting with AMI and on the completed templates after the meeting.

reformat certain items to reduce respondent burden. Appendix D in Volume 2 provides copies of the final instruction booklets for the transactions data collection.

11.3 DATA COLLECTION PROCEDURES

We developed and used different data collection procedures for the mandatory (packers and processors) and voluntary (downstream market participants) components of the data collection. We describe our data collection procedures below.

11.3.1 Mandatory Data Collection: Meat Packers and Processors

Response to the transactions data collection was required for meat packers and processors as a special report under the Packers and Stockyards Act (7 U.S.C. § 222). To facilitate compliance with the mandatory data collection, we contacted sampled business units by telephone throughout the data collection period as a reminder to provide the required data by the designated date and to offer assistance with responding to the data request. For firms with more than one plant in the sample, these contacts were generally made to the corporate headquarters, unless otherwise instructed by the company. Three RTI project team members made the outgoing calls to plants and were available to answer incoming calls from plants. Each individual was assigned a set of plants and therefore made the majority of outgoing and incoming calls to their assigned plants. We developed a control system in Microsoft Excel to track the status of each sampled plant (i.e., call date and outcome, date information packet and transactions data collection packet were sent, and contact information).

The steps in the data collection process are summarized below.

- Beginning on February 13, 2006, we contacted sampled business units by telephone to identify who should receive an information package from RTI containing the prenotice letter from GIPSA, the information form for identifying the responsible person for complying with the data collection, and an information brochure describing the study and our data security procedures (see Appendix E in Volume 2 for copies of these materials). We sent the materials by e-mail, fax, or Federal Express. If we did not receive the completed information form within approximately 5 business days, we contacted the plant to remind them to complete and return the form.
- After receiving the completed information form with the contact information for the responsible person, we sent the transactions data collection materials (instruction booklet, file templates on CD, and materials for sending the data to RTI) via Federal Express.
- Approximately 1 week after the mailing of the transactions data collection materials, we contacted plants by telephone or e-mail to ensure receipt of the package and to inquire if they had any questions about the data request.
- The week of March 27, 2006, we contacted all plants by telephone or e-mail to remind them of the due date for providing the required data.
- The week of April 10, 2006, we contacted plants again to remind them of the due date for the data collection. During these calls, we advised plants that expressed difficulty in meeting the April 14, 2006, deadline to call GIPSA and request a 1-week extension.
- The week of April 17, 2006, we contacted plants that did not meet the original due date and had not requested an extension in order to inquire about the status of their submission and to advise them to contact GIPSA for an extension.
- The week of April 24, 2006, we contacted plants that had not provided data and advised them that we would

notify GIPSA that they did not comply with the mandatory data request.

Throughout the data collection period, we provided a toll-free number and e-mail address that plants could use to contact RTI for assistance in responding to the data request. Many plants contacted RTI during this period with questions on how to comply with the data request.

Upon receipt of the data at RTI, the data were physically and electronically secured, following our data security procedures for the study. Table 11-2 shows the number of plants that provided transactions data, by type of data, and the number of plants that provided useable data. Some plants provided data that we were unable to use in our analysis because the data were in hard copy format or in an electronic format that was incompatible with preparation of the analysis data sets.

Table 11-2. Response to the Transactions Data Collection: Meat Packers and Processors

	Beef Packers	Pork Packers	Lamb Packers	Processors
Initial sample size	60	60	30	50
Revised sample size[a]	37	39	15	45
Provided data on purchases	37	39	12	45
Provided data on sales	33	38	11	25
Provided P&L statement data	37	37	12	20
Provided useable data on purchases	30	28	2	17
Provided useable data on sales	25	22	5	6
Provided useable P&L statement data	25	18	0	0

[a] Excludes plants that were determined to be ineligible for the data collection.

11.3.2 Voluntary Data Collection: Downstream Market Participants

Response to the transactions data collection was voluntary for wholesalers, exporters, retailers, and food service operators. Because the data collection was voluntary, our follow-up efforts were not as intensive as they were for packers and processors. RTI's telephone interviewers made the calls to sampled companies.

Beginning on February 20, 2006, we contacted sampled companies by telephone to identify the individual who should receive an information package from RTI containing the prenotice letter from GIPSA, the information form for identifying the responsible person for complying with the data collection, and an information brochure describing the study and our data security procedures (see Appendix F of Volume 2 for copies of these materials). We sent the materials by e-mail or fax. We mailed the materials to companies that we were unable to reach by telephone. If we did not receive the completed information form within approximately 15 business days, we sent a postcard as a reminder to complete and return the form.

Only four companies returned the completed information form (Table 11-3). We sent these companies the transactions data collection materials (instruction booklet, file templates on CD, and materials for sending the data to RTI) via Federal Express. Because we believed it was unlikely that companies would provide proprietary data on purchases and sales on a voluntary basis, we did not attempt any follow-up calls with downstream companies. No downstream companies provided transactions data.

Table 11-3. Response to the Transactions Data Collection: Downstream Market Segments

	Wholesalers	Exporters	Retailers	Food Service Operators
Initial sample size	72	46	91	122
Revised sample size	35	31	44	36
Completed information form and received transactions data collection packet	0	2	0	2
Provided data on purchases and sales	0	0	0	0

12 Data Set Preparation for the Transactions and P&L Statement Data Collection

> Collecting the transactions data was a complex and time-intensive process. For nearly all plants, we had to contact the plant or company to request clarification on their data or, in many cases, obtain entirely new data sets. Additionally, we found that many companies or plants did not track critical data that were necessary for some of our analyses.

This section describes the procedures used to prepare the data sets for the transactions data and P&L statement data for meat packers and processors. All data set preparation was conducted following our physical and electronic data security procedures. Throughout the study, all analysis data sets were encrypted using PGP software.

For nearly all plants, we had to contact the plant or company to request clarification on their data or, in many cases, obtain entirely new data sets. This demonstrates the complexity of obtaining the data required for conducting the study's analyses and shows that respondents provided substantial cooperation in a very short amount of time. This additional interaction occurred beyond the initial data collection period and delayed us from beginning many of the analyses required for the study.

Furthermore, we found that many companies or plants did not track critical data in their databases. For example, some did not maintain data on the date of purchase or the date of pricing—information that was necessary for some of our analyses. Additionally, some did not record the type of purchase or pricing method used, some did not differentiate the livestock owners' location from the location of the livestock, and some did not segregate shipping and other miscellaneous costs from livestock or total cost.

Below we describe our general rules for preparing the analysis data sets for the purchase transactions data, sales transactions data, and the P&L statement data. Other data set preparation was performed on a case-by-case basis.

12.1 PURCHASE TRANSACTIONS DATA

The general steps we followed to prepare the analysis data sets for the purchase transactions data are summarized below.

- If the data set was not in Excel or Access, we saved the data set to Excel or Access based on the file size (i.e., smaller files were saved to Excel and larger files were saved to Access).
- If the row headers were missing from the data set, we inserted them using the templates provided to respondents.
- We checked the variable format and codes against the specifications provided in the instruction booklet.
- We replaced the plant ID number with the unique survey ID on every record (i.e., observation) so that the transactions data and survey data could be linked.
- We added a company ID number for every record.
- We added the state in which the plant is located to every record.
- We determined if AMA information was available.
  - If no purchase AMA information was available and we were unable to use logical imputation to assign the data, we considered the observation to be unusable.
  - If qualitative information was available, we used it to map AMA data to all observations as appropriate.
  - If AMA information was included in the data set, we verified that data were provided for all fields.
- We checked the cost fields to ensure that total cost equaled the sum of all other costs; if not, we contacted the plant to reconcile the difference.
- To check the accuracy of the volume fields, we summed all of the purchase volumes and compared the total with the maximum capacity for the plant (i.e., maximum capacity times 50 weeks times 2.5 years). If the numbers were not consistent, we contacted the plant to ensure we had all of the available data for the study period.

- If the seller ID number was provided, we added the survey ID in front of the seller ID and then removed the seller name, address, and city (but kept the first three digits of the zip code and the state).
- If the seller ID number was not provided, we created an ID and then removed the name, address, and city (but kept the first three digits of the zip code and the state). The seller ID was equal to the survey ID and a numerical value, concatenated.
- We created a finisher or feedlot ID by concatenating the survey ID and a unique number for each finisher or feedlot name and then removed the finisher or feedlot name, address, and city (but kept the first three digits of the zip code and the state).
- We removed all other identifying information, such as named ranges and file properties.

Additional data set preparation was conducted during the analysis stage.

12.2 SALES TRANSACTIONS DATA

The general steps we followed to prepare the analysis data sets for the sales transactions data are summarized below.

- We imported the data files into SAS.
- We created one data set for each company.
- We checked the variable format and codes against the specifications provided in the instruction booklet.
- For records with negative values for weights or prices, we
  - found the matching record with positive values and deleted both records and
  - deleted any remaining observations with weights or prices less than or equal to zero.
- We suppressed buyer or receiver names that revealed a plant’s identity (e.g., internal transfers, employee sales).
- For buyers, we removed the name, address, and city (but kept the first three digits of the zip code and the state).
- For receivers, we removed the name, address, and city (but kept the first three digits of the zip code and the state).

- We removed all other identifying information, such as named ranges and file properties.

Additional data set preparation was conducted during the analysis stage.

12.3 P&L STATEMENT DATA

The general steps we followed to prepare the analysis data sets for the P&L statement data are summarized below.

- We replaced company name and plant name with the survey ID.
- We removed all other identifying information such as named ranges and file properties.

Additional data set preparation was conducted during the analysis stage.

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January 2007

GIPSA Livestock and Meat Marketing Study

Contract No. 53-32KW-4-028

Volume 3: Fed Cattle and Beef Industries

Final Report

Prepared for

Grain Inspection, Packers and Stockyard Administration
U.S. Department of Agriculture
Washington, DC 20250

Prepared by

RTI International
Health, Social, and Economics Research
Research Triangle Park, NC 27709

RTI Project Number 0209230

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Abstract

Over time, the variety, complexity, and use of alternative marketing arrangements (AMAs) have increased in the livestock and meat industries. Marketing arrangements refer to the methods by which livestock and meat are transferred through successive stages of production and marketing. Increased use of AMAs raises a number of questions about their effects on economic efficiency and on the distribution of the benefits and costs of livestock and meat production and consumption between producers and consumers. This volume of the final report focuses on AMAs used in the fed cattle and beef industry and addresses the following parts of the Grain Inspection, Packers and Stockyards Administration (GIPSA) Livestock and Meat Marketing Study:

- Part C. Determine extent of use, analyze price differences, and analyze short-run market price effects of AMAs.
- Part D. Measure and compare costs and benefits associated with spot marketing arrangements and AMAs.
- Part E. Analyze the implications of AMAs for the livestock and meat marketing system.

This final report follows the publication of an interim report for the study that used qualitative sources of information to identify and classify AMAs and to describe their terms, availability, and reasons for use. The portion of the study contained in this volume of the final report is based on quantitative analyses using industry survey data from producers, feeders, packers, processors, wholesalers, retailers, and food services operators, as well as transactions data and profit and loss (P&L) statements from packers and processors.

This volume of the final report presents the results of analyses of the effects of AMAs on the markets for fed cattle and beef products. Economic and statistical models were developed and estimated to examine the effects of AMAs on fed cattle and beef prices, procurement costs, quality, price risk, and consumers

and producers. Results of analyses of the estimated effects of hypothetical restrictions on AMAs are also presented.

The principal contributors to this volume of the final report are the following:

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We would like to thank the anonymous peer reviewers and GIPSA staff who provided comments on earlier drafts, which helped us improve the report. We also thank Sharon Barrell and Melissa Fisch for editing assistance.

This report and the study on which it is based were completed under a contract with GIPSA, U.S. Department of Agriculture (USDA). Any opinions, findings, and conclusions or recommendations expressed in this report are those of the authors and do not necessarily reflect the views of GIPSA or USDA.

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Executive Summary

As part of the congressionally mandated Livestock and Meat Marketing Study, this volume of the final report presents the results of analyses of the effects of alternative marketing arrangements (AMAs) in the fed cattle and beef industries. This final report focuses on determining the extent of use of AMAs, analyzing price differences and price effects associated with AMAs, measuring the costs and benefits associated with using AMAs, and assessing the broad range of implications of AMAs. The analyses in this volume were conducted using the results of industry interviews, the industry survey data, transactions and profit and loss (P&L) statement data from beef packers, mandatory price reporting (MPR) data, and data from other publicly available sources.

In this report, AMAs refer to all possible alternatives to the cash or spot market. AMAs include arrangements such as forward contracts, marketing agreements, procurement or marketing contracts, packer ownership, custom feeding, and custom slaughter. Cash or spot market transactions refer to transactions that occur immediately, or "on the spot." These include auction barn sales; video or electronic auction sales; sales through order buyers, dealers, and brokers; and direct trades.

It is important to note that the data collection period, October 2002 through March 2005, was an unusual time for the U.S. beef industry. First, the industry was in transition from the end of the liquidation phase and start of the expansion phase in the cattle cycle. Second, discovery of bovine spongiform encephalopathy (BSE) in Canada in May 2003 closed the U.S. border to Canadian cattle and beef imports. Boxed beef imports from Canada resumed in September 2003, but restricted cattle imports did not begin until July 2005. This immediate restriction on the supply of cattle in the United States led to unprecedented cattle prices and producer profits in October 2003 (fed cattle prices reached levels 30% higher than the previous record high). Third, the discovery of BSE in the United States led to suspended beef exports in late December 2003, causing an immediate and significant decline in beef and cattle prices in early 2004. The tight domestic supply of cattle with resumed beef imports and restricted exports pressured packer margins and resulted in negative packer returns during a portion of the study period. In spite of, or perhaps because of, the turmoil in the markets, fed cattle prices posted record high annual average prices in 2003, which were surpassed in 2004, and then topped again in 2005.

With that backdrop on market conditions, the primary conclusions for this final report, as they relate to the fed cattle and beef industries, are as follows:

- **The beef producers and packers interviewed believed that some types of AMAs helped them manage their operations more efficiently, reduced risk, and improved beef quality.** Feedlots identified cost savings of $1 to $17 per head from improved capacity utilization, more standardized feeding programs, and reduced financial commitments required to keep the feedlot at capacity. Packers identified cost savings of $0.40 per head in reduced procurement cost. Both agreed that if packers could not own cattle, higher returns would be needed to attract other investors and that beef quality would suffer in an all-commodity market place.
- **Eighty-five percent of small producers surveyed used only the cash market when selling to packers, compared with 24% for large producers, and pricing methods also differed by size of operation.** Large producers used multiple pricing methods, including individually negotiated pricing (74% of producers), public auction (35%), and formula pricing (57%). In comparison, small producers used individually negotiated pricing (32%), public auction (84%), and formula pricing (6%). Four times as many large producers sold cattle on a carcass weight basis with a grid compared with small producers.
- **Ten percent of large beef packers surveyed reported using only the cash or spot market to**

purchase cattle, compared with 78% of small beef packers. Large packers relied heavily on direct trade and less on auction barns and dealers or brokers for their cattle procurement compared with small packers. Conversely, small packers used AMAs for approximately half as much on a percentage basis as large packers. Both large and small packers used multiple pricing methods when buying cattle, including individually negotiated prices, formula pricing, public auction, and internal transfer pricing. While nearly all packers bought some cattle on a liveweight basis, 88% of large packers purchased cattle based on carcass weight with grids, while almost no small packers used this type of valuation.

- **Neither the producers nor packers surveyed expected the use of AMAs to change dramatically in the next 3 years.** In addition, they indicated that their use of AMAs had not changed significantly from 3 years earlier. Auction markets were the predominate marketing method across all producers selling cattle and calves. Based on the survey results, which tend to represent smaller packers, 19% of fed cattle are purchased through auctions. This is a substantially higher percentage than the estimate based on the transactions data obtained from larger packers.
- **The producers surveyed that used AMAs identified the ability to buy/sell higher quality cattle, improve supply management, and obtain better prices as the leading reasons for using AMAs.** In contrast, the producers surveyed that used only cash markets identified independence, flexibility, quick response to changing market conditions, and ability to buy at lower prices and sell at higher prices as primary reasons for using only cash or spot markets.
- **The packers surveyed that used AMAs said that their top three reasons for using AMAs were to improve week-to-week supply management, secure higher quality cattle, and allow for product branding in retail stores.** Much like producers, packers that used only cash markets identified independence, flexibility, quick response to changing market conditions, and securing higher quality cattle as reasons for using only the cash or spot market.
- **Transactions data summarized from the 29 largest beef packing plants during the time period of the study included more than 58 million cattle and 590,000 transactions and indicated that the cash or spot market was the predominate purchase**

> Note: To ensure the confidentiality of the companies that provided data for this study, the packer ownership category is often combined with other categories in the summary statistics presented in this volume. Results of analysis for the packer ownership category are provided in cases for which the results do not reveal company-specific confidential information.

method used. Specific estimates of the percentage of cattle purchased through each type of marketing arrangement are as follows:

– 61.7% cash or spot market

– 28.8% marketing agreements

– 4.5% forward contracts

– 5.0% packer owned, other method, or missing information

Thus, marketing agreements are the primary AMA used in the fed cattle and beef industries, but other types of AMAs are used extensively by individual firms for specific reasons that benefit their operations.

- **Transactions data indicate that packing plants in the Cornbelt/Northeast used AMAs less frequently than plants in the High Plains or West regions.** High Plains plants procured 61% of cattle by direct trade, 30% through marketing agreements, and a very small percentage through auctions and forward contracts. Cornbelt/Northeast plants bought the majority of their cattle by direct trade, but some were purchased through auctions and marketing agreements. Plants in the West bought a lower percentage by direct trade compared with the other regions and a higher percentage through marketing agreements and auction barns.
- **Individually negotiated pricing was the most common method used to determine purchase prices for fed cattle**. Specifically, 60% of cattle purchased by plants in the High Plains used individually negotiated pricing, with a similar percentage in the Cornbelt/Northeast and a substantially lower percentage in the West. Formula pricing was used to purchase 34% of the cattle in the High Plains, with a higher percentage in the West and a substantially lower percentage in the Cornbelt/Northeast. The formula was based most often on either U.S. Department of Agriculture (USDA)-reported prices or subscription service prices. Cornbelt/Northeast packers purchased the largest percentage of cattle on a liveweight basis (47%) in comparison with the High Plains (40%) and the West (25%). Packers in the West purchased more than half of their cattle using carcass weight with grid valuation, while packers in the High Plains and Cornbelt/Northeast used this valuation method for 42% and 44% of their purchases, respectively. The remainder were

predominately purchased on a carcass weight basis without a grid.

- **Regression analysis of the relationship between all fed cattle transactions prices and use of marketing arrangements indicates that, relative to direct trade transactions, prices for fed cattle sold through auction barns tended to be somewhat higher and prices for fed cattle sold through forward contracts tended to be somewhat lower.** These results are likely due, in part, to the differences in risk associated with the two methods: auction barn sales are subject to greater price risk, but forward contracts ensure market access and a guaranteed price for cattle producers. However, the results also are influenced by the period of the analysis, during which fed cattle prices were at record highs. The prices for fed cattle sold through marketing agreements and transferred through packer ownership were relatively similar to direct trade. Prices for cattle under packer ownership are internal transfer prices that are typically based on external market prices; thus, implications of the results for packer-owned cattle are less clear.
- **Regression analysis of the relationship between cash market (auction barns, dealers and brokers, and direct trade) transactions prices for fed cattle and use of marketing arrangements suggests that if capacity utilization within a plant increases through the use of AMAs, firms pay slightly less per pound for cattle purchased in the cash market.** Specifically, a 10 percentage point increase in capacity utilization through AMAs is associated with a 0.4 cent per pound carcass weight decrease in the cash market price. Furthermore, if more cattle are available through AMAs within the following 21 days, cash market prices decrease slightly. Specifically, a 10% reduction in the volume of cash market transactions, assuming that volume is shifted into AMAs, is associated with a 0.11% decrease in the cash market price.
- **Beef packer plant-level P&L data showed significant economies of scale in beef packing, and costs were decreasing across the entire data range analyzed.** When both are operated close to capacity, smaller plants are at an absolute cost disadvantage compared with larger plants. When larger plants operate with smaller volumes, they have higher costs than smaller plants operating close to capacity and, thus, have an incentive to increase throughput. For all plants, large and small, average total cost increases sharply as

volumes are reduced. A representative plant operating at 95% of the maximum observed volume is 6% more efficient than a plant operating in the middle of the observed range of volumes and is 14% more efficient than a plant operating at the low end of the observed range.

- **Based on an analysis of P&L statements, procurement of cattle through AMAs results in production cost savings to the plants that use them.** However, the results differ across firms and plants. Some plants benefited substantially from AMAs and other plants did not appear to capture any benefits. The weighted average industry total production cost savings associated with AMAs was approximately $6.50 per animal. For an industry with an average loss of $2.40 per head during the 30-month sample period, this is a substantial benefit.
- **Marketing agreements are the most widely used AMAs in the beef industry, and thus restrictions on the use of marketing agreements would have the greatest negative effects on costs of production in the beef packing industry.** Forward contracts and packer-owned cattle were used, but to a much lesser extent. Therefore, restrictions on the use of packer ownership and forward contracts for cattle would have lesser effects on costs of production.
- **While the results differ by plant and firm, simulation analysis indicates that reducing or eliminating AMAs would result in higher average total cost (ATC) for slaughtering and processing beef cattle and, likewise, reduced gross margins and packer profits.** The average increase to beef slaughter and processing ATC would be 4.7% with a hypothetical elimination of AMAs and 0.9% with a hypothetical 25% reduction is use of AMAs. Packer profits are estimated to decrease by 6.0% and 1.5% if AMAs were reduced by 100% or 25%, respectively.
- **Beef quality has a positive effect on beef demand, the producers and packers interviewed and surveyed believe that AMAs are important for beef quality, and quantitative analyses suggest that AMAs are often associated with higher quality.** Regression analysis of MPR data found a small but positive relationship between formula and packer ownership procurement and USDA Quality Grade and found no statistical relationship between cash purchases and USDA Quality Grade. Regression analysis on transactions data found that marketing agreement cattle

had a higher percentage Choice and Prime carcasses without increasing the percentage of Yield Grade 4 and 5 carcasses and had only modest declines in Yield Grade 1 and 2 carcasses. Other procurement methods had a greater trade-off between preferred quality grade and preferred yield grade. Furthermore, marketing agreement cattle and packer-owned cattle were associated with relatively higher quality compared with direct trade cattle, as measured by a composite quality index, but the small percentage of cattle sold through auction barns was associated with the highest quality and the highest variability in quality. The small percentage of cattle sold through forward contracts was associated with the lowest quality but also the lowest variability in quality.

- **The producers and packers surveyed that use AMAs value them as a method of dealing with production, market access, and price risks.** More specifically, feedlots believed that AMAs allow them to secure or sell better quality cattle and calves and improve operational management, efficiency, and capacity utilization. Packers identified AMAs as an important element of branded products and meeting consumer demand by producing a higher quality, more consistent product.
- **Regression analysis accounting for cattle quality and sales month found that auction market and forward contract prices were more volatile than direct trade, marketing agreement, and packer-owned cattle prices.** Furthermore, the volatility of prices for direct trade and marketing agreement cattle were relatively similar. Results were generally consistent for fed beef cattle and fed dairy cattle.
- **Hypothetical reductions in AMAs, as represented by formula arrangements (marketing agreements and forward contracts) and packer ownership, are found to have a negative effect on producer and consumer surplus measures.** Beef and cattle supplies and quality decreased and retail and wholesale beef prices increased because of reductions in AMAs. However, feeder and fed cattle prices decreased because of higher slaughter and processing costs resulting from the AMA restrictions. The short-run, long-run, and cumulative present value surplus for producers and consumers associated with reduced AMA volumes are all negative. Over 10 years, a hypothetical 25% restriction in AMA volumes resulted in a *decrease* in cumulative present value of surplus of

- 2.67% for feeder cattle producers,
- 1.35% for fed cattle producers,
- 0.86% for wholesale beef producers (packers), and
- 0.83% for beef consumers.

A hypothetical 100% restriction in AMA volumes resulted in a *decrease* in cumulative present value surplus of

- 15.96% for feeder cattle producers,
- 7.82% for fed cattle producers,
- 5.24% for wholesale beef producers (packers), and
- 4.56% for beef consumers.

Thus, feeder cattle producers lose more surplus relative to the other sectors under either scenario. In addition, the estimated changes would imply a reduction in the competitiveness of beef relative to other meats.

- **The cost savings and quality improvements associated with the use of AMAs outweigh the effect of potential oligopsony market power that AMAs may provide packers.** In the model simulations, even if the complete elimination of AMAs would eliminate market power that might currently exist, the net effect would be reductions in prices, quantities, and producer and consumer surplus in almost all sectors of the industry because of additional processing costs and reductions in beef quality. Collectively, this suggests that reducing the use of AMAs would result in economic losses for beef consumers and the beef industry.

Decisions regarding methodologies, assumptions, and data sources used for the study had to be made in a short period of time. The analyses presented in this volume are based on the best available data, using methodologies developed to address the study requirements under the time constraints of the study. Some analyses were limited based on availability and quality of the transactions and P&L statement data. However, secondary data were used, as available, to supplement primary data to conduct the analyses.

1 Introduction and Background

Alternative marketing arrangements include all possible alternatives to use of cash or spot markets for conducting transactions.

As part of the congressionally mandated Livestock and Meat Marketing Study, this volume of the final report presents the results of analyses of the effects of alternative marketing arrangements (AMAs) in the fed cattle and beef industries. The types of questions posed by the Livestock and Meat Marketing Study include the following: What types of marketing arrangements are used? What is the extent of their use? Why do firms enter into the various arrangements? What are the terms and characteristics of these arrangements? What are the effects and implications of the arrangements on participants and on the livestock and meat marketing system?

The overall study comprises five parts based on the performance work statement in the contract with GIPSA. An interim report released in August 2005 addressed Parts A and B of the study (Muth et al., 2005). The interim report described marketing arrangements used in the livestock and meat industries and defined key terminology.[1] Results presented in the interim report were preliminary because they were based on assessments of the livestock and meat industries using published data, reviews of the relevant literature, and industry interviews.

This final report describes the results of quantitative analyses, addressing Parts C, D, and E of the study as follows:

- Part C. Determine extent of use, analyze price differences, and analyze short-run market price effects of AMAs.

[1] A glossary of terms used in the study is included in a separate document.

The interim report released in August 2005 addressed the first two parts of the study. This final report focuses on the final three parts of the study (Parts C, D, and E).

- Part D. Measure and compare costs and benefits associated with spot and alternative marketing arrangements.
- Part E. Analyze the implications of AMAs for the livestock and meat marketing system.

The analyses presented in this volume address these final three parts of the study, using information from industry interviews,[2] data from the industry surveys (described in Volume 2), transactions data and profit and loss statements from packers and processors, and a variety of publicly available data. Analyses conducted for the Livestock and Meat Marketing Study are limited to economic factors associated with spot and alternative marketing arrangements and do not analyze policy options or make policy recommendations.

1.1 OVERVIEW OF THE FED CATTLE AND BEEF INDUSTRIES

The beef industry is the largest livestock and meat production industry in the United States. The industry comprises a large number of interrelated sectors that encompass numerous producers, stockers, feeders, packers, processors, distributors, retailers, and exporters across a large number of geographic locations. In this section, we describe the stages of beef cattle production and location of operations as background information for analyses described in later sections of this volume.[3]

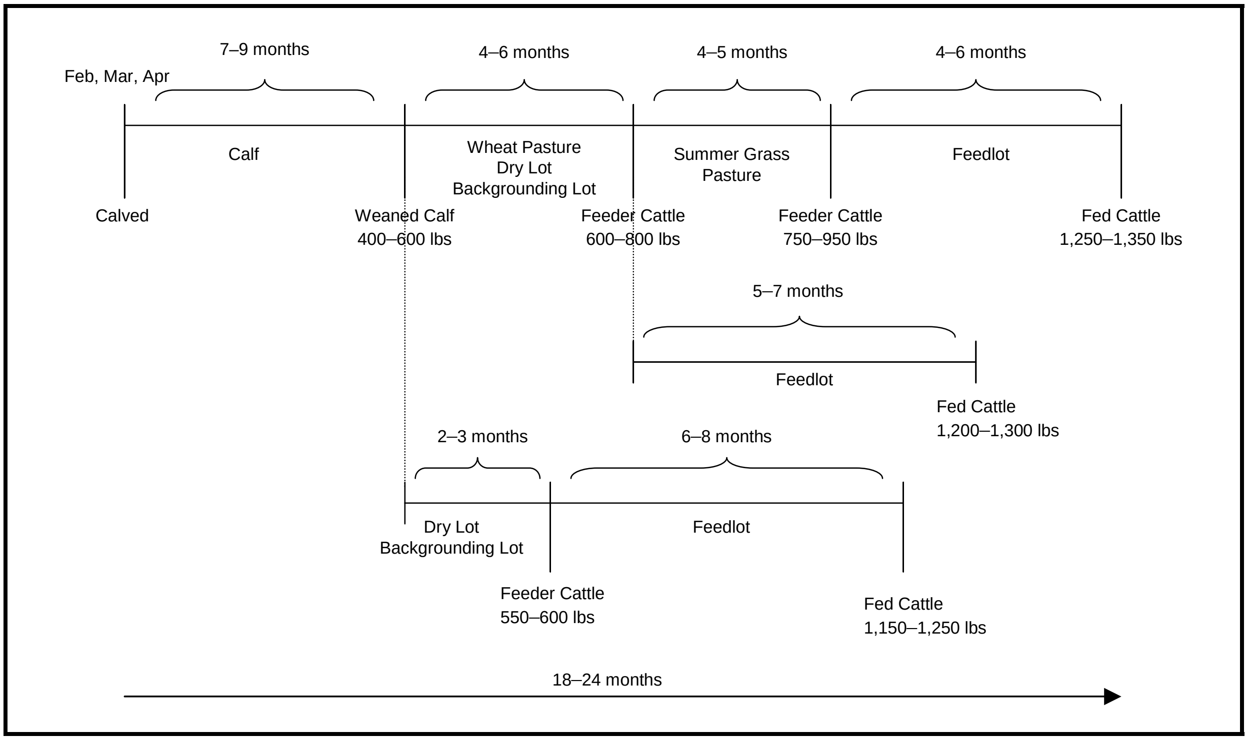
1.1.1 Stages of Beef Cattle Production

In many regions of the country, beef calves are born primarily in the spring and graze pasture with the cow during the summer (Figure 1-1). Calves are weaned during the fall of their birth year and marketed at 400 to 600 pounds. These animals are referred to as calves or weaned calves in the marketing system. Some female animals (about 16% of total inventory) are held back or are not marketed and become breeding stock replacements.

[2] A description of the process for conducting the interviews and the complete findings from the interviews are provided in the interim report (Muth et al., 2005).

[3] A more complete overview of the fed cattle and beef industries is provided in the interim report (Muth et al., 2005).

Figure 1-1. Typical Cattle Production Timeline: Spring-Calved Beef Animal
The method of raising cattle can vary depending on the available resources and the desired finished weight.



The marketed weaned calves are backgrounded in preconditioning lots, backgrounded on backgrounding operations, placed on winter wheat pasture, or placed in other winter pasture systems. Animals may or may not be confined in a lot with other animals. Preconditioning lots and backgrounding lots may involve confinement, but pasture systems do not. Calves are fed forage or hay and some nutritional and protein supplements in confined operations. Grazing largely involves open-range feeding and some supplements. Backgrounding operations use inexpensive feed to add weight to the animal. At this stage, the animal primarily grows bone frame and some muscle, as opposed to heavy muscling and fat of later feeding stages.

Winter pasturing systems tend to be located in the southern United States, and winter wheat pasture systems are located in Kansas, Oklahoma, and Texas. Animals sold from these backgrounding enterprises are referred to as feeder cattle, yearlings, or stocker cattle. They weigh between 600 and 800 pounds and are marketed during the spring. At that time, the feeder cattle enter a feedlot or are placed onto summer pasture. Which path the animals take depends on the animal's size: smaller animals (stocker cattle) are pastured and larger animals are placed into feedlots. The price of high-energy feed, such as corn, also influences an animal's path. Expensive grain feed encourages additional grazing and fewer cattle being fed in feedlots. Summer-pastured cattle are marketed in the fall as feeder animals and weigh between 750 and 950 pounds.

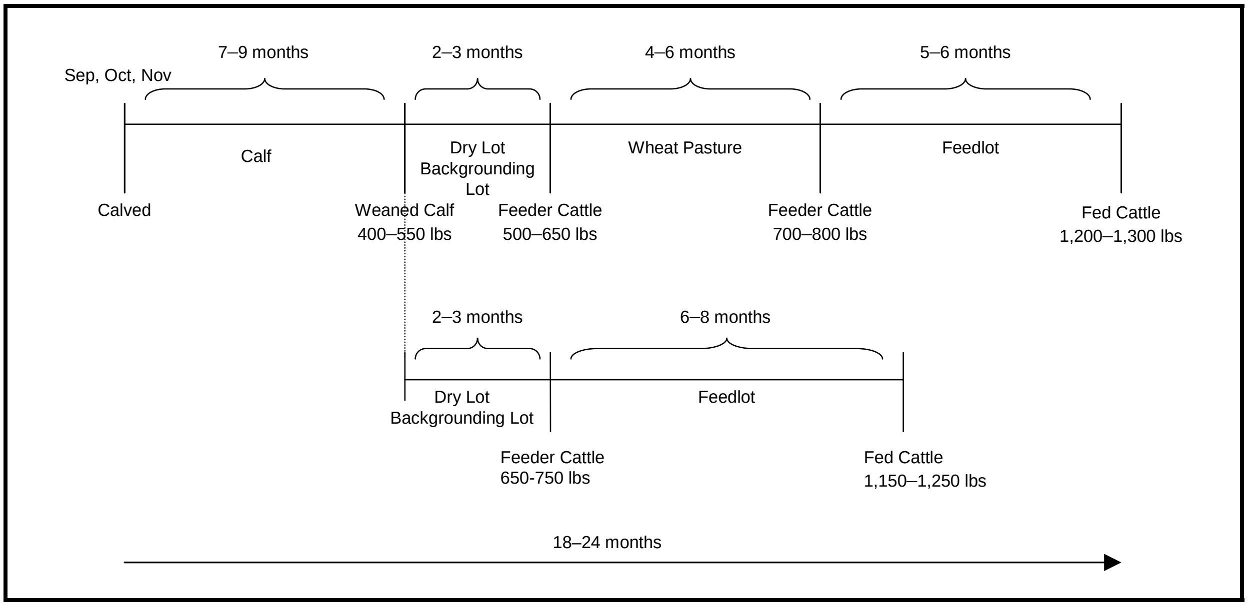
The length of the feeding period depends on the cost of feed, the price of fed animals, the premiums or discounts associated with meat quality, and the size of the animal entering the feedlot.

Animals that enter the feedlot in the spring as yearlings or the fall as feeder cattle are fed a high-energy ration for 4 to 6 months. The length of the feeding period depends on the cost of feeder cattle, the cost of feed, the price of fed animals, the premiums or discounts associated with meat quality, and the size of the animal entering the feedlot. Corn or corn by-products are the main cattle feed, but sorghum and barley also are often used. The diet also contains some forage to support the ruminant animal stomach and some high-protein feed, such as soybean meal. Again, a large variety of roughage feeds is used, including grass hays, corn silage, green-chopped hays, sugar beet pulp, and citrus and other fruit pulps. Cattle-feeding operations tend to locate near inexpensive sources of forage feeds and energy feeds.

The above discussion describes the primary beef production system. However, in some beef cow-calf operations, cows calve during the fall. These operations are in the minority and tend to be located in the southern United States (Figure 1-2). Some calving operations are year round, but these are atypical. Fall calving operations attempt to capture counter seasonal patterns in calf prices. Cows are calved in the fall, and calves graze winter grass pastures with supplemental feed and are either sold as weaned calves in the spring to producers that place the animals on summer pasture or retained by the producer for summer pasture grazing.

After grazing for the summer, feeder animals usually go into preconditioning lots or backgrounding lots for 1 to 2 months and then into a feedlot and on feed during the winter. The path the animal takes depends on the animal's size. Small animals are preconditioned in a lot, whereas larger animals may go to the feedyard. Animals are fed 4 to 6 months in the feedlot. The feeding schedule is the same as for cattle that were spring-born calves. Marketing fed cattle that were fall-born calves is similar to the marketing of spring-born calves.

Figure 1-2. Typical Cattle Production Timeline: Fall-Calved Beef Animal
Changing calving season can allow producers to use different resources.



Most slaughter enterprises are combined with fabrication enterprises that process the carcass into cuts that are a portion of the carcass or specific muscles, but both parts of the enterprise are likely separate profit centers.

***Quality grade** refers primarily to carcass maturity and amount of intramuscular fat.*

After feeding a high-energy ration, fed cattle are marketed as fed or finished steers and heifers. These cattle are marketed to businesses that specialize in slaughter of live animals, production of beef carcasses, and processing and marketing of animal by-product. Most slaughter enterprises are combined with fabrication enterprises that process the carcass into cuts that are a portion of the carcass or specific muscles, but both parts of the enterprise are likely separate profit centers. Cuts are referred to as boxed beef and are vacuum sealed in plastic bags and packaged in cardboard boxes.

Carcasses are inspected for wholesomeness by the U.S. Department of Agriculture's (USDA's) Food Safety and Inspection Service (FSIS) or by a state government inspection system and may be quality graded by USDA's Agricultural Marketing Service (AMS). Federal inspection by FSIS is required for shipment of meat in interstate trade. Grading is not required but is usually performed. Carcasses are quality graded and yield graded. **Quality grade** refers primarily to carcass maturity and amount of intramuscular fat. Mature carcasses cannot receive a high-quality grade. USDA Quality Grades are Prime, Choice, Select, and Standard. Cattle that will grade Standard are typically not graded and are referred to as "No-

__Yield grade__ is the amount of meat or salable meat in the carcass.

__Cow-calf operations__ may be cattle businesses only or the business may diversify into other ranching enterprises, such as haying, and other farming operations, such as row crops.

__Stocker cattle operations__ or backgrounding operations are enterprises with surplus forage.

Roll."[4] Connective tissue in meat is more substantial in older animals, and meat flavor may be stronger and "gamier." Intramuscular fat, the fat tissues that are within the muscle as opposed to fat layers between muscles, impart mild flavors and hold moisture in cooking. Thus, intramuscular fat is desirable and results in a higher quality grade. **Yield grade** is the amount of meat or salable meat in the carcass. USDA Yield Grades are numbered 1 through 5. Increases in the amount of fat cover between the hide and carcass and fat deposits close to edible organs result in a lower yield grade. Smaller muscles also result in lower yield grades.

Cow-calf operations may be cattle businesses only or the business may diversify into other ranching enterprises, such as haying, and other farming operations, such as row crops. The diversification choice depends largely on the environment. Western cow-calf operations tend to be cattle operations only, with some haying if irrigation water is available. Midwestern and southern cow-calf operations tend to be combined with farming enterprises in which cattle graze on land that cannot be used for row crops.

Stocker cattle operations or backgrounding operations are enterprises with surplus forage. Rarely are backgrounding operations single enterprises. It is more cost-effective to move the cattle to the forage than the forage to the cattle. The most common practice is to purchase yearlings for grazing on summer pasture so that the enterprise can essentially market cheap grass through growth on a ruminant animal. Some weaned calves are marketed in the fall because summer pasture will not be available until the following spring. Large proportions of these animals go onto winter wheat pasture in the southern High Plains, followed by grass pasture in the southeastern United States. However, calves can be wintered anywhere with substantive pasture, such as dormant grass with high available protein, but may require supplemental feeding and hay. Many but not all calves in the northern states are shipped south for pasturing.

[4] The term "No-Roll" originated from an earlier practice in which the USDA Quality Grade was rolled on the fat along the length of the carcass using an ink wheel. Carcasses that were "No-Roll" did not receive a quality grade.

***Cattle-feeding operations** are concentrated in the southern Plains States, High Plains States, and the Midwest.*

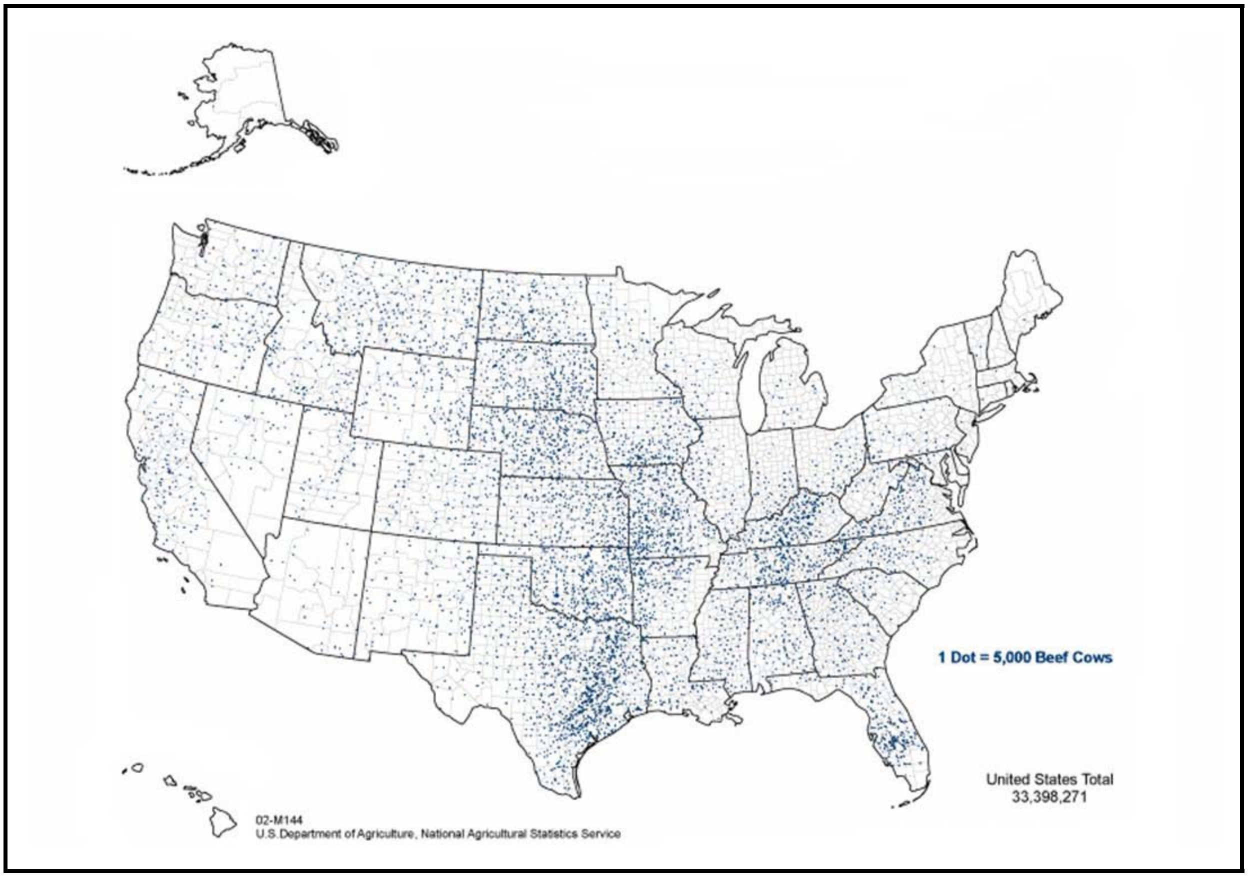
Cattle-feeding operations are concentrated in the southern Plains States, High Plains States, and the Midwest. Feeder cattle move from pasture and backgrounding systems to feedlots in these regions. Large numbers of animals are confined together in these feeding operations, but the animals are also in the outdoors. Cattle-feeding operations are specialized operations. However, the operations may be part of a larger enterprise that grows and manufactures feed. These feedlots grow a portion of their feed supplies, such as corn silage and other forages, and purchase some of the grain needed for feeding. Many cattle-feeding operations own several feedyards. These feedyards are operated by on-site management, but central management may make decisions and capture economies in feed purchasing, feed manufacturing, animal procurement and marketing, financing, and risk management.

1.1.2 Location and Size of Beef Cattle Operations

Cow-calf operations, as illustrated in Figure 1-3, are widely distributed across the United States, although cow-calf operations are concentrated in the Midwest and southern United States because the climate and rainfall are supportive of pastures in these regions. Cow-calf production is also present in the western United States and is important to western agriculture, even though the climate does not support extensive forage production.

Figure 1-4 shows that cattle-feeding operations are concentrated in the southern Plains States, High Plains States, and the Midwest. Large numbers of animals are confined in these feeding operations. Cattle feeding moved to the High Plains from the Corn Belt with the development of irrigated row crop agriculture over the aquifers in the High Plains. However, these regions remain corn deficient and receive shipments of grain from the Midwest for cattle feeding. The improved performance of animals on feed outweighs the transportation costs. The dry climate also makes animal waste management less of an issue than in the wetter and more populous Midwest and Corn Belt states.

Figure 1-3. U.S. Inventory of Beef Cows, 2002
Cow-calf operations are located throughout the country, but are concentrated in the Midwest and South.

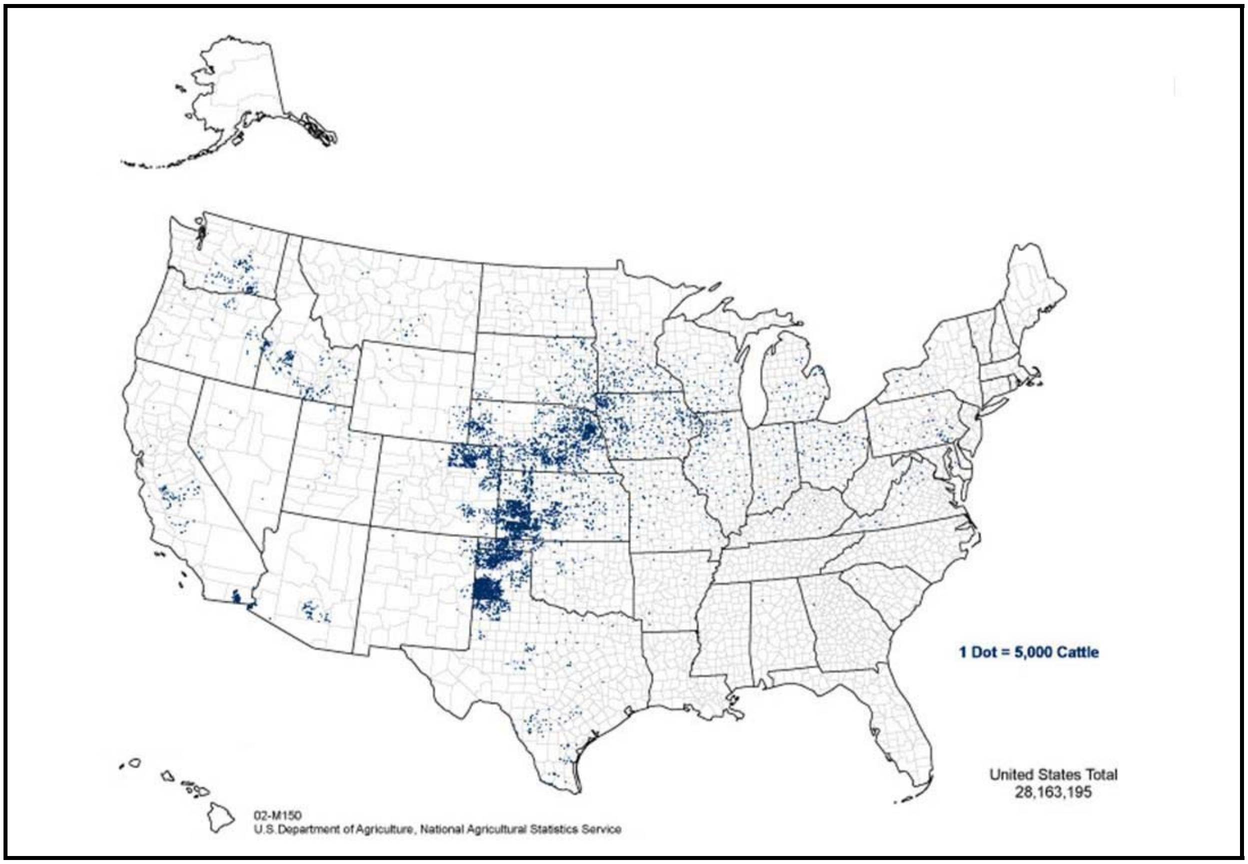


Source: U.S. Department of Agriculture, National Agricultural Statistics Service (USDA, NASS). 2004. "2002 Census of Agriculture." Washington, DC: USDA. <http://www.nass.usda.gov/research/atlas02/>.

Cattle slaughtering and processing operations are located close to cattle-feeding regions (Figure 1-5). Given advances in technology, it is more economical to move meat to people than to move cattle to people. Meatpacking operations that are not located close to cattle-feeding operations are located in regions with larger numbers of beef and dairy herd animals. Most cow slaughter plants are located in Wisconsin and Pennsylvania to be close to dairy production in the Northeast and Southeast.

The majority of cattle operations are relatively small in scale. More than 97% of all beef cattle operations have less than 500 head, and approximately 79% have less than 100 head (USDA, NASS, 2006). Despite the large proportion of small cattle operations, almost half of U.S. cattle come from large operations. Operations with 500 or more head maintain 42% of cattle inventories, and half of those cattle are held on operations with 1,000 or more head.

Figure 1-4. Number of Cattle on Feed Sold, 2002
Cattle feeding is concentrated in the Plains States.



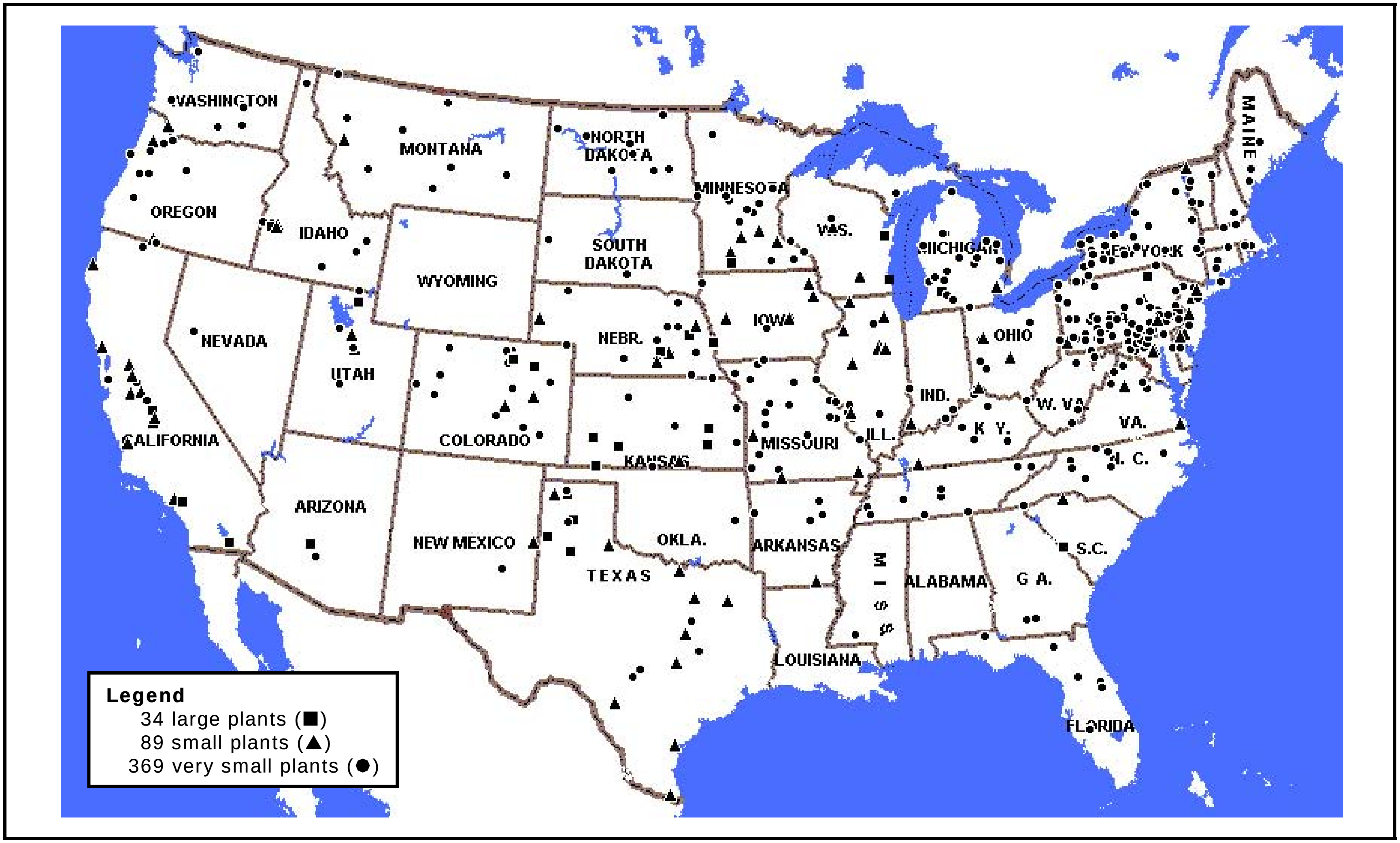
Source: U.S. Department of Agriculture, National Agricultural Statistics Service. 2004. "2002 Census of Agriculture." Washington, DC: USDA. <http://www.nass.usda.gov/research/atlas02/>.

Overall, the structure of the cow-calf sector is very similar to the beef cattle industry; however, the scale is slightly smaller. Approximately 90% of all beef cow operations have less than 100 head, and 78% have less than 50 head. Nearly 47% of the U.S. beef cow inventory is held on operations with less than 100 head. Operations with 500 or more head of beef cows account for less than 15% of the total inventory.

Data from the USDA/ERS Agricultural Resource Management Survey (ARMS) indicate that cattle production is not the primary occupation for the majority of cow-calf producers in covered states.[5] Between 2000 and 2004, an average of 72% of cow-calf producers were classified as Limited Resource,

[5] The states included in the 1996 ARMS of cow-calf producers were: California, Colorado, Florida, Idaho, Illinois, Kansas, Kentucky, Louisiana, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, and Oregon.

Figure 1-5. Location of Federally Inspected Plants that Slaughter Steers and Heifers[a]



[a] Plants that slaughtered at least 50 head of steers and heifers in fiscal year 2004 (October 1, 2003, through September 30, 2004) are included. Of 492 plants, 34 are classified by FSIS as large, with 500 or more employees; 89 are classified as small, with 10 to 499 employees; and 369 are classified as very small, with fewer than 10 employees or less than $2.5 million in annual sales. Plants in Alaska (2) and Hawaii (7) are not shown.

Source: RTI International. 2005. Enhanced Facilities Database. Prepared for the U.S. Department of Agriculture, Food Safety and Inspection Service. Research Triangle Park, NC: RTI.

Retired, or Lifestyle producers (USDA/ERS, 2007). These part-time producers relied on off-farm income to subsidize their farming activities. On average, farming activities reduced part-time producers household income by $3,000, and off-farm activities contributed $49,000 to household income. Full-time cow-calf producers averaged positive returns from both on-farm ($45,000) and off-farm ($49,000) activities between 2000 and 2004.

1.1.3 Trends in Beef Cattle Operations

The cyclical nature of cattle production is evident based on trends in the number of cattle slaughtered.

Prior to the 1970s, animal inventories trended strongly upward. However, beef animal inventories have been decreasing steadily since then. Two cattle cycles ago, there was a large “bust” phase of the cycle, which resulted in very large inventories, very low prices, and substantial losses. Beef cow inventories have declined steadily since the subsequent liquidation. Beef production—pounds of beef produced and marketed—declined initially but has been relatively stable to exhibiting moderate growth since the late 1970s. Recently, during the immediate past liquidation phase of the cattle cycle and with record low corn and other feed prices, beef production achieved new record highs. Figure 1-6 shows the change in cattle inventories during the most recent cattle cycle. The cyclical nature of cattle production is evident based on trends in the number of cattle slaughtered. As seen in Figure 1-7 the number of steers and heifers slaughtered declined during the initial buildup phase (1990–1992) and then gradually increased throughout the herd buildup phase. Because of the biological lags in production, steer and heifer slaughter typically does not begin to decline until after breeding herds have started to be liquidated.

Concentration in the beef packing industry increased sharply in the late 1980s and early 1990s, but has been relatively stable since then.

Four meat packers slaughter and process more than 80% of the fed cattle marketed in the United States (Figure 1-8). All four of those packers own multiple plants, and three slaughter and process multiple species of animals. Concentration in beef packing increased sharply during the wave of mergers in the late 1980s and early 1990s, as declining demand forced beef packers to seek cost savings through economies of scale.[6] However, since then the level of concentration has been relatively stable to slightly declining. Concentration levels in boxed beef processing are slightly higher than for fed animal slaughter.

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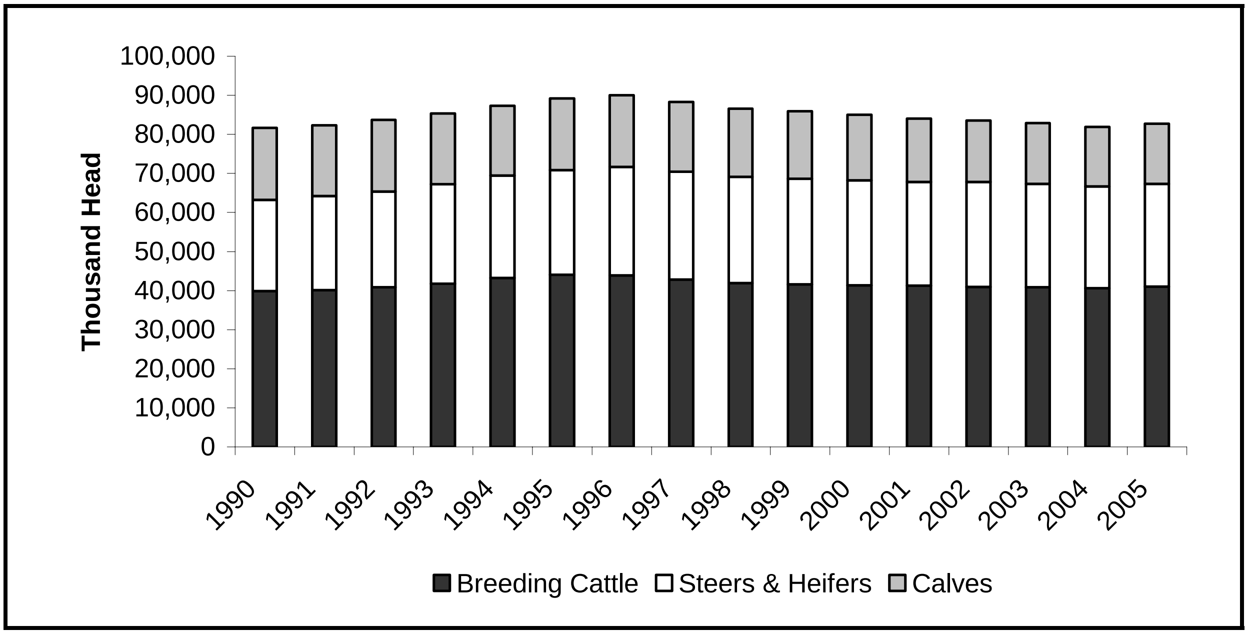
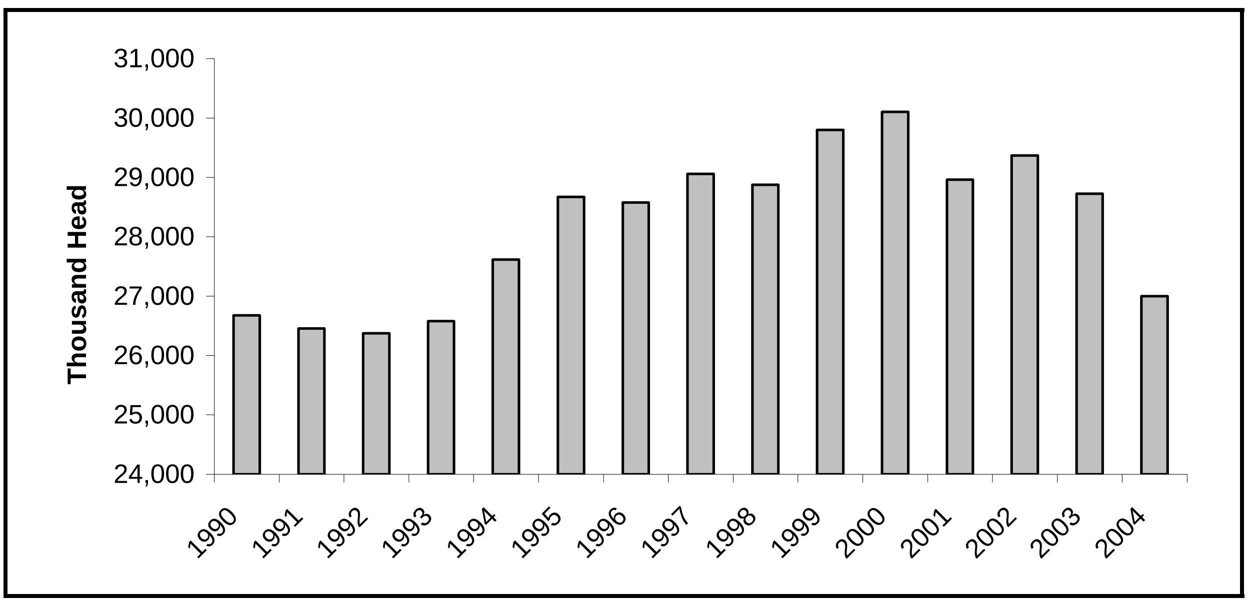
[6] Concentration refers to the portion of industry volume accounted for by the largest firms. The four-firm concentration ratio (CR4), which is a common measure of concentration, is the summation of the market shares of the four largest firms.

Figure 1-6. U.S. Cattle Inventory, 1990–2005
Cattle inventory categories include breeding cattle (beef cows, beef heifers, and bulls), steers and heifers (steers over 500 pounds and heifers other than those considered beef heifers), and calves. Milk cows and dairy heifers are not included in this figure.



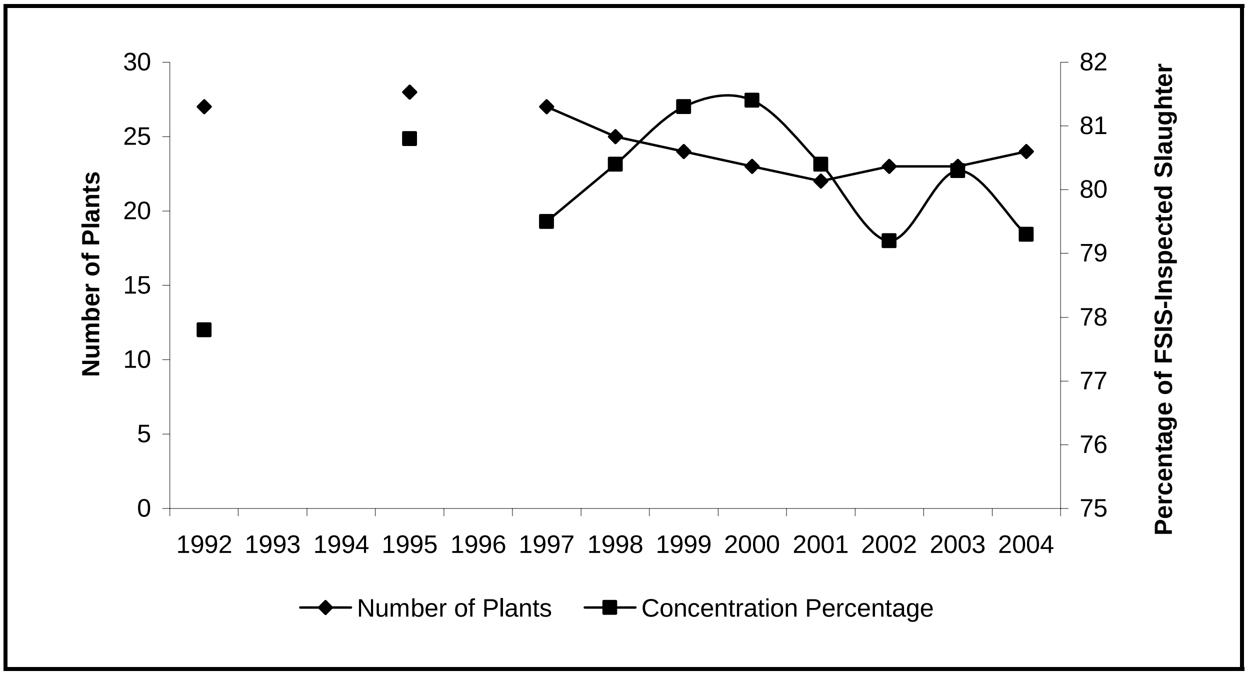
Source: U.S. Department of Agriculture, Economic Research Service, Market & Trade Economics Division. 2006. *Red Meat Yearbook*. Stock #94006. Washington, DC: USDA. <http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1354.>

Figure 1-7. U.S. Commercial Steer and Heifer Slaughter, 1990–2004
Commercial steer and heifer slaughter includes animals slaughtered at federally inspected and nonfederally inspected plants but does not include animals slaughtered on the farm.



Source: U.S. Department of Agriculture, Economic Research Service, Market & Trade Economics Division. 2006. *Red Meat Yearbook*. Stock #94006. Washington, DC: USDA. <http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1354.>

Figure 1-8. U.S. Steer and Heifer Packer Four-Firm Concentration Ratio (CR4), Selected Years 1992–2004
The CR4s show the percentage of all steers and heifers that were slaughtered at plants owned by the four largest firms during the respective year. The total number of plants operated by those firms is also included. Percentages are based on total federally inspected slaughter numbers.



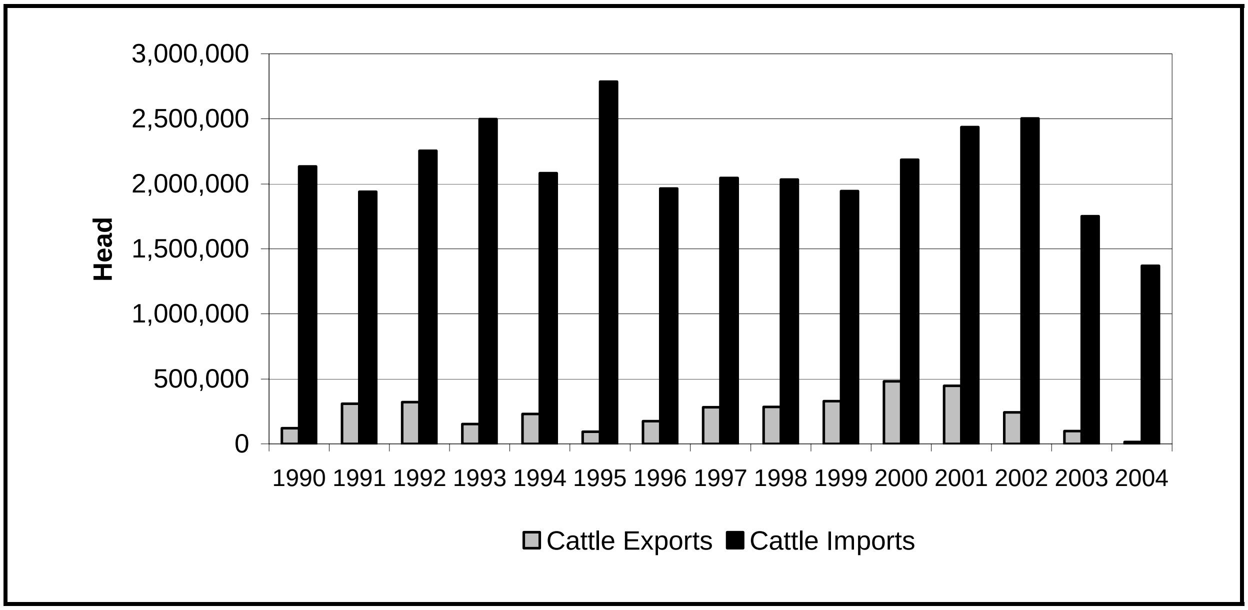
Source: U.S. Department of Agriculture, Grain Inspection, Packers and Stockyards Administration (USDA, GIPSA). 2006. *Packers and Stockyards Statistical Report*. SR-06-1. Washington, DC: GIPSA.

1.1.4 Imports and Exports of Cattle and Beef

The United States is a net importer of live cattle (Figure 1-9). Recent trade restrictions have altered the international market, but the United States has traditionally imported live cattle from Canada and Mexico. These cattle are imported as finished cattle ready for immediate slaughter and feeder cattle that will be fed out in domestic feedlots. Very few live cattle are exported.

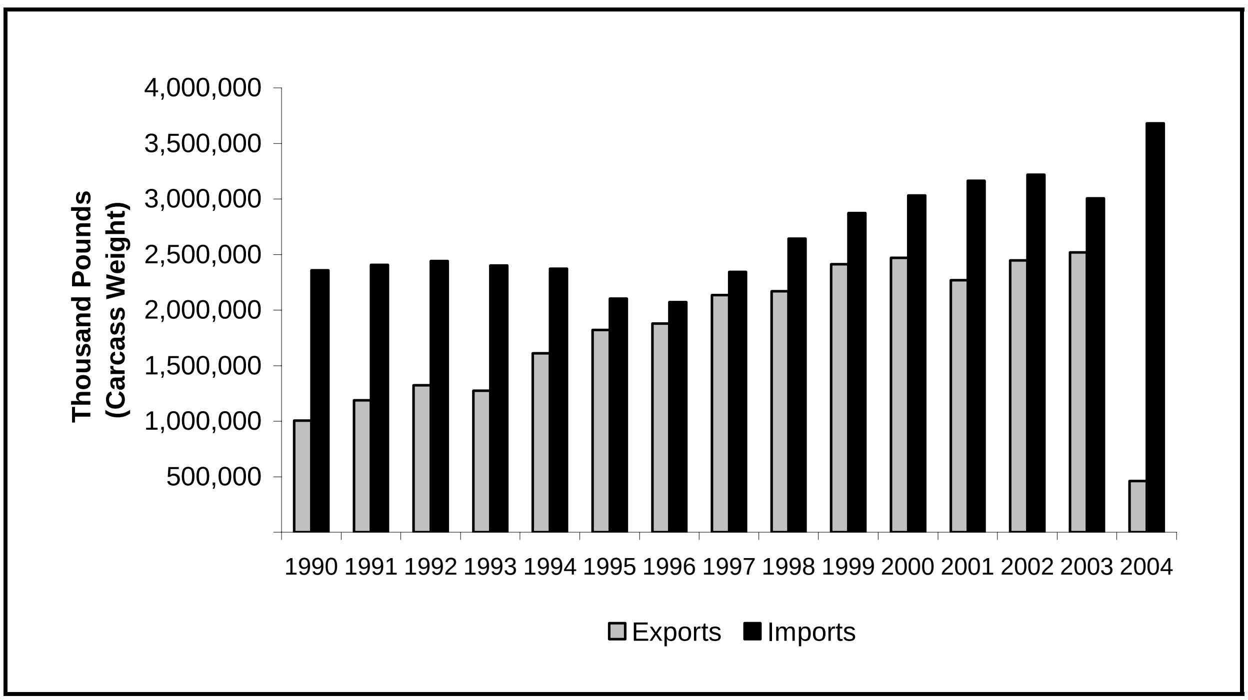
In addition to imports of live cattle, the United States is a net importer of beef (Figure 1-10). In 2003, beef imports were approximately 11% of U.S. beef consumption, and beef exports were approximately 10% of U.S. beef production (USDA, Economic Research Service [ERS], 2004b). Canada has been a growing supplier of beef to the U.S. market, but the majority of imports are from New Zealand and Australia. Grass-fed beef produced in Australia and New Zealand is much different from grain-fed beef produced domestically. Much of this beef is used in processed products, particularly ground beef (USDA, ERS, 2004a).

Figure 1-9. Total U.S. Cattle Imports and Exports, 1990–2004
The United States is a net importer of live cattle. Live animal trade is typically restricted to North America.



Source: U.S. Department of Agriculture, Economic Research Service, Market & Trade Economics Division. 2006. *Red Meat Yearbook*. Stock #94006. Washington, DC: USDA. <http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1354.>

Figure 1-10. Total U.S. Beef and Veal Imports and Exports, 1990–2004
The United States is a net importer of beef and veal. Canada, Australia, and New Zealand are the primary sources of imported beef and veal. Mexico, Japan, and Canada are the primary destinations for U.S. exported beef and veal.



Source: U.S. Department of Agriculture, Economic Research Service, Market & Trade Economics Division. 2006. *Red Meat Yearbook*. Stock #94006. Washington, DC: USDA. <http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1354.>

1.2 OVERVIEW OF MARKETING ARRANGEMENTS IN THE FED CATTLE AND BEEF INDUSTRIES

Key dimensions that define a marketing arrangement include

- procurement or sales method,
- ownership method of the animal or product,
- pricing method (including formula pricing base and internal transfer pricing method), and
- valuation method for livestock.

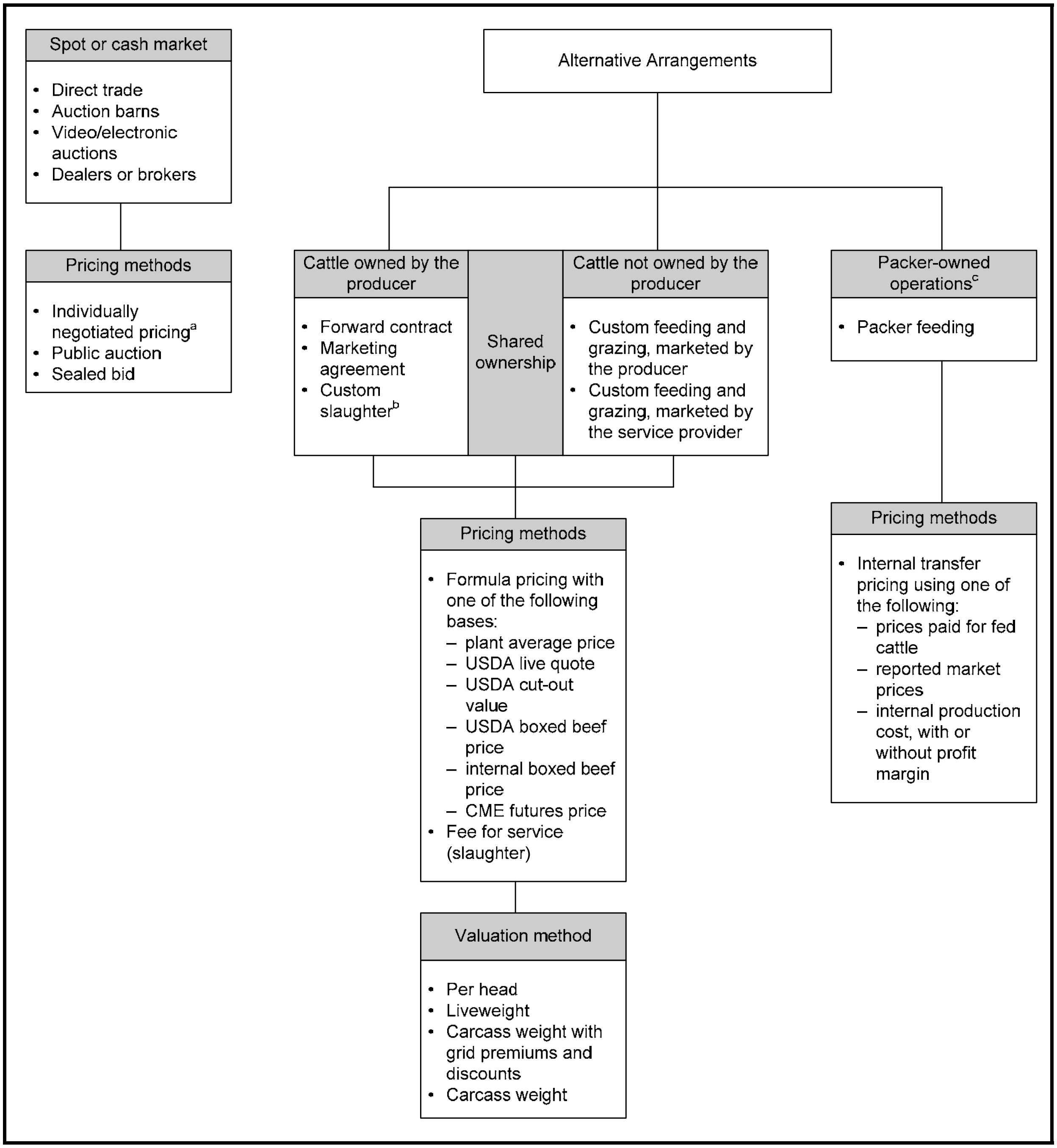
In this report, cash or spot market transactions refer to transactions that occur immediately or "on the spot." These include auction barn sales; video or electronic auction sales; sales through order buyers, dealers, and brokers; and direct trades. The terms "cash market" and "spot market" are used interchangeably. "Alternative marketing arrangements" (AMAs) refer to all possible alternatives to the cash or spot market. These include arrangements such as forward contracts, marketing agreements, procurement or marketing contracts, packer owned, custom feeding, and custom slaughter. For AMAs at the producer level, livestock may be owned by the individual(s) that owns the farm or facility, or the livestock may be owned by a different party.

In addition to the type of procurement or sales method, other key dimensions that define each type of marketing arrangement used in the industry are ownership method of the animal or product, pricing method, and valuation method for livestock. Pricing method is further defined by formula base, if formula pricing is used, and internal transfer pricing method, if the product is transferred within a single company.

Figure 1-11 illustrates the types of marketing arrangements used for sales or transfers of feeder and fed cattle. The key dimensions of marketing arrangements at each stage include the **ownership method** for the animal or product while it is at the feedlot (e.g., cattle owned by the producer or owner of the feedlot, jointly owned by the producer and packer, and packer owned) and the **pricing method** used. If formula pricing is used, a **formula base price** must also be specified. The **valuation method** might be on a per-head basis, liveweight basis, or carcass weight basis or on the accumulated value of individual cuts. Carcass weight valuation methods may also incorporate a grid that offers premiums or discounts based on carcass grade classifications. Premiums and discounts may change weekly based on supply and demand conditions or may be fixed for some period. If animals or products are shipped from one establishment to another owned by the same company, an **internal transfer pricing method** must also be specified.

Figure 1-11. Marketing Arrangements for Sale or Transfer of Feeder and Fed Cattle by Beef Producers

Different types of pricing methods are associated with each type of marketing arrangement used in the industry.



Note: CME = Chicago Mercantile Exchange.

[a] Individually negotiated pricing is often benchmarked against reported prices.

[b] Custom slaughter may be coordinated by a cooperative for its producer members.

[c] Packer-owned operations may also feed cattle that are under partnership or joint venture with other entities.

The types of buying and selling mechanisms vary by stage of the beef production system.

The types of buying and selling mechanisms vary by stage of the beef production system. Figure 1-12 illustrates the types of marketing arrangements used for sales or transfers of all types of meat products (including beef) by packers. Under AMAs, meat products might be sold by the packer or transferred to another establishment owned by the same company or to the owner of the livestock if custom slaughtered. Spot or cash market sales of meat are primarily conducted via individual negotiations. Transactions may be for carcasses, single cuts, or a variety of cuts. Sales representatives usually start negotiations for individual cuts based on a price list and usually must meet sales quotas. Listed prices are discounted if inventories of that cut are plentiful. Other pricing practices used for meat products might include two-part pricing, volume discounts, exclusive dealings, and bundling.

1.3 DESCRIPTION OF THE BEEF PACKER TRANSACTIONS DATA

Many of the analyses conducted for this volume were based on transactions data obtained from beef packers. We obtained usable fed cattle purchase data from 29 beef packing plants and usable beef sales data from 24 beef packing plants. We describe the data preparation process and content of the purchase data set and the sales data set below.

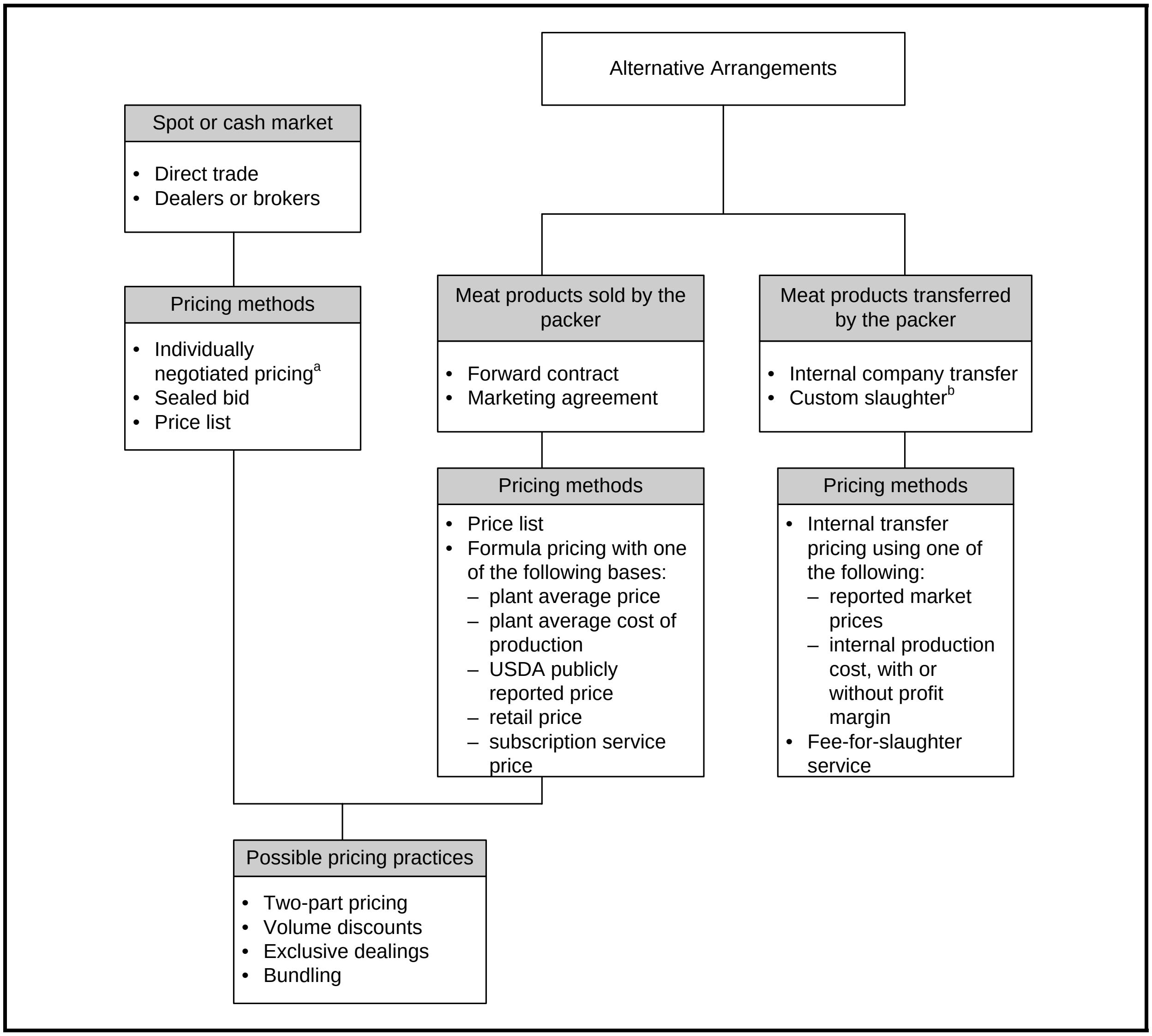
1.3.1 Beef Packer Purchase Transactions Data

For this volume of the report, we used fed cattle purchase records from 29 plants (owned by 10 companies) and beef product sales records from 24 plants (owned by 8 companies), in addition to many other data sources.

Prior to tabulating and analyzing the fed cattle purchase transactions data, we systematically examined the purchase data set to isolate and address data inconsistencies, data reporting errors, or extraneous data. Specific data preparation procedures were as follows:

- **Cattle totals by yield grade.** Plants were asked to record the distribution of cattle into yield grades. For some data records, the number of head in the sale lot did not correspond to the sum of the distribution of yield grades. For cases where the sum of the yield grades was less than the number of head in the sale lot, we allocated the difference to the Yield Grade Other category. For cases where the sum of the yield grades was greater than the number of head in the sale lot, we used the yield total as the number of head in the sale lot.

Figure 1-12. Marketing Arrangements for Sale or Transfer of Meat Products from Packers
Meat products are sold or transferred to processors, wholesalers, exporters, food service operators, or grocery retailers.



[a] Individually negotiated pricing is often benchmarked against reported prices.

[b] Custom slaughter may be coordinated by a cooperative for its producer-members.

- **Cattle totals by quality grade.** The data preparation procedures for quality grade were similar to those for yield grade. Plants were asked to record the distribution of cattle into quality grades. For some data records, the number of head in the sale lot did not correspond to the sum of the distribution of quality grades. For cases where the sum of the quality grades was less than the number of head in the sale lot, we allocated the difference to the Quality Grade Other category.

- **Dairy cattle.** Some plants did not record the mix of cattle in the sale lot (i.e., steers, heifers, cows, or bulls). If a data record indicated a cattle type of primarily beef cattle and the lot was also distributed over the quality grades then the number of head in the sale lot was allocated to steers. If a data record indicated a cattle type of primarily dairy cattle then the record was not retained.
- **Irreconcilable cattle numbers by various categories.** Data records with yield grades, quality grades, or cattle mixes that could not be reconciled with the number of head in the sale lot were deleted (39,719 records deleted).
- **Transaction dates.** Data records with purchase or pricing dates outside the data collection period were deleted (39 additional records deleted).
- **Small cattle lots.** Data records with five or less head in a sale lot were deleted (36,657 additional records deleted). Lots with five or less head were considered to be odd lots, often representing "out" cattle.
- **Missing carcass weights.** Data records that did not contain a hot weight were deleted. This was necessary because all prices were analyzed on a carcass weight basis (4,343 additional records deleted).
- **Out-of-range carcass weights.** Data records that had an average carcass weight greater than or equal to 500 pounds and less than or equal to 1,000 pounds were retained. All records outside this range were deleted (569 additional records deleted).
- **Missing total cost information.** Data records that did not contain total cost were deleted. This was necessary because all prices were based on total cost (981 additional records deleted).
- **Out-of-range prices.** Data records where cost per pound (i.e., carcass weight) was between $0.86 and $1.98 per pound were retained. This range represents $0.10 below the minimum and $0.10 above the maximum prices indicated in mandatory price reporting (MPR) data during the October 2002 through March 2005 period. All records outside this range were deleted (20,482 additional records deleted).

Prior to data preparation, the data set included 725,148 fed cattle purchase records representing 59,820,187 head of cattle. After data preparation, the final data set included 591,410 fed cattle purchase records representing 58,066,144 head of cattle.[7] However, even after data preparation, many records were missing important fields (e.g., date of purchase, date of pricing, purchase method, and pricing method) or did not break down costs into their individual components. In some cases, these missing fields limited our ability to conduct the analyses for the study.[8]

Table 1-1 provides the distribution of these records by region and plant size. The majority (84%) of the fed cattle slaughtered were slaughtered in plants located in the High Plains region. In addition, 75% of the cattle were slaughtered in large plants with slaughter capacity greater than 20,000 head per week. Table 1-2 provides a further breakdown of the characteristics of the fed cattle purchase transactions in the analysis data set.

Table 1-1. Summary of Available Data on Purchases of Steers and Heifers, October 2002–March 2005

Plant Characteristic	No. of Plants	No. of Lots Purchased	No. of Cattle Purchased	% of Cattle Purchased
Region				
Cornbelt/Northeast	5	98,140	4,377,325	8.0%
High Plains	17	426,787	48,496,683	84.0%
West	7	66,483	5,132,136	9.0%
Plant size				
Small	15	202,350	14,256,150	25.0%
Large	14	389,060	43,749,994	75.0%
Total	29	591,410	58,006,144	100.0%

Regions are defined as follows:
Cornbelt/Northeast: IA, IL, MI, MN, PA, WI
High Plains: CO, KS, NE, TX
West: AZ, CA, ID, UT, WA
Sizes are defined as follows:
Small has capacity < 20,000 head/week.
Large has capacity > 20,000 head/week.

[7] The data preparation process resulted in a loss of only 3% of the fed cattle in the data set.
[8] More details on data preparation are provided in Volume 2, Section 12.

Table 1-2. Summary Statistics for Livestock Purchase Lot Characteristics, October 2002–March 2005

Variable	No. of Records	Mean	St. Dev.
No. of head	591,410	98	88
No. of steers	443,963	85	88
No. of heifers	266,673	76	83
No. of cows and bulls	21,147	3	7
Liveweight (lb)	573,604	122,000	110,000
Hot weight (lb)	591,410	76,600	69,700
Total cost ($/lot)	591,410	$101,000	$92,800
Cattle cost ($/lot)	255,985	$105,000	$89,900
Shipping cost ($/lot) positive	143,669	$955	$1,250
Base price ($/lb)	343,062	$1.32	$0.16
Adjustments ($/lb)	42,983	$0.03	$0.07
Quality grade (% of lot)	591,410		
Prime		3.3%	6.1%
Choice		38.8%	32.5%
Upper choice[a]		8.3%	14.6%
Lower choice[a]		12.4%	18.7%
Select		29.1%	20.8%
Standard		1.0%	3.5%
Other or missing		7.2%	16.7%
Yield grade (YG) (% of lot)	591,410		
YG 1		9.2%	9.9%
YG 2		42.6%	18.8%
YG 3		38.2%	18.6%
YG 4		5.5%	7.1%
YG 5		0.6%	1.8%
Other or missing		3.8%	14.4%
30+ months (% of lot)	507,660	0.8%	5.1%
Branded (% of lot)	468,804	23.0%	24.1%

[a] Upper choice and lower choice are types of Choice grades used by some packers.

Note: Base price and adjustments are based on liveweight.

1.3.2 Beef Packer Sales Transactions Data

Prior to tabulating the sales transactions data, we systematically examined the sales data set to isolate and address data inconsistencies, data reporting errors, or extraneous data. Specific data preparation procedures were as follows:

- **Out-of-range list prices**. Data records that had a list price more than three standard deviations (plus or minus) from the mean list price were deleted (25,931 records deleted). With the large number of products, we could not identify precisely which values were actual errors and which were extreme values, so all of these values were considered errors and subsequently deleted.
- **Out-of-range gross prices.** Data records that had a gross price more than three standard deviations (plus or minus) from the mean gross price were deleted (27,068 additional records deleted). With the large number of products, we could not identify precisely which values were actual errors and which were extreme values, so all of these values were considered errors and subsequently deleted.

Prior to data preparation, the data set included 5,969,333 beef product sales records (excluding by-products). After data preparation, the final data set included 5,916,334 beef product sales. However, selling method and pricing method were missing from a substantial number of records.

Table 1-3 provides the distribution of these records by region and plant size. The majority (83%) of beef products sold were sold by plants located in the High Plains region. In addition, 75% of the beef products sold were from large plants with slaughter capacity greater than 20,000 head per week. Table 1-4 provides a further breakdown of the characteristics of the fed cattle sales transactions in the analysis data set.

1.4 ORGANIZATION OF THE FED CATTLE AND BEEF STUDY VOLUME

In the remaining sections of this volume, we present results of the study for the fed cattle and beef industries. Section 2 provides results on volume differences, price differences, and market price effects associated with AMAs. Section 3 provides results on economies of scale, cost, and efficiency differences

Table 1-3. Summary of Available Data on Sale of Beef Products, by Packers, October 2002–March 2005

Plant Characteristic	No. of Plants	No. of Transactions (Records)	No. of Pounds	% of Pounds Sold
Region				
Cornbelt/Northeast	5	526,251	2,794,114,501	9%
High Plains	15	4,131,466	26,336,083,611	83%
West	4	1,258,617	2,652,024,239	8%
Plant size				
Small	11	2,122,176	7,804,461,294	25%
Large	13	3,794,158	23,977,761,056	75%
Total	24	5,916,334	31,782,222,350	100%

Regions are defined as follows:
- Cornbelt/Northeast: IA, IL, MI, MN, PA, WI
- High Plains: CO, KS, NE, TX
- West: AZ, CA, ID, UT, WA

Sizes are defined as follows:
- Small has capacity < 20,000 head/week.
- Large has capacity > 20,000 head/week.

Table 1-4. Summary Statistics for Beef Sales Lot Characteristics, October 2002–March 2005

Variable	No. of Records	Mean	St. Dev.
Total weight (lb)	5,916,334	5,372	28,505
List price ($/lb)	3,777,206	2.74	4.29
Gross price ($/lb)	5,365,067	2.62	1.95
Price adjustments ($/lb)	4,325,933	0.004	0.17
Net price ($/lb)	5,365,067	2.57	1.97
Shipping cost ($/lb)	5,492,076	0.06	0.07
Commission cost ($/lb)	4,597,904	0.01	0.06
	No. of Records	**% of Records**	
Buyer type			
Meat processor/food manufacturer	557,021	10.7%	
Wholesaler/broker/distributor	840,380	16.1%	
Retailer	1,651,586	31.6%	
Food service operator	1,049,524	20.1%	
Foreign buyer	170,021	3.3%	
Other	961,210	18.4%	
Branded	905,384	15.3%	
Other certification	D	D	

(continued)

Table 1-4. Summary Statistics for Beef Sales Lot Characteristics, October 2002–March 2005 (continued)

Variable	No. of Records	% of Records
Quality grade		
Prime	115,614	2.0%
Choice	1,887,640	31.9%
Upper choice	321,309	5.4%
Lower choice	119,700	2.0%
Select	1,318,829	22.3%
Other or missing	2,153,242	36.4%
Product classification		
Carcass or side	D	D
Primal cut	1,605,997	27.2%
Subprimal cut	2,653,306	44.9%
Ground and trimmings	970,454	16.4%
Portion cut	0	0.0%
Case ready	D	D
Processed ready-to-eat (RTE)	0	0.0%
Processed not ready-to-eat (NRTE)	0	0.0%
Other or missing	D	D
Trim level		
3/4 inch	1,743,577	47.9%
1/4 inch	63,072	1.7%
1/8 inch	1,077,513	29.6%
Practically free	621,218	17.1%
Peeled/denuded	136,522	3.8%
Tenderized/marinated	0	D
Added ingredients	D	D
Refrigeration		
Chilled/fresh	4,927,360	92.7%
Frozen	389,448	7.3%
Other	126	0.0%
Packaging		
Vacuum	2,646,257	89.8%
Gas	D	D
Paper	D	D
Combination	D	D
Other	248,268	8.4%

D = Results suppressed.

associated with AMAs. Section 4 provides results on quality differences, and Section 5 provides results on risk shifting associated with AMAs. Section 6 provides results on the measurement of economic effects associated with restricting AMAs by simulating hypothetical scenarios. Finally, Section 7 describes the implications of AMAs, including the incentives associated with changing the use of AMAs and the expected effects of possible changes in use of AMAs over time.

Note that each section of this volume addresses the requirements of the study, as defined in the performance work statement for the contract. Section 2 addresses Part C; Sections 3, 4, and 5 address Part D; and Sections 6 and 7 address Part E.

In addition to these sections, Appendix A includes supplementary analyses of price differences across AMAs, and Appendix B provides further technical details on the modeling approach presented in Section 6.

2 Volume Differences, Price Differences, and Short-Run Spot Market Price Effects Associated with Alternative Marketing Arrangements

In this section, we present results on volume differences associated with AMAs, price differences across AMAs, and the effects of AMAs on cash market prices. The discussion and analyses in this section are based on data from the industry survey and on the transactions data obtained from beef packers.

2.1 CATTLE AND BEEF VOLUMES, BY TYPE OF MARKETING ARRANGEMENT

As a result of the multiple data collection methods used for the study, we obtained estimates of the volume of cattle sold through AMAs from multiple sources. Our primary focus in this section is on the methods for selling or transferring fed cattle from feeders to packers, but we also discuss methods of selling or transferring beef products from packers to processors or other entities. As discussed in Volume 2 of this study, 293 beef producers responded to the industry survey (270 small producers and 23 large producers).[1] In addition, 64 beef packing plants responded to the industry survey (34 small and 30 large).[2]

Volumes of fed cattle sales volumes by type of marketing arrangement are estimated from three sources:

- industry survey responses for beef cattle producer sales of fed cattle (293 producer responses)
- industry survey responses for beef packer purchases of fed cattle (64 packing plant responses)
- transactions data for beef packer purchases of fed cattle (29 packing plant responses)

From the weighted industry survey results, beef producer sales arrangements to packers are as follows:

- **Ownership arrangements.** Based on the responses, 78.0% of small producers are sole owners of all cattle on their operations, while 31.3% of large producers are sole owners of all cattle on their operations. Large producers made more use of partner arrangements, shared ownership, joint ventures, and custom feeding (39.9% of cattle sold for large producers versus 14.9% for small producers). (See Volume 2, Table 6-2, Question S2.2.)
- **Sales methods to packers.** An estimated 85.0% of small producers used only the cash or spot market to sell cattle in the past year compared with 23.8% of large producers. Large producers made more use of AMAs such as forward contracts, marketing agreements, packer ownership, internal transfers, and custom feeding and slaughtering (52.5% of head sold for large producers and 8.5% for small producers). Among large producers, the most frequently used were forward contracts and marketing agreements. (See Volume 2, Table 6-5, Question S5.2).
- **Pricing methods.** Large producers used multiple pricing methods in the past year with the most common being individually negotiated pricing (73.9% of producers), public auction (34.8% of producers), and formula pricing (56.5% of producers). In contrast, small producers used primarily individually negotiated pricing (31.7%) and public auction (83.6%). Only 5.7% of small producers used formula pricing. (See Volume 2, Table 6-5, Question S5.3.)
- **Valuation methods.** Large producers more frequently sold cattle based on carcass weight with a grid (60.0% of producers) compared with small producers (14.6% of producers) in the past year. Otherwise, the percentages of producers using liveweight and carcass weight without a grid were similar across size categories. (See Volume 2, Table 6-5, Question S5.5.)

[1] Large beef producers are defined as the 25 largest feedlots and 25 largest cow-calf operations in the United States, and small beef producers are the remainder.

[2] Large beef packers are defined as the 60 largest beef packers, based on slaughter volume, and small beef packers are the remainder.

Across all these characteristics of marketing arrangements, producers indicated that their sales methods in the past year were relatively similar to the methods they used 3 years ago and the methods they expect to use 3 years from now. The only exception is a slight decline in the expected percentage of cattle sold through auction barns over time, although the expected percentage still remains high.

Responses on the industry survey from beef packers provide information on the purchase of cattle from producers (i.e., the other side of the transactions described above). From the weighted industry survey results, beef packer purchase arrangements from producers were as follows:

- **Ownership arrangements.** Based on the responses, 80.8% of small and 60.9% of large plants are sole owners of all cattle slaughtered in their establishments. On a percentage of head basis, small plants and large plants are sole owners of similar percentages (87.1% of cattle for small plants and 84.1% of cattle for large plants). No beef packing plants that responded to the survey reported that they have joint venture ownership arrangements, but a small percentage have shared ownership arrangements (5.2% of cattle for small packing plants and 3.0% of cattle for large packing plants) and other types of ownership arrangements (7.7% of cattle for small packing plants and 13.0% of cattle for large packing plants).[3] (See Volume 2, Table 7-2, Question S2.1.)
- **Purchase methods.** An estimated 77.8% of small beef packing plants used only the cash or spot market to purchase cattle, while only 10.0% of large beef packing plants used only the cash or spot market. Large packing plants used auction barns and dealers or brokers for fewer purchases (9.4% of head versus 37.8% of head for small packing plants), but used more direct trade (53.9% of head versus 40.4% for small packing plants). In addition, large packing plants procured a higher percentage of cattle through AMAs including forward contracts, marketing agreements, and packer fed/owned (33.4% of head for large packing plants and 18.1% of

[3] A joint venture refers to situations in which a business and one or more other businesses join together under a contractual agreement for a specific venture, such as use of specific animal genetics or brand names. In contrast, shared ownership refers to situations in which the original owner and an operation (business) both retain partial ownership of livestock or meat products (that is, a vertical arrangement).

head for small packing plants). (See Volume 2, Table 7-2, Question S2.2.)

- **Pricing methods.** Large packing plants used multiple pricing methods, with the most common being formula pricing (93.3% of plants), individually negotiated pricing (90.0% of plants), public auction (50.0% of plants), and internal transfer pricing (33.3% of plants). In contract, small packing plants used primarily individually negotiated pricing (67.7% of plants), public auction (41.9% of plants), and formula pricing (19.4% of plants). (See Volume 2, Table 7-2, Question S2.3.) The most frequently used base price for formulas, with or without a grid, were distributed across seven different types of prices. (See Volume 2, Table 7-2, Questions S2.4a and S2.4b.)
- **Valuation methods.** Large packing plants more frequently purchased cattle based on liveweight (90.0% of plants) compared with small packing plants (50.0% of plants). A high percentage of large packing plants used carcass weight with grids (86.7% of plants), while almost no small packing plants used this type of valuation. A high percentage of both large and small packing plants used carcass weight not dependent on grid valuation methods. (See Volume 2, Table 7-2, Question S2.6.)

Across all of these characteristics of marketing arrangements, packers indicated that their purchase methods in the past year were relatively similar to the methods they used 3 years ago and to the methods they expect to use 3 years from now. The only exceptions are a very slight decline in public auction purchases and a very slight increase in formula pricing.

In contrast to purchases of fed cattle by packers, sales of beef products by packers are typically through the cash or spot market (83.6% of sales revenue). Forward contracts, marketing agreements, internal company transfers, and other types of AMAs comprise the remaining 16.4% of sales. Approximately 70% of beef packing plants use only the cash or spot market to sell beef products. Overall, packers responded that the percentages across marketing arrangements were similar 3 years ago and are expected be similar 3 years into the future. (See Volume 2, Table 7–2, Question 5.2.) Thus, although AMAs are often used to buy cattle, the sales arrangements for beef products are less formal. This suggests that, on the sales side, the link between purchases of live cattle to meet specific buyer requirements is often relatively informal.

In addition to the volume data from survey results, the transaction data collected from beef packing plants provides information about the volume of live cattle and beef products traded through different marketing arrangements.[4] As discussed in Volume 2 of this study, 29 beef packing plants provided usable purchase transaction data and 24 beef packing plants provided usable sales transaction data. All of these plants are classified as large in the industry survey. Therefore, to distinguish among plants in the analysis of the transactions data, we classified plants into sizes as follows:

- Large plants have slaughter capacities greater than 20,000 head per week.
- Small plants have slaughter capacities less than 20,000 head per week.

This size classification divides the plants into an approximately equal number of plants in each category.

Based on the transactions data for the October 2002 through March 2005 period, by plant size, beef packer purchase arrangements from producers are as follows:

- **Ownership arrangements.** Table 2-1 shows that more than 97% of cattle slaughtered at small plants and 80% of cattle slaughtered at large plants were owned solely by the plant. A very small percentage of the cattle slaughtered at small and large plants were owned by both the packing plant and the producer (i.e., shared ownership). The remaining cattle were reported as having other ownership arrangements or the ownership arrangements were not reported.
- **Purchase methods.** Packers purchased the majority of their cattle through direct trade and marketing agreements, regardless of size (Table 2-2). Small plants purchased 46% of their cattle through direct trade, 28% through marketing agreements, and 13% from auction barns. Large plants purchased 61% of their cattle through direct trade and 29% through marketing agreements. A very small percentage of the cattle purchased by large plants came from auction barns.

[4] Differences in the volume estimates from survey results and transaction data summaries result from the difference in two samples. The weighted survey responses make inferences to the entire population of beef producers and packers. The transaction data collection included usable data for the purposes of the study for only 29 of the largest beef packing plants.

Table 2-1. Summary of Livestock Ownership Methods, by Plant Size, October 2002–March 2005

Category[a]	Sole Ownership	Shared Ownership	Other or Missing	Total
Small beef packing plants				
No. of lots	198,188	D	D	202,350
% of lots	97.9%			100.0%
No. of head	13,923,727	D	D	14,298,688
% of head	97.4%			100.0%
Large beef packing plants				
No. of lots	318,591	D	D	389,060
% of lots	81.9%			100.0%
No. of head	35,060,740	D	D	43,767,752
% of head	80.1%			100.0%
All beef packing plants				
No. of lots	516,779	D	D	591,410
% of lots	87.4%			100.0%
No. of head	48,984,467	D	D	58,066,440
% of head	84.4%			100.0%

[a] Sizes are defined as follows:
Small has capacity < 20,000 head/week.
Large has capacity > 20,000 head/week.
D = Results suppressed.

- **Pricing methods.** Individually negotiated pricing was the most common method used to determine purchase prices for fed cattle (48% of cattle for small plants and 60% of cattle for large plants) (Table 2-3). Approximately one-third of the cattle purchased by large and small plants were priced using a formula. Live prices reported by the USDA were the most common formula base prices (Table 2-4).
- **Valuation methods.** Small plants purchased approximately 51% of their cattle using carcass weight with grid valuation and 27% on a liveweight basis (Table 2-5). In comparison, large plants purchased approximately 43% of their cattle on a liveweight basis and 40% using carcass weight with grid valuation. Both small and large plants purchased approximately 13% of their cattle on carcass weight basis without a grid.

Table 2-2. Summary of Livestock Purchase Methods, by Plant Size, October 2002–March 2005

Category[a]	Auction Barns	Dealers or Brokers	Direct Trade	Forward Contract	Marketing Agreement	Packer Fed/Owned	Other or Missing	Total
Small beef packing plants								
No. of lots	37,459	3,524	95,829	8,559	44,731	4,529	7,719	202,350
% of lots	18.5%	1.7%	47.4%	4.2%	22.1%	2.2%	3.8%	100.0%
No. of head	1,816,939	228,128	6,638,116	737,345	4,003,867	389,805	484,488	14,298,688
% of head	12.7%	1.6%	46.4%	5.2%	28.0%	2.7%	3.4%	100.0%
Large beef packing plants								
No. of lots	D	D	242,425	14,488	113,974	D	D	389,060
% of lots			62.3%	3.7%	29.3%			100.0%
No. of head	D	D	26,757,900	1,888,872	12,744,448	D	D	43,767,752
% of head			61.1%	4.3%	29.1%			100.0%
All beef packing plants								
No. of lots	44,237		338,254	23,047	158,705	27,167		591,410
% of lots	7.5%		57.2%	3.9%	26.8%	4.6%		100.0%
No. of head	2,426,488		33,396,016	2,626,217	16,748,315	2,869,405		58,066,440
% of head	4.2%		57.5%	4.5%	28.8%	5.0%		100.0%

[a] Sizes are defined as follows:

Small has capacity < 20,000 head/week.

Large has capacity > 20,000 head/week.

D = Results suppressed.

Table 2-3. Summary of Livestock Pricing Methods, by Plant Size, October 2002–March 2005

Category[a]	Negotiated	Public Auction	Formula Pricing	Internal Transfer	Other or Missing	Total
Small beef packing plants						
No. of lots	99,584	D	51,006	D	D	202,350
% of lots	49.2%		25.2%			100.0%
No. of head	6,826,722	D	4,667,417	D	D	14,298,688
% of head	47.7%		32.6%			100.0%
Large beef packing plants						
No. of lots	234,624	D	133,847	D	D	389,060
% of lots	60.3%		34.4%			100.0%
No. of head	26,346,160	D	14,730,179	D	D	43,767,752
% of head	60.2%		33.7%			100.0%
All beef packing plants						
No. of lots	334,208	D	184,853	D	D	591,410
% of lots	56.5%		31.3%			100.0%
No. of head	33,172,882	D	19,397,596	D	D	58,066,440
% of head	57.1%		33.4%			100.0%

[a] Sizes are defined as follows:

Small has capacity < 20,000 head/week.

Large has capacity > 20,000 head/week.

D = Results suppressed.

Table 2-4. Summary of Types of Formula Bases Used for Livestock Pricing, by Plant Size, October 2002–March 2005

Category[a]	Plant Average Price or Cost of Production	USDA Live Quote	USDA Dressed or Carcass Quote	CME Cattle Futures	Subscription Service Price	Not Applicable	Not Reported	Total
Small beef packing plants								
No. of lots	D	17,297	D	D	D	151,345	D	202,350
% of lots		8.5%				74.8%		100.0%
No. of head	D	1,370,692	D	D	D	9,631,305	D	14,298,688
% of head		9.6%				67.4%		100.0%
Large beef packing plants								
No. of lots	D	35,321	D	D	D	255,213	D	389,060
% of lots		9.1%				65.6%		100.0%
No. of head	D	3,512,715	D	D	D	29,037,573	D	43,767,752
% of head		8.0%				66.3%		100.0%
All beef packing plants								
No. of lots	D	52,618		89,206[b]		406,558	D	591,410
% of lots		8.9%		15.1%		68.7%		100%
No. of head	D	4,883,407		8,885,342[b]		38,668,878	D	58,066,440
% of head		8.4%		15.3%		66.6%		100%

[a] Sizes are defined as follows:

Small has capacity < 20,000 head/week.

Large has capacity > 20,000 head/week.

[b] Totals combine USDA dressed or carcass quote, CME cattle futures, and subscription service price.

D = Results suppressed.

Table 2-5. Summary of Livestock Valuation Methods, by Plant Size, October 2002–March 2005

Category[a]	Liveweight	Carcass Weight, Without Grid	Carcass Weight, With Grid	Other or Missing	Total
Small beef packing plants					
No. of lots	61,352	21,276	103,277	16,445	202,350
% of lots	30.3%	10.5%	51.0%	8.1%	100.0%
No. of head	3,828,852	1,776,397	7,326,609	1,366,830	14,298,688
% of head	26.8%	12.4%	51.2%	9.6%	100.0%
Large beef packing plants					
No. of lots	148,218	51,699	176,502	12,641	389,060
% of lots	38.1%	13.3%	45.4%	3.2%	100.0%
No. of head	18,984,258	5,711,105	17,647,798	1,424,592	43,767,752
% of head	43.4%	13.0%	40.3%	3.3%	100.0%
All beef packing plants					
No. of lots	209,570	72,975	279,779	29,086	591,410
% of lots	35.4%	12.3%	47.3%	4.9%	100.0%
No. of head	22,813,110	7,487,502	24,974,407	2,791,422	58,066,440
% of head	39.3%	12.9%	43.0%	4.8%	100.0%

[a] Sizes are defined as follows:
Small has capacity < 20,000 head/week.
Large has capacity > 20,000 head/week.

For additional comparisons of beef packer purchases, we classified plants into regions, as follows:

- Cornbelt/Northeast: Iowa, Illinois, Michigan, Minnesota, Pennsylvania, Wisconsin
- High Plains: Colorado, Kansas, Nebraska, Texas
- West: Arizona, California, Idaho, Utah, Washington

This regional classification puts a larger number of plants in the High Plains region relative to the other two regions, but groups those that are likely to have similarities because of their geographic locations.

By plant region, beef packer purchase arrangements based on the transactions data for October 2002 through March 2005 are as follows:

- **Ownership arrangements.** Table 2-6 shows that more than 99% of cattle slaughtered at plants in the Cornbelt/Northeast region were under sole ownership. In comparison, only 82% to 93% of the cattle slaughtered at plants in the High Plains and West regions were under sole ownership. A small percentage of the cattle slaughtered at plants in the West region were owned by both the packing plant and the producer (i.e., shared ownership), and almost no cattle slaughtered in the Cornbelt/Northeast and High Plains regions were under shared ownership. In addition, a small percentage of the cattle slaughtered in plants in the High Plains region were reported as having other ownership arrangements or the ownership arrangements were not reported.
- **Purchase methods.** Table 2-7 highlights the frequent use of direct trade and marketing agreements across all regions. Packing plants in all three regions purchased the majority of their cattle through direct trade and marketing agreements. In addition, packing plants in the West and Cornbelt/Northeast regions purchased a small percentage of their cattle from auction barns, while packing plants in the High Plains made almost no purchases through auction. The lower reliance on auction barn purchases in the High Plains is likely because these packers are purchasing primarily from large feedlots.

Table 2-6. Summary of Livestock Ownership Methods, by Region, October 2002–March 2005

Category[a]	Sole Ownership	Shared Ownership	Other or Missing	Total
Beef packing plants in Cornbelt/Northeast region				
No. of lots	98,132	D	D	98,140
% of lots	99.99%			100.00%
No. of head	4,401,620	D	D	4,402,616
% of head	99.98%			100.00%
Beef packing plants in High Plains region				
No. of lots	356,318	D	D	426,787
% of lots	83.50%			100.00%
No. of head	39,816,074	D	D	48,523,086
% of head	82.10%			100.00%
Beef packing plants in West region				
No. of lots	62,329	D	D	66,483
% of lots	93.80%			100.00%
No. of head	4,766,773	D	D	5,140,738
% of head	92.70%			100.00%
All beef packing plants				
No. of lots	516,779	D	D	591,410
% of lots	87.40%			100.00%
No. of head	48,984,467	D	D	58,066,440
% of head	84.40%			100.00%

[a] Regions are defined as follows:
Cornbelt/Northeast: IA, IL, MI, MN, PA, WI
High Plains: CO, KS, NE, TX
West: AZ, CA, ID, UT, WA

D = Results suppressed.

Table 2-7. Summary of Livestock Purchase Methods, by Region, October 2002–March 2005

Category[a]	Auction Barns	Dealers or Brokers	Direct Trade	Forward Contract	Marketing Agreement	Packer Fed/Owned	Other or Missing	Total
Beef packing plants in Cornbelt/Northeast region								
No. of lots	D	D	D	D	D	D	0	98,140
% of lots							0.0%	100.0%
No. of head	D	D	D	D	D	D	0	4,402,616
% of head							0.0%	100.0%
Beef packing plants in High Plains region								
No. of lots	D	D	271,537	15,553	121,459	D	D	426,787
% of lots			63.6%	3.6%	28.5%			100.0%
No. of head	D	D	29,774,631	2,037,183	14,327,902	D	D	48,523,086
% of head			61.4%	4.2%	29.5%			100.0%
Beef packing plants in West region								
No. of lots	D	D	D	D	D	4,528	D	66,483
% of lots						6.8%		100.0%
No. of head	D	D	D	D	D	389,769	D	5,140,738
% of head						7.6%		100.0%
All beef packing plants								
No. of lots	44,237		338,254	23,047	158,705	27,167		591,410
% of lots	7.5%		57.2%	3.9%	26.8%	4.6%		100.0%
No. of head	2,426,488		33,396,016	2,626,217	16,748,315	2,869,405		58,066,440
% of head	4.2%		57.5%	4.5%	28.8%	5.0%		100.0%

[a] Regions are defined as follows:
Cornbelt/Northeast: IA, IL, MI, MN, PA, WI
High Plains: CO, KS, NE, TX
West: AZ, CA, ID, UT, WA
D = Results suppressed.

- **Pricing methods.** Individual negotiated pricing was the most common method used to determine purchase prices for fed cattle (Table 2-8). Formula pricing was used for the purchase of about half of the cattle in the West, and 34% of the cattle in the High Plains. The price most commonly used as the formula base varied by region (Table 2-9). Packing plants in the West region most often used live quotes reported by the USDA for the formula base and a small percentage used subscription service prices. A moderate percentage of the formula-priced cattle in the High Plains region were based on a dressed price reported by the USDA. A high percentage of the formula-priced cattle in the Cornbelt/Northeast were based on a subscription service price.
- **Valuation methods.** Table 2-10 shows that packing plants in the Cornbelt/Northeast purchased the largest percentage of cattle on a liveweight basis (47% of all purchases, compared with 40% in the High Plains and 25% in the West). Packing plants in the West purchased more than half of their cattle using carcass weight with grid valuation, while packing plants in the High Plains and Cornbelt/Northeast used this valuation method for 42% and 44% of their purchases, respectively. Carcass weight without grid valuation accounted for a small percentage of purchases by packing plants in all three regions.

Comparing Tables 2-11 through 2-13 reveals the similarities between small and large packing plant sales for the period from October 2002 through March 2005. The most common sales method used by both large and small packing plants was the cash market, accounting for 31% and 35% of beef product pounds sold, respectively. However, packers could not identify or did not indicate the sales method for approximately 40% of beef products sold because this is information that they have limited use for in the management of their operations. Approximately 36% of packing plant sales used individually negotiated pricing to determine sales prices, and 19% of beef pounds sold by small packing plants and 26% of beef pounds sold by large packing plants used formula pricing. However, as with the sales method, packers could not identify or did not indicate the pricing method for a moderate percentage of the beef product sold. Small packing plants almost exclusively used prices reported by the USDA for the base of their formula-priced beef product sales. In addition to USDA-reported prices,

Table 2-8. Summary of Livestock Pricing Methods, by Region, October 2002–March 2005

Category[a]	Negotiated	Public Auction	Formula Pricing	Internal Transfer	Other or Missing	Total
Beef packing plants in Cornbelt/ Northeast region						
No. of lots	D	D	D	0	D	98,140
% of lots				0.0%		100.0%
No. of head	D	D	D	0	D	4,402,616
% of head				0.0%		100.0%
Beef packing plants in High Plains region						
No. of lots	261,855	D	144,284	D	6,793	426,787
% of lots	61.4%		33.8%		1.6%	100.0%
No. of head	29,171,653	D	16,653,820	D	868,946	48,523,086
% of head	60.1%		34.3%		1.8%	100.0%
Beef packing plants in West region						
No. of lots	D	D	D	D	8,095	66,483
% of lots					12.2%	100.0%
No. of head	D	D	D	D	518,413	5,140,738
% of head					10.1%	100.0%
All beef packing plants						
No. of lots	334,208	D	184,853	D	D	591,410
% of lots	56.5%		31.3%			100.0%
No. of head	33,172,882	D	19,397,596	D	D	58,066,440
% of head	57.1%		33.4%			100.0%

[a] Regions are defined as follows:

Cornbelt/Northeast: IA, IL, MI, MN, PA, WI

High Plains: CO, KS, NE, TX

West: AZ, CA, ID, UT, WA

D = Results suppressed.

Table 2-9. Summary of Types of Formula Bases Used for Livestock Pricing, by Region, October 2002–March 2005

Category[a]	Plant Average Price or Cost of Production	USDA Live Quote	USDA Dressed or Carcass Quote	CME Cattle Futures	Subscription Service Price	Not Applicable	Not Reported	Total
Beef packing plants in Cornbelt/Northeast region								
No. of lots	D	0	D	D	D	87,998	0	98,140
% of lots		0.0%				89.7%	0.0%	100.0%
No. of head	D	0	D	D	D	3,948,250	0	4,402,616
% of head		0.0%				89.7%	0.0%	100.0%
Beef packing plants in High Plains region								
No. of lots	D	35,344	D	D	D	282,503	D	426,787
% of lots		8.3%				66.2%		100.0%
No. of head	D	3,517,722	D	D	D	31,869,266	D	48,523,086
% of head		7.3%				65.7%		100.0%
Beef packing plants in West region								
No. of lots	D	17,274	0	0	D	36,057	0	66,483
% of lots		26.0%	0.0%	0.0%		54.2%	0.0%	100.0%
No. of head	D	1,365,685	0	0	D	2,851,362	0	5,140,738
% of head		26.6%	0.0%	0.0%		55.5%	0.0%	100.0%
All beef packing plants								
No. of lots	D	52,618		89,206[b]		406,558	D	591,410
% of lots		8.9%		15.1%		68.7%		100.0%
No. of head	D	4,883,407		8,885,342[b]		38,668,878	D	58,066,440
% of head		8.4%		15.3%		66.6%		100.0%

[a] Regions are defined as follows:

Cornbelt/Northeast: IA, IL, MI, MN, PA, WI

High Plains: CO, KS, NE, TX

West: AZ, CA, ID, UT, WA

[b] Totals combine USDA dressed or carcass quote, CME cattle futures, and subscription service price.

D = Results suppressed.

Table 2-10. Summary of Livestock Valuation Methods, by Region, October 2002–March 2005

Category[a]	Liveweight	Carcass Weight, Without Grid	Carcass Weight, With Grid	Other or Missing	Total
Beef packing plants in Cornbelt/ Northeast region					
No. of lots	47,001	D	44,939	D	98,140
% of lots	47.9%		45.8%		100.0%
No. of head	2,055,531	D	1,947,690	D	4,402,616
% of head	46.7%		44.2%		100.0%
Beef packing plants in High Plains region					
No. of lots	150,841	55,157	197,385	23,404	426,787
% of lots	35.3%	12.9%	46.2%	5.5%	100.0%
No. of head	19,459,388	6,231,258	20,404,712	2,427,729	48,523,086
% of head	40.1%	12.8%	42.1%	5.0%	100.0%
Beef packing plants in West region					
No. of lots	11,728	D	37,455	D	66,483
% of lots	17.6%		56.3%		100.0%
No. of head	1,298,191	D	2,622,005	D	5,140,738
% of head	25.3%		51.0%		100.0%
All beef packing plants					
No. of lots	209,570	72,975	279,779	29,086	591,410
% of lots	35.4%	12.3%	47.3%	4.9%	100.0%
No. of head	22,813,110	7,487,502	24,974,407	2,791,422	58,066,440
% of head	39.3%	12.9%	43.0%	4.8%	100.0%

[a] Regions are defined as follows:

Cornbelt/Northeast: IA, IL, MI, MN, PA, WI

High Plains: CO, KS, NE, TX

West: AZ, CA, ID, UT, WA

D = Results suppressed.

Table 2-11. Summary of Beef Sales Methods, by Plant Size, October 2002–March 2005

Category[a]	Cash or Spot Market	Forward Contract	Marketing Agreement	Internal Company Transfer	Other or Missing	Total
Small beef packing plants						
No. of records	806,451	D	D	D	1,127,598	2,122,176
% of records	38.0%				53.1%	100.0%
No. of pounds	2,755,949,363	D	D	D	3,323,020,638	7,804,461,294
% of pounds	35.3%				42.6%	100.0%
Large beef packing plants						
No. of records	1,352,007	D	D	D	920,376	3,794,158
% of records	35.6%				24.3%	100.0%
No. of pounds	7,387,730,790	D	D	D	8,856,907,757	23,977,761,056
% of pounds	30.8%				36.9%	100.0%
All beef packing plants						
No. of records	2,158,458	1,090,949	463,455	155,498	2,047,974	5,916,334
% of records	36.5%	18.4%	7.8%	2.6%	34.6%	100.0%
No. of pounds	10,143,680,153	5,762,756,758	3,104,424,008	591,433,037	12,179,928,395	31,782,222,350
% of pounds	31.9%	18.1%	9.8%	1.9%	38.3%	100.0%

[a] Sizes are defined as follows:

Small has capacity < 20,000 head/week.

Large has capacity > 20,000 head/week.

D = Results suppressed.

Table 2-12. Summary of Beef Sales Pricing Methods, by Plant Size, October 2002–March 2005

Category[a]	Negotiated	Formula Pricing	Sealed Bid	Internal Transfer Pricing	Other or Missing	Total
Small beef packing plants						
No. of records	814,067	136,286	D	D	D	2,122,176
% of records	38.4%	6.4%				100.0%
No. of pounds	2,826,374,154	1,487,015,802	D	D	D	7,804,461,294
% of pounds	36.2%	19.1%				100.0%
Large beef packing plants						
No. of records	1,419,076	1,343,430	D	D	D	3,794,158
% of records	37.4%	35.4%				100.0%
No. of pounds	8,460,146,247	6,237,322,048	D	D	D	23,977,761,056
% of pounds	35.3%	26.0%				100.0%
All beef packing plants						
No. of records	2,233,143	1,479,716	D	D	D	5,916,334
% of records	37.7%	25.0%				100.0%
No. of pounds	11,286,520,401	7,724,337,850	D	D	D	31,782,222,350
% of pounds	35.5%	24.3%				100.0%

[a] Sizes are defined as follows:
Small has capacity < 20,000 head/week.
Large has capacity > 20,000 head/week.
D = Results suppressed.

Table 2-13. Summary of Types of Formula Bases Used for Beef Sales, by Plant Size, October 2002–March 2005

Category[a]	Plant Average Price	USDA-Reported Price	Other Market Price	Other or Missing	Total
Small beef packing plants					
No. of records	0	135,697	0	589	136,286
% of records	0.0%	99.6%	0.0%	0.4%	100.0%
No. of pounds	0	1,464,304,308	0	22,711,494	1,487,015,802
% of pounds	0.0%	98.5%	0.0%	1.5%	100.0%
Large beef packing plants					
No. of records	D	1,041,711	D	D	1,343,430
% of records		77.5%			100.0%
No. of pounds	D	4,479,397,265	D	D	6,237,322,048
% of pounds		71.8%			100.0%
All beef packing plants					
No. of records	D	1,177,408	D	D	1,479,716
% of records		79.6%			100.0%
No. of pounds	D	5,943,701,573	D	D	7,724,337,850
% of pounds		76.9%			100.0%

[a] Sizes are defined as follows:

Small has capacity < 20,000 head/week.

Large has capacity > 20,000 head/week.

D = Results suppressed.

large packing plants also used other market prices as the base for a small percentage of their formula-priced beef product sales. These other market prices are typically unique combinations of multiple market prices.

Segregating packing plant sales by geographic location yields results similar to the totals (Tables 2-14 through 2-16). That is, beef packing plant sales methods do not differ substantially across regions. However, sales from High Plains' packing plants differ somewhat from the others in three ways. First, more than 20% of the beef sold by packing plants in the High Plains was sold using forward contracts. In contrast, forward contracts accounted for a small percentage of the beef sold by packing plants in the West and in the Cornbelt/Northeast. Second, corresponding to the higher use of forward contracts in the High Plains region, a higher proportion of beef product sales were priced using formula pricing. Third, a small percentage of the beef products formula priced by packing plants in the High Plains was based on an other market price. Packing plants in the Cornbelt/Northeast and the West did not report formula pricing any sales on an other market price.

Table 2-14. Summary of Beef Sales Methods, by Region, October 2002–March 2005

Category[a]	Cash or Spot Market	Forward Contract	Marketing Agreement	Internal Company Transfer	Other or Missing	Total
Beef packing plants in Cornbelt/Northeast region						
No. of records	D	D	D	D	D	526,251
% of records						100.0%
No. of pounds	D	D	D	D	D	2,794,114,501
% of pounds						100.0%
Beef packing plants in High Plains region						
No. of records	1,531,689	1,085,013	439,235	D	D	4,131,466
% of records	37.1%	26.3%	10.6%			100.0%
No. of pounds	8,588,448,574	5,635,791,370	2,553,662,912	D	D	26,336,083,611
% of pounds	32.6%	21.4%	9.7%			100.0%
Beef packing plants in West region						
No. of records	D	D	D	0	D	1,258,617
% of records				0.0%		100.0%
No. of pounds	D	D	D	0	D	2,652,024,239
% of pounds				0.0%		100.0%
All beef packing plants						
No. of records	2,158,458	1,090,949	463,455	155,498	2,047,974	5,916,334
% of records	36.5%	18.4%	7.8%	2.6%	34.6%	100.0%
No. of pounds	10,143,680,153	5,762,756,758	3,104,424,008	591,433,037	12,179,928,395	31,782,222,350
% of pounds	31.9%	18.1%	9.8%	1.9%	38.3%	100.0%

[a] Regions are defined as follows:

Cornbelt/Northeast: IA, IL, MI, MN, PA, WI

High Plains: CO, KS, NE, TX

West: AZ, CA, ID, UT, WA

D = Results suppressed.

Table 2-15. Summary of Beef Sales Pricing Methods, by Region, October 2002–March 2005

Category[a]	Negotiated	Formula Pricing	Sealed Bid	Internal Transfer Pricing	Other or Missing	Total
Beef packing plants in Cornbelt/Northeast region						
No. of records	D	D	0	D	D	526,251
% of records			0.0%			100.0%
No. of pounds	D	D	0	D	D	2,794,114,501
% of pounds			0.0%			100.0%
Beef packing plants in High Plains region						
No. of records	1,598,001	1,457,933	D	D	1,026,103	4,131,466
% of records	38.7%	35.3%			24.8%	100.0%
No. of pounds	9,633,501,910	7,144,398,279	D	D	9,409,835,820	26,336,083,611
% of pounds	36.6%	27.1%			35.7%	100.0%
Beef packing plants in West region						
No. of records	D	D	0	0	D	1,258,617
% of records			0.0%	0.0%		100.0%
No. of pounds	D	D	0	0	D	2,652,024,239
% of pounds			0.0%	0.0%		100.0%
All beef packing plants						
No. of records	2,233,143	1,479,716	D	D	D	5,916,334
% of records	37.7%	25.0%				100.0%
No. of pounds	11,286,520,401	7,724,337,850	D	D	D	31,782,222,350
% of pounds	35.5%	24.3%				100.0%

[a] Regions are defined as follows:
Cornbelt/Northeast: IA, IL, MI, MN, PA, WI
High Plains: CO, KS, NE, TX
West: AZ, CA, ID, UT, WA

D = Results suppressed.

Table 2-16. Summary of Types of Formula Bases Used for Beef Sales, by Region, October 2002–March 2005

Category[a]	Plant Average Price	USDA-Reported Price	Other Market Price	Other or Missing	Total
Beef packing plants in Cornbelt/Northeast region					
No. of records	0	D	0	D	10,664
% of records	0.0%		0.0%		100.0%
No. of pounds	0	D	0	D	160,749,985
% of pounds	0.0%		0.0%		100.0%
Beef packing plants in High Plains region					
No. of records	D	1,156,214	D	20,859	1,457,933
% of records		79.3%		1.4%	100.0%
No. of pounds	D	5,386,473,495	D	93,182,008	7,144,398,279
% of pounds		75.4%		1.3%	100.0%
Beef packing plants in West region					
No. of records	0	D	0	D	11,119
% of records	0.0%		0.0%		100.0%
No. of pounds	0	D	0	D	419,189,587
% of pounds	0.0%		0.0%		100.0%
All beef packing plants					
No. of records	D	1,177,408	D	D	1,479,716
% of records		79.6%			100.0%
No. of pounds	D	5,943,701,573	D	D	7,724,337,850
% of pounds		76.9%			100.0%

[a] Regions are defined as follows:

Cornbelt/Northeast: IA, IL, MI, MN, PA, WI

High Plains: CO, KS, NE, TX

West: AZ, CA, ID, UT, WA

D = Results suppressed.

2.2 PRICE DIFFERENCES ASSOCIATED WITH MARKETING ARRANGEMENTS IN THE FED CATTLE AND BEEF INDUSTRY

In this section, we present the results of descriptive analyses on price differences and trends, by type of marketing arrangement, and quantitative analyses of the relationship between transactions prices and AMAs. We then estimate the relationships between transactions prices and AMAs for all transactions and for only cash market transactions.

2.2.1 Fed Cattle and Beef Prices, by Type of Marketing Arrangement: Averages and Trends

Fed cattle purchase lots typically range from 10 to 200 cattle per lot.[5] Within an individual lot, the quality and characteristics of cattle may vary substantially depending on breed, distribution of steers versus heifers, whether any cattle are culled cows or bulls, weight range, quality grade, and yield grade. To analyze differences in transactions prices, it is necessary to adjust for differences in the composition and quality of the lot. However, prior to conducting the analysis that controls for these characteristics, it is useful to compare a summary of average prices across plant sizes (Table 2-17) and regions (Table 2-18) by type of marketing arrangement.

We computed prices per pound by dividing the total cost of each lot by the total carcass weight of each lot. We then calculated a weighted average price and standard deviation by each type of marketing arrangement. The total cost of a lot comprises

- cost of the cattle in the lot,
- shipping costs (which may be paid by the packer or by the producer),
- commission costs,
- miscellaneous costs (e.g., feed), and
- price adjustments for quality.

[5] Smaller lots of cattle are typically off-quality cattle that are not quality graded.

Table 2-17. Fed Cattle Prices, by Marketing Arrangement by Size of Plant ($ per Pound Carcass Weight), October 2002–March 2005

Category[a]	Auction Barns	Dealers or Brokers	Direct Trade	Forward Contract	Marketing Agreement	Packer Fed/Owned	Other or Missing	Total
Small beef packing plants								
Total cost ($/lb)								
Weighted average	1.34	1.32	1.32	1.30	1.30	1.35	1.28	1.31
St. dev.	0.00016	0.00016	0.00016	0.00014	0.00017	0.00016	0.00015	0.00016
Large beef packing plants								
Total cost ($/lb)								
Weighted average	D	D	1.32	1.28	1.31	D	1.20	1.31
St. dev.			0.00019	0.00020	0.00018		0.00018	0.00019
All beef packing plants								
Total cost ($/lb)								
Weighted average	1.34	1.32	1.32	1.29	1.31	1.32	1.27	1.31
St. dev.	0.00017	0.00019	0.00018	0.00018	0.00018	0.00019	0.00016	0.00018

[a] Sizes are defined as follows:

Small has capacity < 20,000 head/week.

Large has capacity > 20,000 head/week.

D = Results suppressed.

Table 2-18. Fed Cattle Prices, by Marketing Arrangement by Region ($ per Pound Carcass Weight), October 2002–March 2005

Category[a]	Auction Barns	Dealers or Brokers	Direct Trade	Forward Contract	Marketing Agreement	Packer Fed/Owned	Other or Missing	Total
Beef packing plants in Cornbelt/Northeast region								
Total cost ($/lb)								
Weighted average	D	D	D	D	D	NA	NA	1.31
St. dev.						NA	NA	0.00014
Beef packing plants in High Plains region								
Total cost ($/lb)								
Weighted average	D	D	1.31	1.28	1.31	D	1.20	1.31
St. dev.			0.00019	0.00020	0.00019		0.00018	0.00019
Beef packing plants in West region								
Total cost ($/lb)								
Weighted average	D	D	D	1.33	1.31	1.35	1.28	1.33
St. dev.				0.00012	0.00015	0.00016	0.00015	0.00016
All beef packing plants								
Total cost ($/lb)								
Weighted average	1.34	1.32	1.32	1.29	1.31	1.32	1.27	1.31
St. dev.	0.00017	0.00019	0.00018	0.00018	0.00018	0.00019	0.00016	0.00018

NA = not applicable

[a] Regions are defined as follows:

Cornbelt/Northeast: IA, IL, MI, MN, PA, WI

High Plains: CO, KS, NE, TX

West: AZ, CA, ID, UT, WA

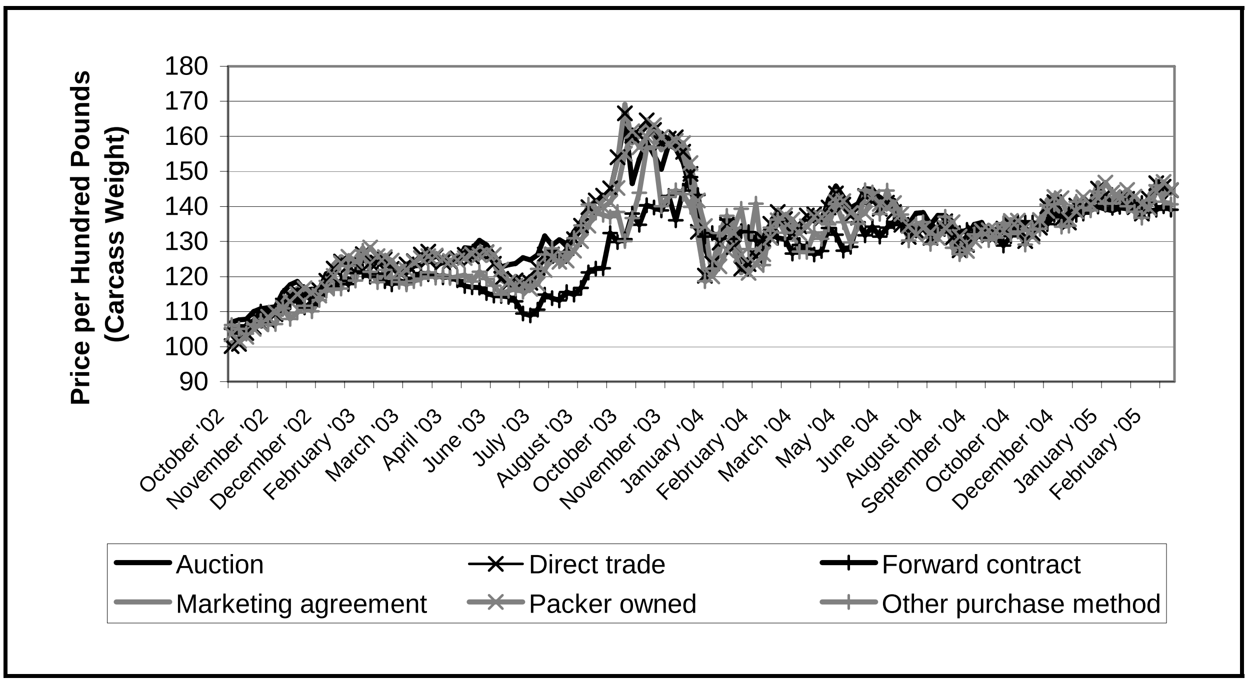
Averages are weighted by number of head.

D = Results suppressed.

Because of substantial variation in reporting of costs by packers, we use the total costs of the lot rather than the cattle cost to compute averages. However, cattle cost typically comprises 97% to 99% of the total cost of the lot. Therefore, the total cost of the lot is a reasonable approximation of the cost of the cattle in the lot.

Figure 2-1 shows the average weekly prices, by marketing arrangement, for a selected group of cattle in the transaction data. Lots with 60% or more cattle in the Choice or Select Quality Grade or lots with 60% or more cattle in Yield Grade 2 or 3 were included in the calculation of the average. All prices trended upward during the data collection period. This trend is partially explained by the phase of the cattle cycle, which changed from liquidation in 2003 and 2004 to rebuilding in 2005. During the rebuilding phase, animal supplies were relatively tight and cattle prices were rising. Cattle supplies within the United States also tightened because of the ban on Canadian cattle imports from May 2003 to July 2005. The U.S. border was closed to Canadian cattle because of the discovery of BSE. Additionally, the first case of BSE in the United States was discovered in December 2003.

Figure 2-1. Average Weekly Price of Cattle from Lots with 60% or More Choice/Select Quality Grade or Yield Grade 2 or 3, by Marketing Arrangement, October 2002–March 2005



The overall average price received for the October 2002 through March 2005 period was $1.31 per carcass weight pound. The average prices across types of marketing arrangements differed by 20 cents across sizes of plants (see Table 2-17) and by 24 cents across regions (see Table 2-18). When comparing average prices across plant sizes and regions, it is important to keep in mind that differences in prices are not necessarily due to differences in the type of marketing arrangement used. Differences could reflect that plants in certain regions or size categories typically purchase specific types of cattle based on their needs.

With these caveats in mind, prices varied 7 cents per pound across marketing arrangements for small packing plants and 20 cents per pound for large packing plants. Prices are generally similar for small and large packing plants. By region, prices paid by packing plants varied 11 cents per pound across marketing arrangements in the Cornbelt/Northeast, 20 cents per pound in the High Plains, and 16 cents per pound in the West. Noted regional differences are as follows:

- Packing plants in the High Plains and West paid the lowest price for cattle purchased through other marketing arrangements or unspecified marketing arrangements.
- Packing plants in the Cornbelt/Northeast paid the lowest price for cattle procured through marketing agreements.
- Packing plants in the Cornbelt/Northeast and High Plains paid the highest average price for cattle purchased through auction barns. This likely reflects the need to purchase more cattle through auction after the closure of the U.S.–Canadian border in order to help maintain a higher capacity utilization for plants in this region.
- Packing plants in the West paid the highest price for cattle purchased from dealers or brokers. This likely reflects that many purchases of cattle through dealers and brokers represent special sales of cattle purchased to meet specialized buyer requirements.

In discussing differences in prices across types of marketing arrangements, it is important to keep in mind that the prices were influenced by the unique time period of the data set. Cash market and AMA prices were generally trending upward, except during the May 2003 through December 2003 period (see Figure 2-1). Forward contract prices often had lower prices than the other types of marketing arrangements, because these prices are set further in advance of the other prices and thus take longer to adjust to unexpected market conditions (e.g., discovery of BSE).

2.2.2 Analysis of the Relationship between Fed Cattle and Beef Transactions Prices and Use of Marketing Arrangements

In this section, we analyze the relationship between purchase prices for fed cattle and the use of marketing arrangements, while controlling for other characteristics of the transactions that affect fed cattle prices. We include both cash market and AMA transactions in the model and evaluate whether individual types of marketing arrangements are associated with higher or lower prices for cattle. We conduct the analysis using the transactions data for the 29 of the largest beef packing plants in the United States for the October 2002 through March 2005 period. The methodology is based on Ward, Koontz, and Schroeder (1998), with changes to reflect a newer data set.

The model is specified as

$$\begin{aligned} PRICE_{ti} &= \beta_0 + \beta_1 D\_AMA_{ti} + \beta_2 CATTLE\_CH_{ti} + \\ &+ \beta_3 d\_beefcattle_{ti} \times D\_AMA_{ti} + \beta_3 D\_PLANT_{ti} + \\ &+ \beta_4 D\_MONTH_t + u_{ti} \end{aligned} \tag{2.1}$$

where t indexes kill week for each lot of fed cattle, $t = 1,\ldots,T$; i indexes transactions (i.e., fed cattle lots purchased by packers), $i = 1,\ldots,I_t$; $PRICE_{ti}$ is transaction price on a per pound carcass weight basis; βs are parameters to estimate, and u_{ti} is a random error term. In addition, D_AMA_{ti} is a vector of binary variables that indicates the type of marketing arrangement used for purchase of the lot, including

- direct trade (*d_direct*)[6] (as the base group),
- auction barns (*d_auction*),
- forward contract (*d_forward*),
- packer owned (*d_packer*), and
- marketing agreement (*d_marketing*).

[6] Transactions through dealers or brokers are combined with the transactions through direct trade because they account for a very small fraction of the total transactions (less than 1%) and are another type of cash market purchase.

$CATTLE\_CH_{ti}$ is a vector of cattle characteristics, including

- whether the fed cattle are a beef or dairy breed (*d_beefcattle*),
- the number of head in the lot (*numberofhead*),
- the percentage of Yield Grade 4 or 5 cattle in the lot (*yg45_pct*),
- the percentage of cattle with Quality Grade of Prime or Choice in the lot (*primechoice_pct*),
- the percentage of cattle that were classified as heavy weight or light weight in the lot according to the definition of heavy weight or light weight used by each individual packer (*outweight_pct*), and
- the percentage of cattle that were eligible for a branded or a certification program in the lot (*branded_pct*).

We also include the interaction term of *d_beefcattle* and *D_AMA* so that the price premium/discount associated with each marketing arrangement is allowed to be different for beef cattle and dairy cattle (fed dairy steers). We also include 28 plant binary variables (*D_PLANT*) to control for the plant-level unobserved fixed effects, such as location and installed capital equipment. Furthermore, 29 binary variables that indicate the month in which the cattle were killed (*D_MONTH*) are included in the model. In this way, we control for seasonality, trend, and other possible unobserved effects related to each month. In particular, these monthly binary variables help control for the effect of the market disruptions that occurred as a result of the BSE discoveries in Canada and the United States during this period. Table 2-19 provides the definitions, means, standard deviations, minimums, and maximums of the variables included in the model, with the exception of the plant and monthly binary variables. Note that transactions with prices below $0.86 and above $1.98 per carcass weight pound were excluded from the model (see the explanation in Section 1.3.1).

Because we used high-frequency data, we take two features of the data into account. First, the price (conditional on the explanatory variables) may be correlated within the same week and across neighboring weeks,[7] even though we have

[7] We are concerned about the correlation within a week rather than within a day because the cattle market is generally a weekly market (i.e., packers arrange their procurement and production activities week by week).

Table 2-19. Descriptive Statistics for the Variables in the Price Difference Model for Fed Cattle Purchase Transactions, October 2002–March 2005

Variable	Notation	Mean	Std. Dev.	Min	Max
price	Transaction price in \$ per pound carcass weight	1.3100	0.140	0.86	1.98
d_direct	Direct trade purchase (1 = yes, 0 = no)	0.5800	0.490	0.00	1.00
d_auction	Auction purchase (1 = yes, 0 = no)	D	D	0.00	1.00
d_forward	Forward contract purchase (1 = yes, 0 = no)	0.0400	0.200	0.00	1.00
d_packer	Packer-owned procurement (1 = yes, 0 = no)	D	D	0.00	1.00
d_marketing	Marketing agreement procurement (1 = yes, 0 = no)	0.2800	0.450	0.00	1.00
d_beefcattle	Mostly beef breed cattle in the lot (1 = yes, 0 = no)	0.7800	0.420	0.00	1.00
numberofhead	Number of head in the lot (100s)	0.9900	0.890	0.06	15.21
yg45_pct	% Yield Grade 4 or 5 in the lot	0.0830	0.0980	0.00	1.00
primechoice_pct	% Prime or Choice in the lot	0.6400	0.240	0.00	1.00
outweight_pct	% heavy weight or light weight cattle in the lot	0.3300	0.370	0.00	1.00
branded_pct	% cattle eligible for branded or certification program in the lot	0.1900	0.230	0.00	1.00

D = Results suppressed.

controlled for the monthly fixed effects. Second, the volatility of the price (conditional on the explanatory variables) may vary by time, AMA choice, or some other explanatory variables. That is, we may have a heteroskedasticity problem. If the correlation and/or heteroskedasticity exist but we failed to model them, our inferences would be invalid.

Therefore, to reflect these two features of the data, we model the structure of the error term u_{ti} as

$$u_{ti} = v_t + \varepsilon_{ti}, \tag{2.2}$$

where v_t is an unobserved weekly effect, which is constant for all transactions with delivery date in week t, and ε_{ti} is a transaction-specific random error term with constant variance. We further assume v_t and ε_{ti} are uncorrelated with the explanatory variables and uncorrelated with each other, and

$$Cov(v_t, v_s) = \begin{cases} \sigma_v^2, & if \quad t = s \\ \rho\sigma_v^2, & if \quad |t-s| = 1 \\ 0, & if \quad |t-s| > 1 \end{cases} \tag{2.3}$$

and

$$\begin{aligned} Var(u_{ti}) = \exp(&\delta_0 + \delta_1 D\_AMA_{ti} + \delta_2 CATTLE\_CH_{ti} + \\ &+ \delta_3 d\_beefcattle_{ti} \times D\_AMA_{ti} + \delta_4 D\_MONTH_t + \varsigma_{ti}). \end{aligned} \tag{2.4}$$

Both the covariance in Eq. (2.3) and the variance in Eq. (2.4) are conditional on the explanatory variables. The setup of Eqs. (2.3) and (2.4) captures the correlation and heteroskedasticity features of transactions price data, as we discussed above. Eq. (2.3) assumes that the conditional covariance of prices between any two transactions delivered in the same week is σ_v^2, the conditional covariance of prices between two transactions delivered in neighboring weeks is $\rho\sigma_v^2$, and the conditional covariance of transaction prices is zero otherwise. Eq. (2.4) assumes that the variance of transaction prices depends on the choice of marketing arrangement, cattle characteristics, and delivery month.

In the model described by Eqs. (2.1) through (2.4), the parameters of interest are β_1, β_3, δ_1, and δ_3. The β_1 and β_3 parameters indicate the average price differences associated with AMAs, holding other explanatory variables fixed. The δ_1 and δ_3 parameters indicate the differences of price volatility associated with AMAs, holding *CATTLE_CH* and *D_MONTH* fixed. We discuss the estimated β_1 and β_3 parameters in this section and return to a discussion of the estimated δ_1 and δ_3 parameters in Section 5 on risk shifting.

Prior to estimating Eq. (2.1), we tested the following three null hypotheses for the existence of heteroskedasticity and/or correlation in the error term:

Hypothesis 1:

$$H_0 : \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0 \quad vs. \quad H_1 : H_0 \quad not \quad true$$

Hypothesis 2:

$$H_0 : \sigma_v^2 = 0 \quad vs. \quad H_1 : \sigma_v^2 > 0$$

Hypothesis 3:

$$H_0 : \rho\sigma_v^2 = 0 \quad vs. \quad H_1 : \rho\sigma_v^2 > 0\,.$$

If the null hypothesis for Hypothesis 1 is true, we would not have to model heteroskedasticity. If the null hypothesis for Hypothesis 2 is true, we would not have to model the price correlation among transactions within the same week.[8] If the null hypothesis for Hypothesis 3 is true, we would not have to model the price correlation between neighboring weeks. However, Wald tests reject each of the three hypotheses at the 1% significance level.[9] These results support modeling both heteroskedasticity and correlation in the error term.

Eq. (2.1) is estimated using ordinary least squares (OLS) and the estimates for the parameters, the βs, are reported in the second column of Table 2-20.[10, 11] The standard errors are consistent with the error structure in Eqs. (2.3) and (2.4).

The results suggest that while holding other explanatory variables fixed, (1) beef breed direct trade cattle are priced 2.7 cents per pound higher than dairy breed direct trade cattle, (2) cattle with higher yield grades or higher quality grade receive a higher average price, (3) a 1% increase in branded cattle in a lot is related to a 2.7 cent per pound higher average price, and (4) the price of light weight or heavy weight cattle is discounted. In addition, average prices are slightly higher for larger cattle lots.

Tables 2-21 and 2-22 summarize the estimated average price differences among AMAs for beef cattle and dairy cattle respectively. All the differences are individually significant at the 5% level, based on Wald tests. The average prices are closest among the direct trade, marketing agreement, and packer-owned transactions, with the estimated differences ranging from 0.1 to 1.2 cents per pound carcass weight. The

[8] Of course, if the null hypothesis 2 is true, the null hypothesis 3 must also be true, unless the model is misspecified.

[9] The Breusch-Pagan test and the White test also reject the null hypothesis of homoskedasticity at the 1% level.

[10] Theoretically, Feasible Generalized Least Squares (FGLS) is more efficient than OLS. However, FGLS is computationally difficult (if not impossible) because of the size of the data set and the complexity of the error structure.

[11] We also estimated Eq. (2.1) using quantile regression and report the coefficient estimates for different price quantiles7 in Appendix A of this volume.

Table 2-20. Parameter Estimates for the Price Difference Models of Fed Cattle Purchase Transactions, October 2002–March 2005

Variable	Price Coefficient (Std. Error)	Log(var(u)) Coefficient (Std. Error)
d_auction	0.016 (0.0011)	0.92 (0.053)
d_forward	–0.047 (0.0008)	0.56 (0.025)
d_packer	–0.012 (0.0017)	–0.32 (0.073)
d_ma	-0.006 (0.0005)	–0.22 (0.013).
d_beefcattle	0.027 (0.0003)	–0.16 (0.010)
*d_beefcattle*d_auction*	0.093 (0.0016)	0.54 (0.055)
*d_beefcattle*d_forward*	-0.000017 (0.0008)[a]	0.52 (0.032)
*d_beefcattle*d_packer*	0.013 (0.0018)	0.22 (0.075)
*d_beefcattle*d_ma*	0.012 (0.00043)	0.019 (0.016)[a]
numberofhead	0.0049 (0.0001)	–0.10 (0.0035)
yg45_pct	–0.073 (0.001)	0.70 (0.033)
primechoice_pct	0.062 (0.0005)	–0.23 (0.012)
outweight_pct	–0.021 (0.0005)	0.31 (0.0092)
branded_pct	0.027 (0.0006)	–0.16 (0.014)
Other variables[b]	Not reported	
No. of observations (lots)	571,608	571,608
R^2	0.7744	0.1260

[a] Coefficient is insignificant at the 5% level. All other variables are significant at the 5% level.

[b] The “other variables” include an intercept, monthly binary variables, and plant binary variables.

Table 2-21. Estimated Average Price Differences among AMAs for Beef Breed Fed Cattle Purchase Transactions, October 2002–March 2005 (Cents per Pound Carcass Weight)

Marketing Arrangement	Direct Trade	Auction	Forward Contract	Packer Owned	Marketing Agreement
Direct trade	—	–10.9	4.7	–0.1	–0.6
Auction	10.9	—	15.6	10.8	10.3
Forward contract	–4.7	–15.6	—	–4.8	–5.3
Packer owned	0.1	–10.8	4.8	—	–0.5
Marketing agreement	0.6	–10.3	5.3	0.5	—

Note: The differences are computed as the average price for each AMA listed in the left column minus each listed in the top row.

Table 2-22. Estimated Average Price Differences among AMAs for Dairy Breed Fed Cattle Purchase Transactions, October 2002–March 2005 (Cents per Pound Carcass Weight)

Marketing Arrangement	Direct Trade	Auction	Forward Contract	Packer Owned	Marketing Agreement
Direct trade	—	–1.6	4.7	1.2	0.6
Auction	1.6	—	6.3	2.8	2.2
Forward contract	–4.7	–6.3	—	–3.5	–4.1
Packer owned	–1.2	–2.8	3.5	0.0	–0.6
Marketing agreement	–0.6	–2.2	4.1	0.6	—

Note: The differences are computed as the average price for each AMA listed in the left column minus each listed in the top row.

auction barn transactions price is estimated to be about 10.9 cents higher for beef breed cattle and 1.7 cents higher for dairy breed cattle than for the corresponding direct trade cattle, although both are cash market procurement methods. Transactions prices associated with forward contract transactions are the lowest among all the procurement methods. This result may suggest that farmers who choose forward contracts are willing to give up some revenue in order to secure market access and to fix the price at least 2 weeks before delivery.

The result that auction barn prices are the highest and forward contract prices are the lowest could also be due, in part, to the unique time period of the analysis, including the stage of the cattle cycle and the closure of the border with Canada after the discovery of BSE in May 2003. Our model compares the prices among procurement methods for the cattle delivered in the same month but does not control for the pricing dates related to individual transactions. Transactions prices are correlated with the expectation of market conditions at the delivery date based on the information available at the pricing date. The difference between pricing dates and delivery dates is systematically different among procurement methods.

According to the transactions data, on average, forward contract cattle are priced 12 days ahead of delivery date, direct trade cattle are priced six days ahead, and auction barn cattle are priced only two days ahead. Consider a forward contract lot and an auction barn lot that are delivered at the same time. If there is an positive market shock (e.g., the closure of the border with Canada) that occurs before the pricing time of auction barn cattle but is not expected at the time when forward contract cattle are priced. The forward contract cattle would be priced lower than the auction barn cattle due to the unexpected random market shock. If the time period represented in the data was long enough, this would not bias the estimation results because positive shocks should be offset by negative shocks in the long run. However, this may not be true in this case because the represented time period is relatively short. That is, if the unexpected market shock is systematically positive during our represented period, failing to control for market expectations at the pricing date would bias the estimates of price differences among procurement methods. It is difficult to incorporate the pricing date information because these data are unreliable in the data set and are only available for about 40% of the total transactions. However, we believe the effect of this bias is limited because the largest average pricing date difference among procurement methods is a maximum of 12 days. We examined the average two-week price difference in the Nebraska cash market for steers and found that this difference is both economically and statistically insignificant (the mean value of the difference is 0.18 cent per pound dressed weight, and the P value of the t-test is 0.78).

2.3 EFFECTS OF MARKETING ARRANGEMENTS ON CASH MARKET PRICES IN THE FED CATTLE AND BEEF INDUSTRY

In this section, we analyze the relationship between cash market prices for fed cattle and the use of AMAs, while controlling for other characteristics of the transactions that affect cash market prices. The transactions included in the model represent all cash market purchases (auction barn and combined dealer/broker and direct trade) for the October 2002 through March 2005 period. We conducted the analysis using the transactions data from 29 of largest beef packing plants in the United States. As in Section 2.2, the methodology is based on Ward, Koontz, and Schroeder (1998), with changes to reflect a newer data set.

The model is specified as

$$\begin{aligned} PRICE_{ti} &= \beta_0 + \beta_1 d\_auction_{ti} + \beta_2 direct\_nogrid_{ti} \\ &+ \beta_3 direct\_grid_{ti} + \beta_4 direct\_other_{ti} + \beta_5 showlist_t + \\ &\beta_6 utilization\_ama_{ti} + \beta_7 MARKET_t + \beta_8 CATTLE\_CH_{ti} \\ &+ \beta_9 D\_PLANT_{ti} + \beta_{10} D\_MONTH_t + u_{ti}, \end{aligned} \tag{2.5}$$

where *d_auction*, *direct_nogrid*, *direct_grid*, and *direct_other* are binary variables indicating auction barn transactions,[12] direct trade transactions using carcass weight not dependent on grid valuation, direct trade transactions using carcass weight dependent on grid valuation, and direct trade transactions with another valuation method. The base group is the variable for direct trade transactions using liveweight valuation (i.e., the binary variable was omitted from the regressions). The vector *MARKET* includes two weekly lagged price variables:

- *price_choice* (the value of boxed beef cutout for Choice quality grade in the preceding week)
- *price_futures* (the previous week's closing live cattle futures market price for the nearby contract)

These variables serve as proxies for cattle market expectations. The vectors *CATTLE_CH*, *D_PLANT* and *D_MONTH* are the same as described in Section 2.2.2.

[12] In almost all auction barn transactions, cattle are valued by liveweight. In this sample, only 9 out of 38,583 auction barn transactions used some valuation method other than liveweight.

Showlist and *utilization_ama* are the key variables in this regression. These variables are computed as follows:

- *Showlist* is computed as the total number of cattle (in 100,000 head) purchased through auction barns or direct trade that were delivered to the 29 beef packing plants within the subsequent 21 days, calculated from the previous Friday. This serves as a proxy for the total available cattle for delivery in the cash market (i.e., the cattle available for delivery that are not under AMAs).
- *Utilization_ama* is the proportion of average weekly AMA delivery relative to the weekly slaughter capacity for a plant.

Both *showlist* and *utilization_ama* capture the effect of AMAs on cash market transaction prices. However, the two variables differ in two ways. First, *showlist* is a market-level variable, while *utilization_ama* is at the plant level. Second, we expect the coefficient of *utilization_ama* to be negative because, when relatively high capacity utilization is being maintained through use of AMAs,[13] the packer would be expected to negotiate less aggressively, thus tending to pay less in the cash market (Schroeter and Azzam, 2003). In contrast, the direction of the effect of *showlist* on cash market prices is an empirical question. When more cattle are procured by AMAs, fewer are available in the cash market (i.e., *showlist* decreases). However, the demand for cash market cattle by packers would also be reduced. Therefore, the overall effect is unknown conceptually (Schroeder et al., 1993). The descriptive statistics for the variables included in Eq. (2.3) are summarized in Table 2-23.

We estimate Eq. (2.5) using OLS with Huber-White heteroskedasticity-robust standard errors. The parameter estimates are reported in Table 2-24. Compared with direct trade transactions with live weight valuation, the average cattle price associated with auction barn transactions is 2.4 cents higher, direct trade transactions with carcass weight not dependent on grid valuation are 1.3 cents lower, and direct trade transactions with carcass weight dependent on grid valuation are 1.8 cents lower, holding other explanatory variables in the model fixed. As with the results in Section 2.2.2, cattle with better quality (such as better yield grade,

[13] One major reason that packers use AMAs is to maintain a relative high capacity utilization.

Table 2-23. Descriptive Statistics for the Variables in the Cash Market Price Model for Fed Cattle Procurement Transactions, October 2002–March 2005

Variable	Notation	Mean	Std. Dev.	Min	Max
price	Transaction price in $ per pound carcass weight	1.3800	0.120	0.86	1.98
d_auction	Auction (1 = yes, 0 = no)	0.1000	0.310	0.00	1.00
direct_nogrid	Direct trade purchases valued by carcass weight, not dependent on grid value (1 = yes, 0 = no)	0.1700	0.370	0.00	1.00
direct_grid	Direct trade purchases valued by carcass weight dependent on grid value (1 = yes, 0 = no)	0.2800	0.450	0.00	1.00
direct_other	Direct trade purchases valued by other than liveweight or carcass weight (1 = yes, 0 = no)	0.0040	0.063	0.00	1.00
showlist	Number of cattle available in the cash market in the next 21 days (in 100,000 head)	8.6000	0.760	6.50	10.30
utilization_ama	Capacity utilization from AMA cattle[a]	0.1700	0.170	0.00	1.00
price_choice	Choice boxed beef cutout value in the preceding week	1.4600	0.140	1.25	1.94
price_futures	Previous week's closing live cattle futures market price for the nearby contract	0.8600	0.058	0.75	1.01
d_beefcattle	Mostly beef breed cattle in the lot (1 = yes, 0 = no)	0.8300	0.380	0.00	1.00
numberofhead	Number of head in the lot (100s)	0.9600	0.860	0.06	15.20
yg45_pct	% Yield Grade 4 or 5 in the lot	0.0950	0.110	0.00	1.00
primechoice_pct	% Prime or Choice in the lot	0.6600	0.250	0.00	1.00
outweight_pct	% heavy weight or light weight cattle in the lot	0.3600	0.376	0.00	1.00
branded_pct	% cattle eligible for branded or certification program in the lot	0.2000	0.250	0.00	1.00

[a] Plant capacity is each plant's stated maximum operating capacity given its current operating schedule.

better quality grade, beef breed, and eligible for a branded or certification program) receive premiums on the cash market, and cattle with undesirable characteristics (such as light weight or heavy weight) are discounted. Also, large cattle lots receive statistically significant but economically small premiums.

As expected, capacity utilization through AMAs (*utilization_ama*) has a negative coefficient. The results suggest that if capacity utilization through AMAs in a plant (as measured by *utilization_ama*) increases by 10 percentage points, the plant pays 0.4 cents per carcass weight pound less for cattle purchased in the cash market. *Showlist* has a positive coefficient, which suggests that 100,000 more cattle available in the cash market (or 100,000 fewer cattle through AMAs) increases the cash market price by 0.18 cents. Alternatively, the estimated *showlist* coefficient indicates that a 10% increase in total cattle available through AMAs (within the next 21 days)

Table 2-24. Parameter Estimates for the Cash Market Price Model for Fed Cattle Purchase Transactions, October 2002–March 2005

Variable	Coefficient[a] (Robust Standard Error)
d_auction	0.0240 (0.00190)
direct_nogrid	–0.0130 (0.00039)
direct_grid	–0.0180 (0.00043)
direct_other	–0.0110 (0.02700)
showlist	0.0018 (0.00040)
utilization_ama	–0.0400 (0.00190)
price_futures	0.6200 (0.01400)
price_choice	0.2000 (0.00460)
beefcattle	0.0370 (0.00073)
numberofhead	0.0055 (1.8×10^{-4})
yg45_pct	–0.0920 (0.00320)
primechoice_pct	0.0630 (0.00140)
outweight_pct	–0.0260 (0.00110)
branded_pct	0.0300 (0.00120)
Other variables[b]	Not reported
No. of cash market observations	203,017
F(55,202961)	5,010
R^2	0.6571

[a] All coefficients are significant at the 5% level.

[b] The “other variables” include an intercept, monthly binary variables, and plant binary variables.

decreases the cash market price by 0.11% on average.[14] This is an important result because it suggests that thin cash markets result in slightly lower prices.

Our empirical result suggests a negative (partial) correlation between spot market prices and AMA delivery by packers (both at the plant level and market level). This result is consistent with the results of many previous empirical studies using weekly or monthly market-level time-series data (See section 3.3.1 of the interim report (Muth et al., 2005) for a summary of this literature.). Many researchers have attempted to explain the negative relationship between AMA delivery and cattle market price. A typical explanation is that the negative correlation is due to price manipulation. However, a recent study by Schroeter (2007) suggests that this negative correlation may be an artifact of cattle delivery timing decisions made by price-taking market participants.

2.4 SUMMARY

In this section, we summarized volumes and prices for fed cattle purchases by beef packers and analyzed price relationships across different type of marketing arrangements. The data used for the analysis are from October 2002 through March 2005, and thus the results may be influenced by the fact that the cattle cycle was in the contraction phase and by the discovery of BSE in Canada in May 2003 and in the United States in December 2003. The survey data are from 293 beef cattle producer and feeder responses and 64 beef packing plant responses across a range of sizes. The purchase data represent all purchases of fed cattle by 29 of the largest beef packing plants during the time period and include 58,066,440 head sold in 591,410 transactions.

Based on the survey data and transactions data, most packing plants are sole owners of the cattle slaughtered in their plants, but a small percentage of cattle are under shared ownership arrangements with the producer. Cash market transactions include auction barns, direct trade, and dealer/broker sales, while AMAs include forward contracts, marketing agreements, and packer ownership. Custom slaughtering in which the

[14] This percentage is calculated by multiplying 0.1 by the coefficient on the *showlist* variable (0.0018) by the average level of the *showlist* variable (8.6), divided by the average transaction price (1.38).

producer retains ownership of the cattle and beef through slaughter also occurs, but is not represented in the data. Summaries of the purchase transactions data, which are generally in line with the survey responses, indicate the following:

- The highest percentage of fed cattle sales to packing plants are through direct trade (58% of head slaughtered), followed by sales through marketing agreements (29% of head slaughtered). Fed cattle sales using auction barns, dealers or brokers, forward contracts, and packer fed/owned each represent a very small percentage of fed cattle transactions. Smaller beef packing plants rely much more on auction barn purchases than do larger beef packing plants. Beef packing plants in the Cornbelt/Northeast rely much more on auction barn purchases and plants in the West rely much more on marketing agreements compared with the other regions.
- Negotiated pricing is the most common pricing method (57% of head slaughtered), followed by formula pricing (33% of head slaughtered). Smaller beef packing plants rely much more on auction pricing than larger beef packing plants. Beef packing plants in the West rely more on formula pricing and much less on negotiated pricing compared with the Cornbelt/Northeast and plants in the West rely on formula pricing somewhat more than plants in the High Plains.
- The most common formula bases used in formula pricing are, in order of frequency, USDA live quotes, USDA dressed or carcass quotes, and subscription service prices. The use of formula bases is similar across plant sizes but different across regions. In particular, plants in the West use USDA live quotes much more frequently than the other regions and do not use USDA dressed or carcass quotes; plants in the Cornbelt/Northeast primarily use subscription service prices.
- Fed cattle are most often valued on a carcass weight with grid (43% of fed cattle purchases) and on a liveweight (39% of fed cattle purchases) basis. Small beef packing plants rely somewhat more on carcass weight with grid valuation and less on a liveweight basis than larger beef packing plants. Beef packing plants in the Cornbelt/Northeast tend to use more liveweight valuation compared with the other regions, and beef packing plants in the West tend to use more carcass weight with grid and much less liveweight valuation than the other regions.

Summaries of the beef sales transactions data indicate that the cash or spot market is the most common method of selling beef products by beef packing plants (32% of pounds sold). Forward contracts are also used but primarily by large beef packing plants and packing plants in the High Plains regions. However, many packing plants do not track or did not report the type of sales method used. Thus, all results of the sales data summaries should be interpreted with caution. For those plants that did indicate information about beef sales method, negotiated pricing was most often used (36% of pounds), followed by formula pricing (24% of pounds), particularly for large beef packing plants in the High Plains. The bases of formulas were USDA-reported prices for the vast majority of formula pricing transactions across all plant sizes and regions.

Summaries of fed cattle purchase transactions indicate that prices were relatively similar across purchase methods. The overall average price on a carcass weight basis was $1.31 per pound during the time period of the data. Average prices ranged from $1.27 per pound to $1.34 by type of marketing arrangement used, with some differences by size and location of plant. However, differences in prices reflect not only the type of marketing arrangement but also the quality of cattle and local market conditions.

We conducted an econometric analysis of the relationship between all fed cattle transactions prices and use of marketing arrangements, while controlling for differences in cattle quality and delivery month. The results indicate that relative to direct trade transactions, prices for fed cattle sold through auction barns tend to be somewhat higher and prices for fed cattle sold through forward contracts tend to be somewhat lower. These results are likely due, in part, to the differences in risk associated with the two methods; auction barn sales are somewhat more risky and have a higher cost because of commissions and weight shrink, but forward contracts ensure market access and a guaranteed price for cattle producers. The prices for fed cattle sold through marketing agreements and transferred through packer ownership are relatively similar to direct trade.

We also conducted an econometric analysis of the relationship between cash market (auction barns, dealers and brokers, and direct trade) transactions prices for fed cattle and use of marketing arrangements, which provides evidence of the effect of AMA supplies on the markets for cattle. The results suggest that if capacity utilization through the use of AMAs within a plant increases, plants pay slightly less per pound for cattle purchased in the cash market. Specifically, a 10% increase in capacity utilization through AMAs is associated with a 0.4 cent per pound carcass weight decrease in the cash market price. Furthermore, if more cattle are available through AMAs within the following 21 days, cash market prices decrease slightly. Specifically, a 10% increase in cattle available through AMAs is associated with a 0.11% decrease in the cash market price. However, these results are not necessarily indicative of manipulation of prices by packers but could instead be resulting from benign cattle delivery timing decisions made by price-taking market participants.

3 Economies of Scale, Costs Differences, and Efficiency Differences Associated with Alternative Marketing Arrangements

In this section, we present results on the economies of scale, cost differences, and efficiency differences associated with AMAs. First, we describe qualitative evidence regarding the effects of AMAs on costs in the beef industry from the industry interviews and industry survey. Then we present the results of analyses using profit and loss (P&L) statement data from beef packing firms.

3.1 QUALITATIVE EVIDENCE OF THE EFFECTS OF AMAS ON COSTS

The use of AMAs has effects on the cost of procurement of cattle and on the cost of production of beef by packers. In the earlier phase of the study, we interviewed producers and packers on the effect of AMAs on beef cattle and beef products (see Muth et al., 2005, Section 1.3 for a discussion of the interview process). The fed cattle producers we interviewed said that when selling cattle to packers, the use of AMAs instead of cash markets affects costs because of

- a need for fewer employees to manage many of the activities associated with production;
- better feeding programs;
- the ability to be able to obtain services such as financing, risk management, and procurement;
- reduced costs of production of $1.25 to $10.00 per head, as reported by some producers, or 17% to 22% of costs, as reported by other producers; and
- increased capacity utilization of the feedyard from a range of 77% to 80% to a range of 97% to 100%.

On the packer side, packers said that when purchasing cattle from producers, the use of AMAs instead of cash markets affects costs because of

- the need for fewer buyers (approximately $0.40 per head), and
- increased efficiencies in the production process.

However, the respondents indicated that the ability to obtain cattle to fit specific programs for meeting consumer demand and the ability to provide a consistent supply of quality product were other important reasons for using AMAs.

In the industry surveys described in Volume 2 of this report, we asked fed cattle producers and beef packers the three most important reasons for using either the cash market or an AMA. For fed cattle producer sales, 22.8% of respondents who use only the cash or spot market indicated doing so because it reduces the costs of activities for selling calves and cattle. In contrast, only 12.8% of respondents who use an AMA indicated doing so because it reduces the costs of activities for selling calves and cattle. Thus, based on the survey results, the costs of activities for selling calves and cattle appear to not be a major factor in the use of marketing arrangements, but do appear to be a more important factor for producers that choose to use only the cash market. Therefore, although the interview results indicate that cost reductions due to the use of AMAs can be substantial, higher selling prices, reduced price variability, and the ability to sell higher quality cattle are more important.

We obtained too few responses to make comparisons regarding the costs of buying and selling activities between respondents that use only the cash market and those that use an AMA for beef packer purchases. However, the most important reasons for using only the cash market for beef packer purchases are that it allows for independence, complete control, and flexibility of one's own businesses. Respondents also believe they can obtain higher quality cattle. Thus, the effects of marketing arrangements on costs are less important than these factors. The most important reasons for using AMAs are because they improve week-to-week supply management and because the respondents believe they can obtain higher quality cattle. Improved week-to-week supply management likely has an effect on costs of production and is consistent with the interview responses.

3.2 DESCRIPTION OF PROFIT AND LOSS STATEMENT DATA

In this section, we describe the P&L data obtained from the largest beef packing firms.[1] The P&L data are by plant, within each firm that slaughters and processes fed beef cattle. All results presented are aggregated across plants and firms included in the analysis. Thus, although results specific to any individual packer are not presented, all analyses were conducted on P&L data from individual plants.

The volume of head slaughtered and processed by the firms included in the analysis for the October 2002 through March 2005 period was more than 80% of USDA-reported federally inspected steer and heifer slaughter. All of the firms included in the analysis provided P&L information for each of their plants. Many smaller beef packers were not included in the analyses because they did not have P&L data in electronic form. Although other smaller beef packers provided electronic data, they could not be included in the analysis for a variety of reasons. These reasons included incomplete data (e.g., missing fields), changes in accounting systems during the data collection period resulting in changes in the format of data reported, and extremely small volumes relative to the industry as a whole. Twenty-one plants owned by four beef packing companies reported data suitable for this analysis.

[1] This is the first economic analysis of P&L data from the beef packing industry that has been conducted as part of an industry study. GIPSA has collected packer P&L data but only reports the data aggregated across firms. Therefore, it is not possible to examine individual firm performance or individual plant performance. This is the first study to examine plants and firm performance with the same information that firm managers have.

P&L data are maintained differently across the major packers. The structure of the P&L statements is different across firms, and there are large variations in the categories of information that are detailed. For example, some firms reported very detailed by-product revenue information, while other firms reported very few lines associated with revenue categories. The placement of specific types of information within P&L statements also varies across packers. Some firms reported labor as a variable cost, while others reported labor with other costs that are most likely fixed costs. Likewise, some firms reported plant costs as a fixed cost, and some reported plant costs with other costs that are most likely variable costs. Some of the largest firms reported slaughter and fabrication on separate P&L statements, even when the slaughter and fabrication operations were at the same facility site. The other firms combined slaughter and fabrication into a single P&L statement.

While all beef packing firms complied with the request for P&L data, analysis was only attempted for those with data in electronic form. In most cases, the electronic form of the P&L data were exact images of P&L statements. The level of detail provided in P&L statements varied by company. As mentioned above, they also differed in how they categorized variable and fixed costs. Thus, only data from plants that provided cost and revenue data in an electronic format and in sufficient detail were used in the analysis.

Because of the differences in P&L statements across firms, only basic information can be compared with confidence. Thus, the details reported in this section focus on

- average total costs per head (ATC),
- average gross margin per head (AGM), and
- average profit per head (PPH).

Total costs, total gross margin, and total profits are available for each plant from each monthly P&L statement.[2] We divided each total by the number of head slaughtered or processed each month to create an average value per head per month figure. We constructed these variables for each plant within each firm included in the analysis.

[2] For plants that maintain P&L statements on a weekly basis, we aggregated the data to a monthly basis.

3.3 METHODOLOGY FOR ANALYZING PROFIT AND LOSS DATA

This section describes the methodology used to analyze the beef packer P&L data. Because of the differences in P&L statements across firms, the analyses of costs and revenues focus on total costs, gross margins, and profit. We conducted more detailed analysis of the firms that provided more detailed data and found the results to be generally consistent with those in this report. However, specifics of the disaggregated firm analyses will not be presented in order to preserve confidentiality and because comparisons across firms may be misleading. Fixed costs associated with plants could be easily identified for some packers and were of expected magnitudes. However, efforts to identify fixed costs for other packers resulted in magnitudes that were not reasonable.

Below, we describe the details of the models for ATC, AGM, and PPH. We present the results in Section 3.4. Models are estimated for each plant. However, the results are aggregated over all plants to protect confidentiality. The aggregate plant can be thought of as a “representative” plant for the industry.

3.3.1 Total Costs per Head Model

The primary modeling effort using P&L data involves regressing ATC as a function of the volume processed or slaughtered and the percentages of volumes that are procured through AMAs. The basic ATC model is as follows:

$$TotalCostsPerHead_t = \beta_0 + \beta_1 \ln(Volume_t) + \beta_2 (P\_FC_t) + \beta_3 (P\_MA_t) + \beta_4 (P\_PO_t) + \sum_j \alpha_j x_{jt} + \varepsilon_t \quad , \qquad (3.1)$$

where t denotes the month within the sample. The variables *P_FC*, *P_MA*, and *P_PO* denote forward contract, marketing agreement, and packer-owned fed cattle, respectively, expressed as a percentage of total monthly procurement volumes. x_j represents a trend variable and labor, energy, and capital input price variables obtained from the U.S. Bureau of Labor statistics sources. However, none of the input price variables were significant and of the correct sign and, thus, were removed from the final specification.

Initially, separate models were estimated for each plant within each company. The semilogarithm form of the model specified above was found to be most appropriate for the majority of the plants. Thus, we used the semilogarithm form in all cases for uniformity across the firms and plants and for simplicity in programming the policy simulations. Quadratic ATC functions were not used for Eq. (3.1) because the data showed no points where ATC increased with higher volumes. Increasing ATCs with larger volumes was not observed in the data.

Coefficients on the AMA variables in Eq. (3.1) measure whether higher volumes of fed cattle purchased through AMAs are associated with lower ATC, as expressed on monthly plant-level P&L statements. In other words, the coefficients are direct-effect measurements of the cost differences caused by the use of AMAs for procuring cattle. Furthermore, these coefficients represent the cost differences that the firms see or recognize through their P&L accounting.

The model can be used to calculate or simulate changes in ATCs when AMA volumes are changed or limited because of policy intervention. For example, if a hypothetical restriction required that no cattle be procured through AMAs, then substituting zero for the AMA variables enables a calculation of the change in ATCs due to the restriction, while holding all else constant. Likewise, the effects of other types of restrictions can be simulated by varying the values substituted into Eq. (3.1). However, resulting estimates are specific to the sample of 30 months covered by the data collection (October 2002 through March 2005).

When using the model to conduct policy simulations, in addition to the direct effects, there are two important indirect effects that result. First, if a policy change results in reduced volumes of cattle slaughtered and processed at packing plants, then the effect of those changes can be measured through the volume coefficient in the ATC model. Thus, the cost impact of the volume reduction needs to be measured. Second, if a policy change results in changes in the variability in the number of cattle slaughtered and processed through packing plants, then the change needs to be measured. Random draws from the new distribution of cattle can be used with the ATC equation to measure the changes in average total costs due to a more variable supply of cattle for slaughter. The slope and curvature of the ATC function and increasing variability of procurement will result in increased costs.

Model of Plant-Level Volumes

Determining the changes in plant-level volumes and changes in variability brought about by changes in AMA volumes requires two additional modeling efforts. Changes in volumes are modeled as follows:

$$Volume_t = \beta_0 + \beta_1(USDAFI_t) + \beta_2(FC_t) + \beta_3(MA_t) + \beta_4(PO_t) + \varepsilon_t, \quad (3.2)$$

where the total volume of head slaughtered and processed at a plant (*Volume*) is modeled as a function of AMA volumes (*FC*, *MA*, and *PO*) measured in number of head and the monthly USDA federally inspected steer and heifer slaughter volumes (*USDAFI*) measured in thousands of head. We estimated one model for each plant so that plant-specific associations are measured. The *USDAFI* variable captures general changes in supply numbers. During the study period, cattle numbers were initially large because the market was in the liquidation phase of the cattle cycle. Cattle numbers were smaller toward the end of the sample, as the cycle changed to the expansion phase. In addition to the cattle cycle effects, a distinct seasonal pattern was also observed in the *USDAFI* variable. The model measures how changes in the total volume of cattle slaughtered and processed at a plant vary with changes in AMA volumes, while holding the total volume of cattle in the marketplace constant. Some plants readily substitute cash market cattle for AMA-procured cattle. For example, if volume of marketing agreement cattle decreases by 1,000 head, then those cattle might be offset by an increase of 900 cash market cattle and the total cattle purchase volume will decrease by 100 head. On the other hand, some plants substitute fewer cash market cattle to make up for variations in volumes of cattle procured through AMAs. For example, if the volume of AMA cattle decreases 1,000 head, then those cattle might be offset by 200 cash market cattle and the total volume will decrease by 800 head. Substantial differences occur across plants, and some plants appear to readily substitute across types of AMAs while other plants do not. However, this substitution holds constant the variations in total U.S. fed steer and heifer slaughter volumes.

As with the ATC model in Eq. (3.1), the volume model in Eq. (3.2) can be used to simulate changes in individual plant volumes when AMA volumes are changed or limited because of policy intervention. If a hypothetical restriction required that no cattle be procured through AMAs, then substituting zero for the AMA variables would enable a calculation of the change in plant slaughter volumes due to the restriction, while holding all else constant. Likewise, the effects of other types of restrictions can be simulated by varying the values substituted into Eq. (3.2).

Model of Plant Volume Variability

The second modeling effort measures indirect effects on costs due to variability of plant-level cattle volumes obtained from different fed cattle procurement sources. By definition, the variance of plant volumes is the variance of the sum of the different procurement sources, as follows:

$$\begin{aligned} Var(Volume) &= Var(Cash + FC + MA + PO) \\ &= Var(X_1 + X_2 + X_3 + X_4). \end{aligned} \tag{3.3}$$

A constant is multiplied by each procurement source to maintain the mean level of total volume, as follows:

$$\begin{aligned} &Var(Volume) = Var(k_1X_1 + k_2X_2 + k_3X_3 + k_4X_4) = \\ &\sum_{i=1}^{4} k_i^2 Var(X_i) + \sum_{i=1}^{4}\sum_{j=1}^{4} k_i k_j Cov(X_i, X_j). \end{aligned} \tag{3.4}$$

For example, if half of the volume for a plant is procured from AMA sources, and if policy intervention prohibits the use of AMAs, then to maintain the mean total volume the plant will have to procure twice the volume from the cash market. The cash procurement constant is adjusted so that reductions in cattle through AMAs are added to the constant, ensuring the mean of total volume is preserved. Because of this adjustment, the variance changes are mean preserving. This method allows for estimation of a variability effect caused by changing use of AMAs, but changes in the variability of plant volumes are not confounded by changes in the mean of plant volumes.

The variance calculation can be used to simulate changes in variability of plant volumes when AMA volumes are limited because of policy intervention. If a hypothetical policy intervention requires that no cattle be procured through AMAs, then zeroing out the variables that represent AMA volumes will allow for calculation of the change in plant-level volume variability due to the policy change. These changes in variance are used in the simulation scenarios for the variance parameter presented in Section 3.4.4.

3.3.2 Average Gross Margin per Head Model

The second primary modeling effort using P&L data involves modeling AGM as a function of the slaughter volume and the percentages of volumes procured through AMAs. The basic AGM model is as follows:

$$\begin{aligned}&Gross\ Margin\ /\ Head_t = \beta_0 + \beta_1 \ln(Volume_t) + \beta_2 (P\_FC_t) \\ &+ \beta_3 (P\_MA_t) + \beta_4 (P\_PO_t) + \sum_j \alpha_j\ x_{jt} + \varepsilon_t\ ,\end{aligned} \tag{3.5}$$

where *t* denotes the month within the sample and *P_FC*, *P_MA*, and *P_PO* denote forward contract, marketing agreement, and packer-owned procurement of cattle, respectively, expressed as a percentage of the total monthly volume. Initially, separate models were estimated for each plant within a company. Other variables, represented by x_j in Eq. (3.5), were found to be important for this model. These other variables include a trend variable and the deflated monthly USDA ERS farm-to-wholesale price spread. The price spread variable captures general conditions that all packers face in the markets for cattle and beef, and plant specific variables included in the model measure the performance of the plant relative to those market conditions.

Gross margins are calculated as the difference between meat and by-product revenues and fed cattle purchase costs. The model is used to examine whether margins for plants with larger AMA volumes are larger than for plants with larger cash market volumes. The model helps determine whether AMA cattle generate more revenue or reduced costs for the packer because of factors such as better quality, better quality control, or participation in a branded program beef. However, the source of the improved margins is not identified in the data and any improvements to margins may be specific to the time period included in the data collection. Nonetheless, the uniqueness of the P&L data provides an opportunity to measure the effect on margins caused by AMA use if it is observed in the data.

3.3.3 Average Profit per Head Model

The third main modeling effort using P&L data involves modeling PPH as a function of slaughter volume and the percentages of volumes that are procured through AMAs. The basic PPH model is as follows:

$$
\begin{aligned}
Profit\ /\ Head_t &= \beta_0 + \beta_1 \ln(Volume_t) + \beta_2(P\_FC_t) + \\
&\beta_3(P\_MA_t) + \beta_4(P\_PO_t) + \sum_j \alpha_j\ x_{jt} + \varepsilon_t\ ,
\end{aligned}
\tag{3.6}
$$

where t denotes the month within the sample and *P_FC*, *P_MA*, and *P_PO* denote forward contract, marketing agreement, and packer-owned procurement of cattle, respectively, expressed as a percentage of the total monthly volume. Other variables, represented by x_j in Eq. (3.6), were found to be important for this model. These other variables include a trend variable and the deflated monthly USDA ERS farm-to-wholesale price spread.

Profits can be defined as gross margins minus total costs. All firms include other special revenues (e.g., facility equipment sales) and other nonrecurring costs (e.g., management bonuses) in their P&L statements. Eq. (3.6) is used to examine whether profits are associated with purchasing fed cattle using AMAs rather than on the cash market. That is, the model helps determine whether AMA cattle generate more profits for the packer. Changes in PPH due to changes in AMA volumes are not used in the simulation model presented in Section 6 but are used as validation for the ATC and AGM models. Specifically, changes in costs and changes in revenue should approximately total changes in profits.

3.3.4 Model Estimation Details

The ATC (Eq. [3.1]), AGM (Eq. [3.5]), and PPH (Eq. [3.6]) equations are estimated jointly for all plants within a firm using seemingly unrelated regression (SUR). The block of equations also contains other equations specific to each packer. For example, labor costs, plant costs, sales costs, boxed beef revenue, cattle costs, and other costs and revenues were available from some of the firm P&L statements. Models explaining the relationships among these variables were estimated along with the ATC, AGM, and PPH models. Cost-related items were estimated with the same specification as the ATC model, and revenue-related items were estimated with the same specification as the AGM model. The limiting feature is that SUR cannot be estimated for cases in which a linear combination of some of the dependent variables equals another dependent variable. In these cases, equations were dropped from the system to allow estimation. However, we also examined the results of OLS estimation of these dropped equations. There is strong cross-equation correlation in the system of estimated equations. The errors for all of the ATC, AGM, and PPH models across plants are highly correlated. Specifically, there are strong negative correlations between the errors for the ATC models and the errors for the AGM and PPH models, and there are also strong positive correlations between the errors for the AGM models and the PPH models. The SUR method appears to improve the model estimates, while also improving model efficiency.

3.4 RESULTS OF PROFIT AND LOSS DATA ANALYSIS

In this section, we begin with a description of the summary statistics of the data used in the modeling efforts and then we present results of the models described in Section 3.3. We also present the estimated effects on costs of the simulation scenarios in modeling the economic effects of restricting AMAs (see Section 6). Finally, we describe the implications of the results for determining whether efficiencies occur through use of AMAs.

3.4.1 Descriptive Statistics from the P&L Data

Summary statistics for ATC, AGM, and PPH are reported in Table 3-1. Values shown in Table 3-1 are weighted averages across plants, using the relative proportion of head slaughtered as the weights. As indicated in the table, the weighted average values for the time period of the data are as follows:

- ATC is $138.61 per head.
- AGM is $140.73 per head.
- PPH is a loss of –$2.40 per head.

ATC and AGM are typical values for costs and revenues. ATC does not include cattle costs, and AGM is revenue from beef and by-product sales net of cattle costs. The average PPH value is negative because some firms included irregular costs and revenues in their P&L statements. In addition, it was an unprofitable time for some beef packers because of tight cattle

Table 3-1. Weighted Average Summary Statistics for Variables Used in the Average Total Cost per Head, Average Gross Margin per Head, Average Profit per Head, and Volume Equations

Variable	Mean	Standard Deviation	Minimum	Maximum
Average total cost per head (ATC)	$138.61	10.7476	120.3196	164.2098
Average gross margin per head (AGM)	$140.72	38.8241	22.6245	211.9827
Average profit per head (PPH)	–$2.40	43.8242	–137.3646	73.3409
AMA volumes (%)				
Forward contract	0.0424	0.0414	0.0020	0.1661
Marketing agreement	0.2951	0.0742	0.1716	0.4594
Packer owned	D[a]	D	D	D
Other	0.0016	0.0024	0.0000	0.0092
AMA volumes (no. of head)				
Forward contract	18,216	4,086	196	16,884
Marketing agreement	145,227	9,398	14,121	52,121
Packer owned	D	D	D	D
Other	1,340	250	0	1,004
Total fed cattle volume (no. of head)	426,759	14,341	68,102	127,845

D = Results suppressed.

[a] Based on data presented in Section 2, this value has an upper bound of 0.05.

supplies. However, many individual plants or firms were profitable during most of the sample period, and some firms were more profitable than others. No one firm had all plants operating at an average positive profit for the entire period. However, the cost and profit variation within each firm was larger than across firms. High-cost firms are also high-gross margin firms, indicating either that additional processing creates additional value or that there are accounting differences across firms. The most profitable firm was a low-cost firm and relatively low-gross margin firm.

The variables for the percentage of fed cattle purchased through AMAs were created for each plant within each firm using the transactions data. The P&L data are monthly. Thus, the different sources of cattle by cash and AMA methods were totaled for each month for each plant within each firm, using the transactions data. The total numbers of cattle procured by each type of marketing arrangement are very close to the total numbers of cattle slaughtered and processed, as reported on the P&L statements. The average discrepancy was less than 1%, and the largest discrepancy was less than 2%.

Summary statistics of the AMA percentage variables are also reported in Table 3-1. For the period represented in the data, the weighted average percentages of AMAs used are as follows:

- marketing agreements—29.5% of the fed cattle volume
- forward contracts—4.2% of the fed cattle volume
- packer owned—less than 5% of the fed cattle volume
- other method—0.2% of the fed cattle volume
- missing—less than 1% of the fed cattle volume

The remainder of the volume was through auction barns or direct trade (approximately 60%). The percentage variables used in the models and reported in the tables range from zero to one. For example, a 10% increase is 0.10. Large variation in procurement methods occurs across firms and for different plants within firms. The modeling methods described in Section 3.2 measure and account for the differences across plants within firms.

Other variables were included in the ATC model, but most were found to be unimportant in explaining the variation in ATCs across firms. These other variables are denoted as x_j in Eq. (3.1). For example, labor, energy, and capital input price variables were obtained from U.S. Bureau of Labor Statistics sources and included in the preliminary models. None of these variables were significant and of the correct sign, so were removed them from the final model. However, we did include a trend variable in the final model. Based on the estimated coefficient on the trend variable, real average total costs increased for most plants and firms over the sample period. We also included interactions terms between the input price variables and the AMA variables, but none of these interaction terms were significant. All of the dollar variables were deflated to 2004 dollars. However, inflation was mild in the sample period and deflating had little effect on the results.

3.4.2 Results of Estimation of the Volume Models

Results of the volume models (Eq. [3.2] and a first differenced version of Eq. [3.2]) are reported in Table 3-2. We estimated these equations in levels and first differences using OLS. However, we did not find large differences in the results, and

Table 3-2. Weighted Average Results of the Models of Total Plant Volumes, as a Function of AMA Volumes

Header	Plant Volume Levels (Eq. [3.2]) Coefficient (Standard Error)	Plant Volume Levels (Eq. [3.2]) Implied Elasticities[a]	Plant Volume Changes (Eq. [3.2] in First Differences) Coefficient (Standard Error)
Mean dependent variable	103733	—	–574.1694
Standard deviation of error	8558.2429	—	9186.7250
Intercept	90261.7364 (6950.7315)	—	–339.5124 (1718.4385)
Quantity of forward contract cattle	0.2289 (0.5226)	+0.0098	0.1140 (0.4742)
Quantity of marketing agreement cattle	0.5125 (0.3154)	+0.1744	0.3827 (0.3434)
Quantity of packer-owned cattle	0.0394 (0.0957)	+0.0012	0.0507 (0.1006)
R^2	0.6561	—	0.5527

[a] The elasticities are calculated from the weighted average values.

therefore, we present and discuss the results of estimation in levels. The coefficients, standard errors, and model statistics presented in Table 3-2 are weighted averages across all plants in the sample. The weights are the volume of cattle slaughtered or processed at that plant. Thus, the results can be considered to reflect a representative plant in the industry.

Based on the results of estimation of Eq. (3.2), decreases in procurement of fed cattle through marketing agreements, forward contracts, and packer-owned sources result in a substitution of cattle purchased in the cash market. The coefficients and implied elasticities for forward contract and packer-owned cattle are small compared with marketing agreement cattle. The specific results are as follows:

- A 1% decline in forward contract cattle is estimated to result in a 0.0098% decline in the total volume of cattle purchased and a 0.9902% increase in the volume of cattle purchased in the cash market.
- A 1% decline in packer-owned cattle is estimated to result in a 0.0120% decline in the total volume of cattle purchased and a 0.9880% increase in the volume of cattle purchased in the cash market.

- A 1% decline in marketing agreement cattle is estimated to result in a 0.1744% decline in the total volume of cattle purchased and a 0.8256% increase in the volume of cattle purchased in the cash market.

Thus, based on these results, it appears that packers readily substitute cattle purchased on the cash market for cattle procured through forward contracts and packer ownership. Based on these results, and because the percentage of cattle that are forward contracted or packer owned is small, a policy that affects forward contracting or packer-owned procurement of fed cattle would have little effect on individual plants or the overall market. However, such a policy would have a large effect on some packers and some plants owned by specific packers. Unlike with forward contract and packer-owned cattle, packers do not appear to be able to readily substitute cash market cattle for marketing agreement cattle. Therefore, a policy that affects procurement of cattle through marketing agreements likely would result in packers operating plants at lower volumes. Cattle slaughter plants that currently procure a substantial portion of their cattle through marketing agreements would be particularly affected.

Based on results of estimation of Eq. (3.3), volumes of cattle procured through the cash market are typically almost twice as variable as the volumes of cattle procured through AMAs. Thus, elimination of AMAs would increase the variability of volumes slaughtered and processed at plants. Specifically, the weighted average variability of volumes at cattle slaughter plants is 174% greater when cattle are procured only through the cash market compared with when cattle are procured through both the cash market and AMAs. In other words, the mean-preserving variance change suggests that if packers are required to purchase all cattle in the cash market, the monthly slaughter and processing volumes would be 74% more variable than current slaughter and processing volumes. Because of the curvature of the ATC function, costs would also increase (see discussion in Section 3.4.3).

This general conclusion about the relative magnitude of the variability is supported by secondary data provided by USDA AMS' MPR, which began in 2001. MPR data provide information of the volume of transactions through the cash market and AMA sources. Since 2001, there have been fairly large changes in cash market volumes and AMA volumes. However, the variability of cash volumes, as measured by month-to-month changes, is clearly larger than for AMA volumes. Depending on the sampling interval, monthly cash market volume variability is two to four times larger than AMA volume variability.

3.4.3 Results of Average Total Cost, Gross Margin, and Profit Model Estimation

Results of the ATC (Eq. [3.1]), AGM (Eq. [3.5]), and PPH (Eq. [3.6]) models are presented in Table 3-3. The model coefficients, standard errors, and summary statistics are weighted averages across all of the plants; the weights are the total volume slaughtered and processed for each plant over the sample period. Model efficiency is clearly improved between the OLS and SUR results. However, the SUR results are more uniform and more coefficients are significant across plants for the volume and percentage of AMA variables.

Table 3-3. Weighted Average Results of the Average Total Cost per Head, Average Gross Margin per Head, and Average Profit per Head Equations[a]

	Average Total Cost (Eq. [3.1])	Average Gross Margin (Eq. [3.5])	Average Profit (Eq. [3.6])
Mean dependent variable	138.6078	140.0170	–2.3963
Standard deviation of error	7.4986	34.5537	36.8929
Intercept	497.0765 (88.53819)	–287.5320 (384.0612)	–800.6312 (408.1619)
Ln (Volume)	–31.2401 (7.6893)	37.0480 (33.3851)	69.2281 (35.4712)
Percentage of forward contract cattle[b]	–16.5507 (30.5976)	–90.7020 (134.4086)	–73.9346 (141.2289)
Percentage of marketing agreement cattle[b]	–12.1548 (20.2700)	30.6730 (92.6972)	48.5780 (98.5002)
Percentage of packer-owned cattle[b]	3.3190 (7.4724)	1.3886 (27.6756)	–1.7875 (30.4790)
R^2	0.5763	0.3947	0.4567

[a] Values in parentheses are weighted average standard errors.

[b] Estimated coefficients represent estimated effects on a cents per head basis.

Average Total Cost Model Results

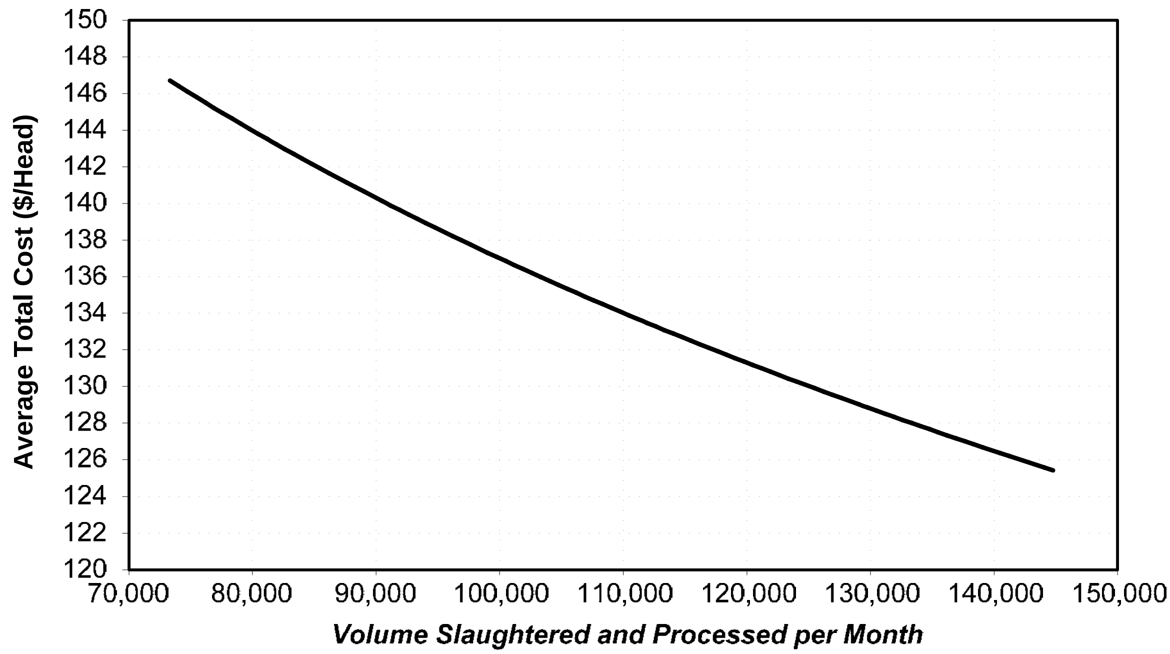
The primary result from the ATC model (Eq. [3.1]) estimates shows that there are substantial economies of size for meat packing firms. Larger firms have substantially lower costs at higher slaughter volumes. The predicted values from the estimated equation fit through the center of the actual data in a each XY plot. In addition, the predicted values from the estimated equations do not miss the data at the edges of the data ranges. The volume variable in the ATC models accounts for 70% to 90% of the reported R^2. The results for a representative firm have an R^2 of 58%.

Based on the individual plant model results, when larger plants operate with smaller volumes, they have higher costs than smaller plants operating close to capacity. Thus, the importance of large plants operating at capacity is apparent. Likewise, small plants appear to have cost advantages relative to large plants when volumes are smaller. However, smaller plants are at an absolute cost disadvantage compared with larger plants when both are operated at close to capacity. The lowest cost for larger plants is typically $1 to $3 per head lower than the lowest cost for smaller plants.

However, for all plants, ATCs increase sharply as volumes are reduced. Figure 3-1 illustrates the ATC function for a representative plant over the representative range of plant slaughter volumes. A representative plant operating at 95% of the maximum observed volume is 6% more efficient than a plant operating in the middle of the observed range of volumes and is 14% more efficient than a plant operating at the low end of the observed range. The ATC function displays some curvature but the curvature is slight. We also observe this slight curvature in the raw data; ATCs decline sharply and continuously over the observed slaughter volumes. In addition, ATCs never appear to increase at higher volumes in the data, nor is there a flat spot reflecting the minimum of the function. This result is similar to much of the past research on meat packing economics and specifically to the results found by Ward (1990, 1993) and summarized in MacDonald (2003). However, the result remains striking. The magnitude of scale economies is substantial and clearly a main factor in the decision-making process of meat packing firms.

The effects of AMA volumes on ATC are somewhat mixed but primarily as hypothesized. In general, increases in the percentages of cattle procured through AMAs, while holding total volume constant, are associated with lower ATCs. AMAs appear to allow for predictable cattle procurement volumes and cattle quality and thus enable the packer to reduce slaughter

Figure 3-1. Average Total Cost per Head Curve for a Representative Fed Cattle Slaughter Plant



and processing costs. However, for some plants, the percentages of cattle procured through AMAs appear to have no effect, and in other plants, higher percentages of cattle procured through AMAs are associated with higher total slaughter and processing costs. Approximately 49% of the coefficients on the AMA variables were negative, and 51% were positive. Negative signs were expected prior to estimation. Of the negative coefficients, 33% were statistically significant, and of the positive coefficients, 9% were statistically significant.

The weighted average results in Table 3-3 indicate that a 1% increase in the percentage of cattle procured through marketing agreements is associated with a $0.12 per head (0.1%) decrease in slaughter and processing costs, holding the total volume slaughtered and processed constant. This result appears to be statistically insignificant in Table 3-3, but the reported coefficient and standard error include all of the significant and insignificant results across all plants and firms. The plants with statistically significant coefficients in the ATC models have estimated coefficients in the –$0.12 to –$0.18 per head range, for a 1% change in procurement of fed cattle though marketing agreements. Based on examination of the individual firm-level equation estimates, some firms and some plants within those firms are able to reduce plant operating costs using AMAs, whereas some firms are not experiencing those same cost reductions.

While the percentage of cattle procured through marketing agreements has the largest significant effects on ATCs based on the individual firm-level estimates, the percentage of cattle procured through forward contracts also has a large effect, although many of the individual plant coefficients are insignificant. For a representative plant, a 1% increase in the percentage of cattle procured through forward contracts is associated with a $0.17 per head (0.1%) decrease in slaughter and processing costs, holding the total volume slaughtered and processed constant. However, the percentage of cattle procured through forward contracts is much smaller than that for marketing agreements, so the total effect of forward contract cattle on slaughter and processing costs is smaller. Most of the results for individual plants were insignificant, but some individual plants experienced reduced costs due to procurement of cattle through forward contracts.

Finally, the sign of the coefficient associated with the percentage of cattle procured through packer ownership is not as expected and the estimated coefficients are statistically insignificant. These results occur both for a representative plant and for individual plants. The results imply that a reduction in the percentage of cattle procured through packer ownership reduced ATCs. For a representative plant, a 1% increase in the percentage of cattle procured through packer ownership is associated with a $0.03 per head (<0.1%) increase in slaughter and processing costs, holding the total volume slaughtered and processed constant. The result is counterintuitive because, if packer-owned cattle result in higher costs, it is not clear why packers would own cattle. However, it may be that cattle are owned by the packer for reasons other than improving plant operations, and these reasons are not apparent on the P&L statements. Another explanation is that the results are due to the uniqueness of the time period and short time frame of the sample. Furthermore, very few firms own cattle and, for firms that do own cattle, they use these cattle to supply relatively few plants.

One of the unique characteristics of the period included in the analysis was the border closing for live imports of cattle and beef from Canada after the discovery of bovine spongiform encephalopathy (BSE) in Canada in May 2003. This closure caused major disruptions in the U.S. market. Then, in January 2004, many countries stopped allowing imports of beef from the United States because of the discovery of BSE in the United States at the end of December 2003. The time period between the closing of the border with Canada and the closing of the border to exports was a period of disrupted flow of cattle and beef. The prices of fed cattle in the United States increased above $1.00 per pound liveweight, which is a historical market precedent.

Based on our examination of the data, the packers that have packer-owned cattle appeared to have foreseen the shortage of fed cattle in fall 2003. They owned larger numbers of fed cattle than they typically do, and many of these fed cattle were slaughtered and processed in fall 2003. The costs of slaughtering and processing that appear in packer P&L statements during fall 2003 are larger than typical costs because of the reduced volumes slaughtered during that time. It is likely that some other factors affected costs associated with packer-owned cattle, but the regression model assigns the higher costs to slaughtering and processing of packer-owned cattle. It could be that packer-owned cattle are not higher cost cattle but that firms with packer-owned cattle experienced higher costs associated with disruption of the market. The firms and plants for which packer-owned cattle increased costs operate in regions that were more affected by the loss of Canadian fed cattle imports and beef products exports.

When considering the results of the ATC models, there are also issues within firms related to accounting practices and the usefulness of examining accounting data to understand economic behavior. For example, the ATCs for all plants within some firms were substantially lower than other firms within the same month. In addition, firms may have had substantially higher ATCs in one plant while simultaneously having substantially lower ATCs in other plant. It appears that firms are making decisions about the assignment of costs and revenues to plants within the firm. We included binary variables in the models to account for these differences across plants. However, there is some question as to whether subtle changes in costs can be observed with substantial confidence when the accounting data also contain “random” assignments of costs (from the econometrician’s standpoint). Thus, there will be some sample-specific results and plant-specific results that cannot be explained.

Another general observation is that costs were higher and profits lower for some firms and some plants within firms during the market disruptions of 2003. These changes cannot be attributed solely to reduced volumes and the market condition variables included in the models. In other words, the unique market disruptions during the time period of the data appear to have caused higher costs within some firms.

Average Gross Margin and Profit Model Results

Table 3-3 also reports results of the AGM (Eq. [3.5]) and PPH (Eq. [3.6]) models. As with the ATC models, the AGM and PPH models showed relative changes in those variables in response to larger volumes of cattle purchased. In general, slaughtering and processing costs in the beef packing industry decrease, margins increase, and profits increase when fed cattle supplies are relatively large. Gross margins increase because, although beef product prices were lower for larger fed cattle supplies, reductions in cattle costs are proportionally greater. In addition, profits per head are greater for larger fed cattle supplies because margins increase and slaughtering and processing costs per head decrease. However, the magnitude of the change in costs is not as great as the change in gross margins, although this conclusion should be made cautiously. The volume variables in the AGM models are frequently insignificant, but the coefficients themselves are larger than the estimated coefficients in the ATC models. In any case, the conclusion is that increased profitability experienced by beef packing firms when fed cattle supplies are large is clearly associated with cost economies. Still, the farm-to-wholesale price spread variable (represented by x_j in the equations) accounts for 50% to 60% of the reported R^2 in the AGM and PPH models. Thus, market conditions are the primary determinants of gross margins and profitability. Cattle slaughter volumes are the next most important variables, followed by the AMA variables.

The effects of the percentage of fed cattle procured through AMAs on gross margins and profits are much more mixed than the ATC results, but the direction of the effects are primarily as hypothesized. Increased percentages of cattle procured through AMAs are associated with higher gross margins and higher profits. In contrast, there are many plants at which cattle procurement through AMAs has no effect on gross margins and profits and some particular cases in which cattle procurement through AMAs are associated with lower gross margins and profits. However, as with ATC model results, some firms clearly use AMAs to enhance the value of meat sold relative the fed cattle cost. Yet, some firms are clearly not able to use AMAs to procure fed cattle with greater meat product value or to increase profits.

Plant-level effects of AMAs are not presented in Table 3-3, but the results indicate clear differences across firms. These results may be specific to the period of the analysis, but they are observable in these fairly simple models of gross margins and profits per head.

The weighted average results indicate that increases in the percentage of cattle procured through marketing agreements have a positive effect on AGM and PPH. Specifically, a 1% increase in the percentage of cattle procured through marketing agreements is associated with a $0.31 per head increase in AGM and a $0.49 per head increase in PPH, holding the total volume slaughtered and processed constant. Although the weighted average results presented in Table 3-3 appear to be insignificant, for some plants, the percentage of cattle procured through marketing agreements is associated with higher AGM and PPH and the estimated coefficients are statistically significant. However, for other plants, the coefficient estimate for the percentage of cattle procured through AMAs is insignificant in both models.

Approximately 35% of the coefficients on the AMA variables in the AGM models were positive and 65% were negative. Positive signs were expected prior to estimation. Of the positive coefficients, 40% were statistically significant, and of the negative coefficients, 14% were statistically significant. Approximately 62% of the coefficients on the AMA variables in the PPH were positive and 37% were negative. Positive signs were expected prior to estimation. Of the positive coefficients, 44% were statistically significant, and of the negative coefficients, 11% were statistically significant.

In contrast to the effects of marketing agreements, the percentage of fed cattle procured through forward contracts appears to have a negative effect on AGM and PPH. For a representative plant, a 1% increase in the percentage of fed cattle procured through forward contracts is associated with a $0.91 per head decrease in AGM and a $0.74 per head decrease in PPH, holding the total volume slaughtered and processed constant. While many of the estimated coefficients for individual plants are insignificant, the results for several other plants indicate that increases in the percentage of cattle procured through forward contracts reduces margins and profits. In any case, the total volume of fed cattle procured through forward contracts is small and therefore the total effect of forward contracted cattle is small, even though the marginal impacts are large. At first it appears that packers are poor market timers with respect to forward contracting decisions. However, based on a close examination of the data for the plants in which the percentage of fed cattle procured through forward contracts has the greatest effect on margins and profits, the number of forward contracts for these plants increased during the time when total fed cattle supplies were the tightest.

Finally, the effect of the percentage of fed cattle procured through packer ownership on AGM and PPH is mixed. Specifically, the effect on AGM is positive and the effect on PPH is negative. However, the results are primarily statistically insignificant. Thus, the results for packer ownership are generally consistent with the ATC model, and limitations to the analysis discussed above apply.

3.4.4 Simulation Scenario Results

Results from the ATC and AGM models are used to calculate the estimated changes in costs associated with hypothetical restrictions on AMAs for the simulation model presented in Section 6. The scenarios included in the analysis are (1) a 25% reduction in volumes of cattle procured through AMAs and (2) a 100% reduction in volumes (or elimination) of cattle procured through AMAs. We simulated the effects of these scenarios in the ATC, AGM, and PPH models, which hold constant other variables included in the model, and incorporated the volume and variance calculations. The policy interventions suggested within each scenario are incorporated into the cost, gross margin, and profit models. We then multiplied the estimated effects by the percentage of industry cattle slaughter volumes represented by the firms in the analysis. This adjustment assumes that the effects of the simulation scenarios do not generalize to the other smaller firms in the industry.

The estimated cost, revenue, and profit changes for each scenario are presented in Table 3-4. Three types of cost changes are presented. The first cost change is the direct cost change measured by the estimated coefficients on *P_FC*, *P_MA*, and *P_PO*. For example, in scenario 2 in which all AMAs are eliminated, the variables are replaced with zero, the absolute change in ATC for each plant is calculated, and then the absolute change in ATC is converted to a percentage basis.

Table 3-4. Estimated Effects of Restricting Fed Cattle AMA Volumes on Monthly Average Total Costs per Head, Average Gross Margins per Head, and Average Profit per Head

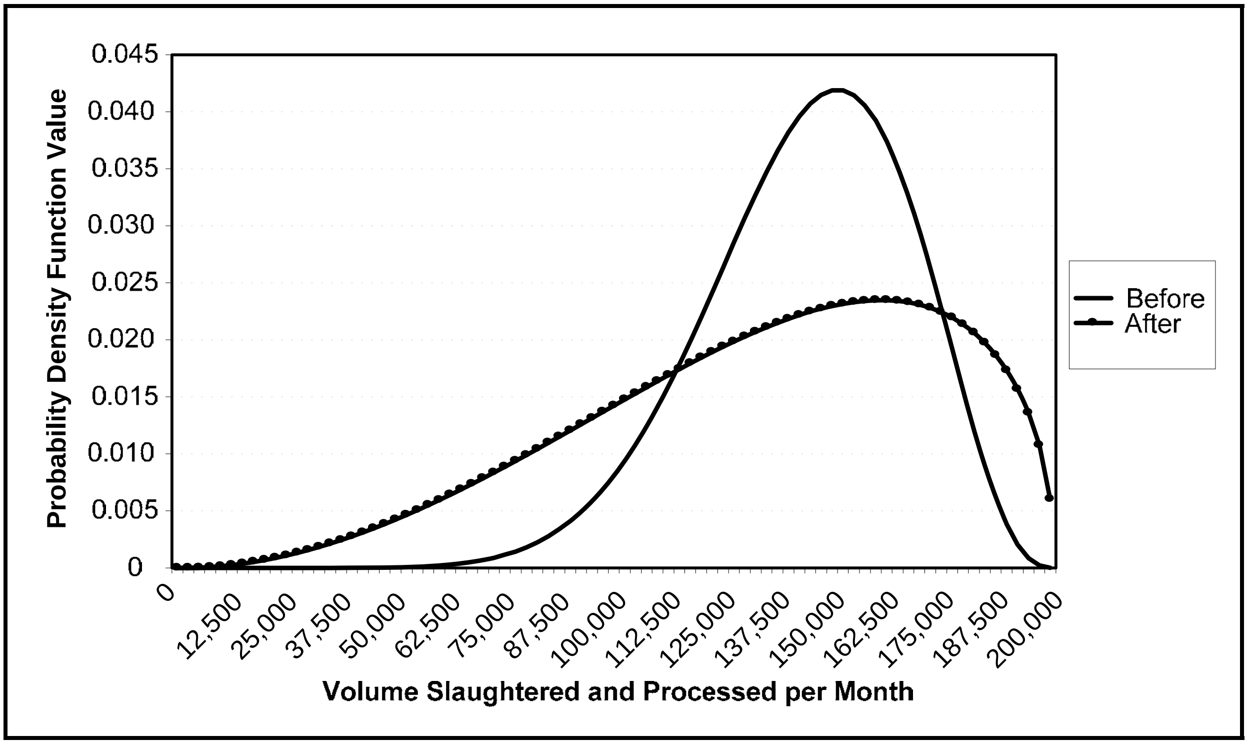
Effect	25% Reduction in AMA Volumes	100% Reduction in AMA Volumes
Percentage change in average total cost		
Direct measurement	+0.0022	+0.0088
Change due to reduced volumes	+0.0049	+0.0257
Change due to increased variability	+0.0015	+0.0123
Total percentage change in average total cost	+0.0086	+0.0468
Percentage change in total volume	–0.0196	–0.0804
Percentage change in variability	+0.1090	+0.7390
Percentage change in revenue (measured through changes in gross margin)	–0.0095	–0.0380
Percentage change in profit	–0.0149	–0.0595

The second cost change is that implied by the volume change. The volume models are used to calculate a change in plant volumes under each scenario. This estimated change in volume is then used in the ATC equation to calculate an absolute change in ATC, and then the absolute change in ATC is converted to a percentage basis. This change in costs due to change in volume does not include the direct change in ATC measurements; the two are embedded but the direct effect is netted out.

The third cost change is due to increased volume variability. First, we make a random draw from the distribution of volumes observed in the data. This distribution has a variance implied by the simulation scenario. Each random draw from the distribution of volumes is used in the ATC equation to calculate a predicted ATC value. Randomness in the ATC equation is added by including a random draw from the distribution of error terms from the ATC model. The number of replications (or random draws) used is 10,000. The change in costs due to changes in variability does not include the direct change in ATC measurements; the two are embedded but the direct effect is netted out. The change in variability also does not include a change in volume. The mean volume is preserved and only the variance is changed.

The distribution of cattle volumes slaughtered and processed for each plant is assumed to be a generalized beta distribution unique to that plant. The distribution of ATC model errors is a normal distribution based on statistical tests, but the plant volumes are not. If a normal distribution was used to simulate changes in plant volumes, the random draws at the top end of the distribution would be much larger than any volumes observed in the data. However, each plant has an installed capacity above which the plant cannot process. Using a generalized beta distribution addresses this problem. The maximum parameter is chosen to be 5% more than the observed maximum and the minimum parameter is chosen to be zero. The other two parameters in the beta distribution, α and β, are estimated through maximum likelihood. The variance is then increased by the prescribed amount by changing the parameter values. In all cases, the distribution is broader, with more mass in the top end of the distribution (but not equal to or over the maximum of the range) and with more mass in the lower end of the distribution over the center of the volume range. Example beta distributions are shown in Figure 3-2. One distribution uses parameters similar to actual plants (i.e., the “before” line), and the second shows the change in the distribution shape resulting from increasing the variance by 90% (i.e., the “after” line).

Figure 3-2. Example Beta Distribution for Fed Cattle Procurement Volumes Before and After a 90% Increase in Procurement Variance (Mean Value is Held Constant)



In the simulation, the percentage AMA variables are used to calculate the direct effects in each simulation scenario if the coefficient estimates are significant at the 10% level.[3] The estimated effects of a 25% reduction in AMA use (scenario 1) are as follows:

- a total increase in ATC of 0.86% resulting from
  - a 0.22% direct increase in ATC,
  - a 0.49% increase in ATC due to reduced volumes, and
  - a 0.15% increase in ATC due to increased variability in slaughter and processing volumes
- a decrease in cattle procurement volume of 1.96%
- an increase in cattle procurement variability of 10.90%
- a decrease in gross margin of 0.95%
- a 1.49% decrease in PPH

[3] In some cases, coefficients that were significant at the 11% or 12% level were used if the magnitudes were reasonable.

The estimated effects of a 100% reduction in AMA use (scenario 2) are as follows:

- a total increase in ATC of 4.68% resulting from
  - a 0.88% direct increase in ATC,
  - a 2.57% increase in ATC due to reduced volumes, and
  - a 1.23% increase in ATC due to increased variability in slaughter and processing volumes
- a decrease in cattle procurement volume of 8.04%
- an increase in cattle procurement variability of 73.90%
- a 3.8% decrease in gross margin
- a 5.95% decrease in PPH

3.4.5 Efficiency and Multiplant Coordination Results

In addition to the simulation scenario results, the P&L data analysis allows us to draw conclusions regarding efficiency within the beef packing industry. Although the results of the analysis are specific to individual firms, we can discuss the general results. We estimated the ATC equation, Eq. (3.1), separately for plant costs only, labor costs only, and procurement and sales costs only for the packing firms that provided detailed data. For plants with a statistically significant percentage of AMA variables in the ATC model, the same variables were significant in exploratory models that were estimating using fixed costs instead of total costs for a subset of the plants. The percentages of AMA variables were also more likely to be significant in the exploratory fixed cost models where the same variables were not significant in the total cost models. The percentage of AMA variables were almost never significant in the models of costs using measures of variable costs, such as labor expenses, or in the models of costs using measures of fixed costs that are not related to production, such as corporate management costs or sales costs. An estimated 85% to 100% of the reduction in ATC that is associated with the percentages of AMA use is due to reductions in plant-related fixed costs. For some individual plants, labor costs also are lower because of procurement of cattle through AMAs, but these results do not apply to all plants. Plants with lower labor costs tend to be plants with very large and relatively stable volumes of cattle procured through AMAs. Plants with variations in AMA procurement volumes do not exhibit the same lower levels of labor costs and may in fact have higher labor costs associated with procurement of cattle through AMAs.

Other interesting efficiency-related conclusions can be drawn with the P&L data. Monthly plant slaughter and fabrication volumes are highly positively correlated across plants within firms. Furthermore, the volumes are positively correlated in levels and first differences. That is, when a firm increases volumes slaughtered and processed, it does so at all plants. Likewise, when it decreases volumes, it does so at all plants. Thus, firms do not appear to be making multiplant production decisions. Even if a firm has two plants that are reasonably close geographically, volumes appear to increase and decrease at both plants simultaneously. We do not observe instances in the data in which one plant is operating at full capacity while another plant is operating at less than capacity.

However, for two reasons, it is difficult to draw strong conclusions about multiplant coordination by observing differences in volumes across plants. First, transportation costs are ignored and are not in the P&L data. It may be cost prohibitive to transship to neighboring plants even if they are nearby. Furthermore, the decision to transship is not solely the plant's decision but is also the cattle feeder's decision. Shipment affects cattle quality and an alternative plant may not be acceptable to the cattle feeder. Second, the ATC equation does not have much curvature and is rather steep. Thus, a small reduction in volume at all plants may have roughly the same cost impact as a large reduction at one plant.

In contrast to the firms in which volumes in individual plants appear to move in the same direction simultaneously, a few firms appear to conduct some degree of multiplant coordination. In particular, these firms appear to reduce volume most frequently at one or two plants. However, the multiplant coordination is not readily apparent. Also, during part of the time period, it is clear that many plants were operating at relatively low capacity and experiencing losses as a result. Even small packing plants that are close to large packing plants continued to operate, but both sizes of plants were operating at substantially reduced volumes. It is interesting to note that some plants operated with persistent losses throughout the entire sample. In addition, some firms operated all plants at less than 60% of capacity for several months. Based on these observations, it appears that multiplant coordination is lacking and that individual plants appear to be operated as separate profit centers.

3.5 SUMMARY

In conclusion, this analysis of P&L data from beef packers is the first of its kind. The data provided an opportunity to examine packer plant–level P&L data for evidence of economies of size and cost economies related to procurement of cattle through different types of AMAs.

The research results clearly document economies of size in beef packing. Average total cost functions are downward sloping over the entire range of volumes slaughtered and processed. In addition, there appears to be substantial cost savings to firms and to the market when plants operate at capacity and substantial diseconomies and losses when plants do not. The excess capacity currently present in the industry is an economic problem because, from a cost and efficiency standpoint, the excess investment in plant capacity is an economic loss.

Based on the results presented in this section, procurement of cattle through AMAs results in cost savings to the firms that use them. However, the results differ across firms. Some firms benefit substantially from AMAs and other firms do not appear to capture any benefits. We draw these conclusions from beef packing firms' own accounting data. The direct cost savings from AMAs is approximately 0.9% of ATCs, or approximately $1.22 per head. Packers also experience additional cost savings from reduced variability in cattle supplies ($1.70 per head) and increased slaughter volumes ($3.56 per head) at packing plants. The total cost savings associated with AMAs is approximately $6.50 per animal. For an industry with an average loss of $2.40 per head during the 30-month sample, this is a substantial benefit.

Thus, the results indicate clear evidence that procurement of cattle through AMAs results in reduced costs and increased profitability for the firms that use them, although it is important to keep in mind that the results differ across firms. While some firms appear to be reducing costs through some means by procuring cattle through AMAs, others do not.

It is also important to keep in mind that within the beef industry, AMAs are largely marketing agreements. Forward contracts and packer ownership are used, but to a lesser extent. Thus, restrictions on the use of marketing agreements would have the greatest negative effects on the beef industry. Restrictions on the use of packer ownership and forward contracts for cattle would have lesser effects.

4 Quality Differences Associated with Alternative Marketing Arrangements

In this section, we present an analysis of differences in animal and meat quality associated with use of marketing arrangements. In particular, we focus on the effects of AMAs between fed cattle producers and beef packers. Some analysts believe that the use of AMAs facilitates quantity and quality requirements of meat processors (Schroeder et al., 1991; Ward and Bliss, 1989). The desire for higher quality fed cattle is a result of increasing consumer demand for higher quality retail beef.

The results in this section are based on information obtained through industry interviews conducted for the study, analysis of transactions data obtained from 29 beef packing plants, and analysis of MPR data.

4.1 DESCRIPTIVE RESULTS RELATED TO QUALITY DIFFERENCES ACROSS MARKETING ARRANGEMENTS

The use of AMAs affects the quality of cattle that packers are able to procure, thus affecting the quality of beef products sold. As noted in Section 1, quality in the beef industry is measured primarily by quality grade, which refers to carcass maturity and amount of intramuscular fat, and by yield grade, which measures the amount of saleable meat in the carcass. Quality grades include Prime, Choice, Select, Standard, and no-roll or ungraded, and yield grades range from Yield Grade 1 through 5. Unlike the hog industry, the use of these quality measures is relatively consistent across the beef industry.

Qualitative information from the industry interviews and industry surveys indicate that the effect of AMAs on quality of cattle and beef products is an important factor in their use.

In the earlier phase of the study, we interviewed producers and packers about the effects of AMAs on beef cattle and beef products (see Muth et al., 2005, Sections 1 through 3 for a discussion of the interview process). Beef producers said that cattle quality would suffer in an all-cash market environment because it is more difficult to control quality when using the cash market rather than using long-term or forward contract arrangements. Although many believe it is possible to purchase quality cattle in the cash market, they also believe that the quality of cattle procured in the cash market is more variable.. In addition, the ability to obtain quality cattle on the cash market depends on experience of buyers and existing relationships between buyers and sellers.

When selling to packers, cattle producers believe that, as a result of delivering higher quality cattle, they obtain a premium of 1% to 1.5%, $1/cwt (liveweight basis), or $15 to 17 per animal for cattle sold under an AMA compared with the cash market. Some producers stated that they need formula sales under a marketing agreement to obtain premiums for producing cattle for customized buying programs.

Packers said the ability to obtain quality cattle under AMAs was a much stronger incentive than issues related to procurement costs. Because beef product buyers are demanding higher quality products, packers use AMAs to ensure that cattle purchased meet the quality standards needed to meet buyer requirements for beef products.

In the industry survey described in Volume 2 of this report, we asked beef producers and beef packers the three most important reasons for using either cash markets or AMAs. For cattle producers, 16.3% of respondents who use only the cash or spot market report doing so because it allows for the sale of higher quality calves and cattle. In contrast, 51.6% of respondents who use an AMA report doing so because it allows for the sale of higher quality calves and cattle. For respondents that use only the cash market, seven other reasons for using these types of arrangements ranked higher than quality. In contrast, for respondents that use AMAs, quality was ranked highest. (See Volume 2, Table 6-1, Questions 7.1 and 7.2.)

For beef packer purchases of live cattle, 44.3% of respondents that use only the cash market report doing so because it allows for the procurement of higher quality fed cattle. In contrast, 53.8% of respondents that use an AMA report doing so because it secures higher quality fed cattle. Interestingly, this reason was ranked second among the list of possible reasons for both groups of respondents. However, packer survey respondents also indicated that AMAs allow for product branding in retail sales (46.2%) and improve efficiency of operations due to animal uniformity (42.3%). Packers also indicated a variety of other reasons for using AMAs. (See Volume 2, Table 7-1, Questions 4.1 and 4.2.)

Finally, for packer sales of beef products, the ability to sell higher quality products was not a primary motivator in selecting the type of marketing arrangements used with buyers. However, 72% of packers using AMAs for the sale of beef products responded that AMAs increase their flexibility in responding to consumer demand. These responses indicate that providing the highest level of quality might not be as important as logistical issues related to quantity and delivery timing. (See Volume 2, Table 7-1, Questions 7.1 and 7.2.)

Quality of purchased cattle is based on

- quality grade,
- yield grade,
- certification or branding, and
- weight range.

Table 4-1 presents measures of quality (i.e., quality grade, yield grade, branded/certified, and weight range) by type of marketing arrangement for fed steers and heifers purchased by packers from October 2002 through March 2005. The table shows numbers and percentages of head for each procurement method–quality measure combination. In total, 60.8% of cattle graded Choice or better. The highest percentage of cattle grading Choice or better (78.7%) were purchased through dealers and brokers, but only a small percentage of all cattle were traded using this method. Many sales through dealers and brokers represent specialty sales of small lots of cattle that primarily service high-quality niche markets. The second and third highest percentages of cattle grading Choice or better were purchased through auction barns and marketing agreements, each with slightly less then 65%. Cattle purchased through direct trade (60.0%) and forward contracts (61.5%) graded similar to the total. The lowest percentage of cattle grading Choice or better were packer-fed/owned cattle. Packer-

Table 4-1. Beef Quality Measures Based on Transactions Data, by Fed Cattle Procurement Method, October 2002–March 2005

Quality Measure	Auction Barns	Dealers or Brokers	Direct Trade	Forward Contract	Marketing Agreement	Packer Fed/Owned	Other or Missing	Total
Quality grade								
Prime								
No. of head	116,380	42,999	760,822	70,135	298,965	24,933	19,909	1,334,142
% of head	6.0%	9.0%	2.3%	2.7%	1.8%	1.1%	3.5%	2.3%
Choice								
No. of head	1,049,428	332,444	10,646,490	840,909	5,799,483	243,505	261,751	19,174,010
% of head	53.8%	69.7%	31.9%	32.0%	34.6%	10.6%	46.1%	33.0%
Upper choice								
No. of head	D	0	3,501,318	273,577	2,276,544	D	D	6,244,745
% of head		0.0%	10.5%	10.4%	13.6%			10.8%
Lower choice								
No. of head	D	0	5,119,625	430,930	2,201,590	D	D	8,539,462
% of head		0.0%	15.3%	16.4%	13.1%			14.7%
Select								
No. of head	502,154	78,620	10,267,438	875,146	5,409,723	1,001,764	208,244	18,343,088
% of head	25.8%	16.5%	30.7%	33.3%	32.3%	43.5%	36.7%	31.6%
Standard								
No. of head	29,423	1,211	307,830	27,516	230,672	11,213	8,469	616,334
% of head	1.5%	0.3%	0.9%	1.0%	1.4%	0.5%	1.5%	1.1%
Other quality grade or missing								
No. of head	D	D	2,792,493	108,005	531,340	171,712	D	3,814,660
% of head			8.4%	4.1%	3.2%	7.5%		6.6%
Total								
No. of head	2,426,488		33,396,016	2,626,217	16,748,315	2,869,405		58,066,440
% of head	100.00%		100.00%	100.00%	100.00%	100.00%		100.00%
Yield grade								
YG 1								
No. of head	123,955	24,946	3,172,095	225,651	1,890,053	200,385	24,447	5,661,531
% of head	6.4%	5.2%	9.5%	8.6%	11.3%	8.7%	4.3%	9.8%
YG 2								
No. of head	1,154,935	183,448	13,103,948	1,146,197	7,122,314	880,077	264,973	23,855,891
% of head	59.2%	38.4%	39.2%	43.6%	42.5%	38.2%	46.6%	41.1%

(continued)

Table 4-1. Beef Quality Measures Based on Transactions Data, by Fed Cattle Procurement Method, October 2002–March 2005 (continued)

Quality Measure	Auction Barns	Dealers or Brokers	Direct Trade	Forward Contract	Marketing Agreement	Packer Fed/Owned	Other or Missing	Total
YG 3								
No. of head	553,713	222,292	12,983,464	1,018,918	6,589,808	897,026	233,311	22,498,531
% of head	28.4%	46.6%	38.9%	38.8%	39.3%	39.0%	41.1%	38.7%
YG 4								
No. of head	42,099	40,700	2,085,836	152,877	895,955	141,250	23,424	3,382,140
% of head	2.2%	8.5%	6.2%	5.8%	5.4%	6.1%	4.1%	5.8%
YG 5								
No. of head	D	D	232,655	15,434	85,878	12,785	D	363,279
% of head			0.7%	0.6%	0.5%	0.6%		0.6%
Other yield grade or missing								
No. of head	D	D	1,818,019	67,142	164,309	D	17,807	2,305,067
% of head			5.4%	2.6%	1.0%		3.1%	4.0%
Total								
No. of head	2,426,488		33,396,016	2,626,217	16,748,315	2,869,405		58,066,440
% of head	100.00%		100.00%	100.00%	100.00%	100.00%		100.00%
Branded/certified								
No. of head	63,093	D	6,533,165	580,427	3,224,494	818,968	D	11,373,171
% of head	3.2%		19.6%	22.1%	19.3%	35.6%	D	19.6%
Weight range								
Heavy weight								
No. of head	34,325	D	9,147,158	457,396	4,282,405	122,718	D	14,380,608
% of head	1.8%		27.4%	17.4%	25.6%	5.3%		24.8%
Light weight								
No. of head	428,912	D	324,579	24,069	243,002	20,110	D	1,047,343
% of head	22.0%		1.0%	0.9%	1.5%	0.9%		1.8%
Unknown								
No. of head	D	D	23,924,279	2,144,752	12,222,908	D	D	42,638,489
% of head			71.6%	81.7%	73.0%			73.4%
Total								
No. of head	2,426,488		33,396,016	2,626,217	16,748,315	2,869,405		58,066,440
% of head	100.00%		100.0%	100.0%	100.0%	100.00%		100.0%

D = Results suppressed.

fed/owned cattle may be of lower quality because packers use these cattle for capacity utilization. In addition, relatively few packers own cattle, so the difference in quality may be due to differences in plant-specific priorities.

In total, 89.6% of cattle were Yield Grade 1 through 3. The percentages across different marketing methods are relatively similar, but cattle purchased through auction barns had a higher percentage of Yield Grade 1 through 3 (94.0%), as did cattle purchased through marketing agreements (93.1%). Similar to the quality grades noted above, packer-fed/owned cattle had a lower percentage of Yield Grade 1 through 3 (85.9%).

Packer-owned cattle were most likely to qualify for a branded or certification program (35.6%), while cattle purchased at auctions or through other marketing arrangements were least likely to qualify for a branding or certification program. Between 19% and 22% of the cattle purchased through marketing agreements, direct trade, dealers/brokers, and forward contracts were eligible for branding or certification programs.

A final quality measure relates to whether cattle are identified as heavy weight or light weight relative to the desired weight range for the packing plant. Based on the results of the industry survey, heavy weight cattle are typically those with carcass weights greater than 850 pounds,[1] and light weight cattle are typically those with carcass weights less than 575 pounds.[2] Cattle purchased through auction barns were more often classified as light weight (22.0% of cattle purchased). For the other methods, the percentage of light weight cattle was 1.5% or less. Most of the cattle purchased through dealers and brokers were classified as heavy weight. Approximately one-quarter of the cattle purchased through direct trade and marketing agreements were classified as heavy weight (27.4% and 25.6%, respectively). Overall, cattle purchased or procured through other marketing arrangements, packer fed/owned, and forward contracts were most likely to be within the desired weight range for the packer.

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[1] The 95% confidence interval for the upper weight limit before cattle are classified as heavy weight is 787 to 921 pounds.

[2] The 95% confidence interval for the lower weight limit before cattle are classified as light weight is 521 to 633 pounds.

Table 4-2 presents measures of quality (i.e., quality grade, yield grade, branded, and other certification) by type of marketing arrangement for beef sold by packers from October 2002 through March 2005. The table shows numbers and percentages of pounds for each sales method–quality measure combination. Collectively, of all the beef products sold by packers, 38% (by weight) did not report the sales method used. However, for the beef sales records that designated sales method, product characteristics were similar. Less than 1% of the meat sold through each sales method graded Prime, and approximately 27% to 33% graded Choice. More than one-quarter of the beef sold through cash markets, forward contracts, and marketing agreements graded Select. In contrast, nearly one-half of internal transfers were Select beef products. The quantity of branded beef products ranged from 9% to 15%. Very few products carried any other type of certification.

Table 4-2. Beef Quality Measures Based on Transactions Data, by Beef Sales Method, October 2002–March 2005

Quality Measure	Cash or Spot Market	Forward Contract	Marketing Agreement	Internal Company Transfer	Other or Missing	Total
Quality grade						
Prime						
No. of pounds	54,342,710	19,489,508	8,424,508	3,239,405	54,422,767	139,918,898
% of pounds	0.5%	0.3%	0.3%	0.5%	0.4%	0.4%
Choice						
No. of pounds	2,928,073,693	1,567,083,175	705,577,143	175,556,952	2,644,805,509	8,021,096,472
% of pounds	28.9%	27.2%	22.7%	29.7%	21.7%	25.2%
Upper choice						
No. of pounds	302,182,528	D	D	D	374,940,927	849,062,443
% of pounds	3.0%				3.1%	2.7%
Lower choice						
No. of pounds	107,836,029	D	D	D	64,533,963	244,751,280
% of pounds	1.1%				0.5%	0.8%
Select						
No. of pounds	2,797,534,554	1,481,855,843	815,789,389	268,392,481	1,601,815,508	6,965,387,776
% of pounds	27.6%	25.7%	26.3%	45.4%	13.2%	21.9%
Other quality grade or missing						
No. of pounds	3,953,710,640	2,571,082,281	1,456,002,581	141,800,260	7,439,409,720	15,562,005,482
% of pounds	39.0%	44.6%	46.9%	24.0%	61.1%	49.0%
Total						
No. of pounds	10,143,680,153	5,762,756,758	3,104,424,008	591,433,037	12,179,928,395	31,782,222,350
% of pounds	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Branded						
No. of pounds	972,711,781	840,417,309	262,739,086	60,057,143	525,631,668	2,661,556,987
% of pounds	9.6%	14.6%	8.5%	10.2%	4.3%	8.4%

D = Results suppressed.

4.2 RESULTS OF ANALYSIS OF QUALITY DIFFERENCES ASSOCIATED WITH ALTERNATIVE MARKETING ARRANGEMENTS USING TRANSACTIONS DATA

In this section, we analyze the relationship between AMAs and quality of cattle using quality grade and yield grade as measures of quality using transactions data. We conducted the analysis for individual measures of quality first and then using a constructed quality index. We estimated models using the quality index to analyze differences across AMAs and across methods of fed cattle valuation.

4.2.1 Analysis of Quality Using Individual Quality Measures

In this section, we analyze the relationship between individual measures of quality for fed cattle and the use of marketing arrangements, while controlling for seasonality and the fixed effects of slaughter plants. Specifically, we calculated the percentage of cattle in each lot by yield grade and quality grade and regressed this variable on the procurement method and a set of control variables. The dependent variable (i.e., the percentage of cattle in the lot in each quality and yield grade category) ranges between 0 and 1. A large percentage of observations have values of 0 or 1 because a lot might not have any cattle or all of its cattle might be of a specific quality or yield grade. For example, no cattle were classified as Yield Grade 4 or 5 in approximately 29% of the lots. Because of this feature of the data, we used a Tobit model to estimate the following four equations individually:

$$yg12\_pct_{ti} = \max[0, \min(\beta_0 + \beta_1 D\_AMA_{ti} + \beta_2 D\_beefcattle_{ti} + \beta_3 D\_PLANT_{ti} + \beta_4 D\_SEASON_t + u_{ti}, 1)] \quad (4.1)$$

$$yg45\_pct_{ti} = \max[0, \min(\beta_0 + \beta_1 D\_AMA_{ti} + \beta_2 D\_beefcattle_{ti} + \beta_3 D\_PLANT_{ti} + \beta_4 D\_SEASON_t + u_{ti}, 1)] \quad (4.2)$$

$$primechoice\_pct_{ti} = \max[0, \min(\beta_0 + \beta_1 D\_AMA_{ti} + \beta_2 D\_beefcattle_{ti} + \beta_3 D\_PLANT_{ti} + \beta_4 D\_SEASON_t + u_{ti}, 1)] \quad (4.3)$$

$$belowselect\_pct_{ti} = \max[0, \min(\beta_0 + \beta_1 D\_AMA_{ti} + \beta_2 D\_beefcattle_{ti} + \beta_3 D\_PLANT_{ti} + \beta_4 D\_SEASON_t + u_{ti}, 1)] \quad (4.4)$$

where *yg12_pct* and *yg45_pct* are the percentages of cattle in the lot that were classified as Yield Grade 1 or 2 (better yield grade), and Yield Grade 4 or 5 (worse yield grade), respectively, and *primechoice_pct* and *belowselect_pct* are the percentages of the cattle that were classified as Prime or Choice (better quality grade), and below the grade Select (worse quality grade), respectively.[3] The notations of *D_AMA*, *d_beefcattle*, and *D_PLANT* were described in Section 2.2.2. *D_SEASON* is a vector of binary variables that indicate the month of the year when the cattle were delivered. The random error term, u_{ti}, is assumed normally distributed, conditional on the explanatory variables. The descriptive statistics of the variables are summarized in Table 4-3.

Table 4-3. Descriptive Statistics for the Variables in the Fed Cattle Quality Difference Model, Using Fed Cattle Purchase Transactions Data, October 2002–March 2005

Variable	Notation	Mean	Std. Dev.	Min	Max
yg12_pct	% Yield Grade 1 or 2 in the lot	0.530	0.220	0.00	1.00
yg45_pct	% Yield Grade 4 or 5 in the lot	0.062	0.081	0.00	1.00
primechoice_pct	% Prime or Choice quality grade in the lot	0.640	0.240	0.00	1.00
belowselect_pct	% Standard or below quality grade in the lot	0.065	0.110	0.00	1.00
d_direct	Direct trade purchase (1 = yes, 0 = no)	0.580	0.490	0.00	1.00
d_auction	Auction purchase (1 = yes, 0 = no)	D	D	0.00	1.00
d_forward	Forward contract purchase (1 = yes, 0 = no)	0.040	0.200	0.00	1.00
d_packer	Packer owned procurement (1 = yes, 0 = no)	D	D	0.00	1.00
d_marketing	Marketing agreement purchase (1 = yes, 0 = no)	0.280	0.450	0.00	1.00
d_beefcattle	Mostly beef breed cattle in the lot (1 = yes, 0 = no)	0.780	0.420	0.00	1.00

D = Results suppressed.

Table 4-4 reports the parameter estimates (βs) for the four equations using 572,000 cattle purchase lots representing approximately 58 million head of cattle for the October 2002 through March 2005 period. The base group of the regressions is direct trade (i.e., the direct trade binary variable was omitted from the regressions). Table 4-5 reports the expected difference of the percentage of cattle in a lot by yield grade or quality grade between each type of marketing arrangement. Note that the values in Table 4-4 are not necessarily equal to the corresponding difference of the coefficients on the binary variables for each marketing arrangement because of the use of

[3] Separate regressions were not run for middle quality cattle (Yield Grade 3 and Select quality grade).

Table 4-4. Tobit Parameter Estimates in the Fed Cattle Quality Difference Models, Using Fed Cattle Purchase Transactions Data, October 2002–March 2005

	Coefficient[a] (Std. Error)			
Variable	**yg12_pct**	**yg45_pct**	**primechoice_pct**	**belowselect_pct**
d_auction	–0.1163 (0.0053)	0.0599 (0.0026)	0.2508 (0.0053)	–0.0223 (0.0038)
d_forward	0.0111 (0.0014)	–0.0054 (0.0007)	–0.0097 (0.0014)	–0.0090 (0.0010)
d_packer	–0.0572 (0.0016)	0.0182 (0.0008)	0.0240 (0.0016)	–0.0166 (0.0012)
d_marketing	–0.0122 (0.0007)	–0.0049 (0.0003)	0.0219 (0.0006)	–0.0258 (0.0005)
d_beefcattle	–0.0320 (0.0010)	0.0344 (0.0006)	–0.0117 (0.0011)	–0.0144 (0.0008)
Other variables[b]	Not reported			
No. of observations (lots)	571,608	571,608	571,608	571,608
LR Chi-square	192811	125389	97039	101424
Prob > Chi-square	0.0000	0.0000	0.0000	0.0000

[a] All coefficients are significant at the 5% level.

[b] The "other variables" include an intercept, monthly (seasonality) binary variables, and plant binary variables.

Table 4-5. Estimated Average Quality Differences among AMAs for Fed Cattle Purchase Transactions, Computed at the Means of the Variables (%), October 2002–March 2005

Marketing Arrangement	% Yield Grade 1 or 2	% Yield Grade 4 or 5	% Prime or Choice	% Quality Grade Lower than Select
Auction	–12.0	4.5	22.0	–1.3
Forward contract	1.1	–0.3	–0.9	–0.6
Packer owned	–5.7	1.2	2.3	–1.0
Marketing agreement	–1.2	–0.3	2.1	–1.5

Note: The differences are computed as the estimated percentage of cattle in each lot by yield grade or quality grade for the AMAs listed minus that for direct trade.

the Tobit model. Compared with direct trade cattle, fed cattle sold through auction barns and packer-owned cattle have better quality grades but worse yield grades, forward contract cattle have better yield grades and a slightly larger percentage are classified as Select, and marketing agreement cattle have better quality grades and a slightly larger percentage classified as Yield Grade 3. On average, auction barn cattle have the highest quality grade (22% more are classified as Prime or

Choice compared to direct trade cattle) but the lowest yield grade (12% less are classified as Yield Grade 1 or 2 compared to direct trade cattle) among all of the five marketing arrangements. Packer-owned cattle and market agreement cattle are slightly higher in quality grade (about 2% more are classified as Prime or Choice) than direct trade cattle. Direct trade cattle and forward contract cattle share similar quality characteristics (both yield grade and quality grade).

An inverse relationship between quality grade and yield grade is expected. There is a positive correlation between intramuscular fat (marbling) and external fat that increases yield grade. Most of the procurement methods show a tradeoff between preferred Yield Grades (1 and 2) and preferred Quality Grades (Prime and Choice) and less preferred Yield Grades (4 and 5). The marketing agreement cattle, perhaps because of tighter specifications, include more Prime and Choice cattle without increases in Yield Grade 4 and 5 and only a modest reduction in Yield Grade 1 and 2.

4.2.2 Construction of a Quality Index

In this section, we construct a quality index that summarizes the quality information of each cattle lot into a composite measure using several quality measures. The quality index is used as a dependent variable to explore the relationship between cattle quality and AMAs and the relationship between cattle quality and valuation method. This index incorporates information on quality grade, type of cattle, and whether the cattle are under a certification program. However, yield grade information is not incorporated because yield grade is not a meaningful quality indicator for beef at the retail level. Specifically, the quality index (*qindex*) for each lot is constructed as follows:

$$\begin{aligned} qindex_{ti} = {} & (prime\_price \times prime\_pct_{ti}) + (choice\_price \times \\ & \times choice\_pct_{ti}) + (select\_price \times select\_pct_{ti}) + \\ & + (standard\_price \times standard\_pct_{ti}) + (qualityother\_price \times \\ & \times qualityother\_pct_{ti}) + (certified\_premium \times certified\_pct_{ti}) - \\ & - (dairycattle\_discount \times dairycattle\_binary)_{ti}, \end{aligned} \tag{4.5}$$

where $prime\_pct_{ti}$, $choice\_pct_{ti}$, $select\_pct_{ti}$, and $standard\_pct_{ti}$ are the percentages of cattle in the lot that were classified as prime, choice, select, and standard, respectively. The variable $qualityother\_pct_{ti}$ refers to the percentage of cattle that were of lower quality than grade Select or were not graded. The variable $dairycattle\_binary_{ti}$ is a binary variable that is set equal to one for fed cattle lots that primarily consist of dairy breeds. The notations and values of *prime_price*, *choice_price*, *select_price*, *standard_price*, *qualityother_price*, *certified_premium*, and *dairycattle_discount* are summarized in Table 4-6. Note that these values are fixed because they are computed using average market prices, adjusted for premiums or discounts. Therefore, this quality index should be free of the effects of short-term demand shifters. We then can interpret that the variable $qindex_{ti}$ is a quality-adjusted average market price for individual lots of cattle.

Table 4-6. Descriptive Statistics for Market Prices, Premiums, and Discounts Used to Construct the Quality Index, October 2002–March 2005

Variable	Description	Value ($/cwt)
choice_price	Average live fed steer price (Nebraska direct) for Choice grade cattle over the data collection period	83.31
prime_price	*choice_price* plus average premium for Prime grade cattle	90.40
select_price	*choice_price* minus average discount for Select grade cattle	73.35
standard_price	*choice_price* minus average discount for Standard grade cattle	64.83
qualityother_price	*choice_price* minus the average discount for bullocks/stags, hardbone, and dark cutter	57.54
certified_premium	Average premium for certified cattle	1.81
dairycattle_discount	Average discount for dairy cattle	1.97

4.2.3 Analysis of Quality Differences across AMAs Using a Quality Index

In this section, we analyze the relationship between the fed cattle quality index and the use of marketing arrangements, while controlling for seasonality and the fixed effects of slaughter plants. The model is specified as

$$qindex_{ti} = \beta_0 + \beta_1 D\_AMA_{ti} + \beta_2 D\_SEASON_t + \\ + \beta_3 D\_PLANT_{ti} + u_{ti} \tag{4.6}$$

and

$$Var(u_{ti}) = \exp(\delta_0 + \delta_1 D\_AMA_{ti} + \delta_2 D\_SEASON_t + \varsigma_{ti}). \tag{4.7}$$

The definitions of D_AMA_{ti}, D_SEASON_t, and D_PLANT_{ti} are the same as in Section 4.2.1. The summary statistics for *D_AMA* were listed in Table 4-3. The coefficient on D_AMA_{ti} in Eq. (4.6) indicates the relationship between each type of marketing arrangement and higher or lower than average cattle quality. The coefficient on D_AMA_{ti} in Eq. (4.7) indicates the relationship between each type of marketing arrangement and cattle quality consistency across lots.

Table 4-7 reports parameter estimates from Eqs. (4.6) and (4.7). Auction barn cattle have the highest average quality and the least consistent quality. Compared with direct trade cattle, the quality of packer-owned cattle and marketing agreement cattle are both higher and more consistent. The quality of forward contract cattle is lower but more consistent than direct trade cattle.

Table 4-7. OLS Parameter Estimates for the Quality Index Model in Terms of AMAs ($/cwt Liveweight), October 2002–March 2005

Variable	Quality Index Coefficient[a] (Robust Std. Error)	Var(u) Coefficient (Std. Error)
d_auction	3.24 (0.064)	29.50 (0.160)
d_forward	–0.19 (0.019)	–2.98 (0.210)
d_packer	0.68 (0.024)	–0.97 (0.230)
d_ma	0.57 (0.010)	–1.53 (0.093)
Other variables[b]	Not reported	
No. of observations (lots)	571,608	571,608
F statistic	F(42,571565) = 9,403	F(15,571592) = 2,412
Prob > F	0.0000	0.0000
R^2	0.2772	0.0595

[a] All coefficients are significant at the 5% level.

[b] The “other variables” include an intercept, monthly (seasonality) binary variables, and plant binary variables.

We summarize differences in fed cattle quality among marketing arrangements in Table 4-8. The difference in quality index between any two marketing arrangements can be interpreted as the difference in average market values. For example, the average quality index for marketing agreement cattle was \$0.57/cwt higher than direct trade cattle. That is, the value of marketing agreement cattle was \$0.57/cwt higher than direct trade cattle because of higher quality.

Table 4-8. Estimated Average Quality Index Differences among AMAs for Fed Cattle Purchase Transactions (\$/cwt Liveweight), October 2002–March 2005

Marketing Arrangement	Direct Trade	Auction	Forward Contract	Packer Owned	Marketing Agreement
Direct trade	—	–3.24	0.19	–0.68	–0.57
Auction	3.24	—	3.43	2.56	2.67
Forward contract	–0.19	–3.43	—	–0.87	–0.76
Packer owned	0.68	–2.56	0.87	0.00	0.11
Marketing agreement	0.57	–2.67	0.76	–0.11	—

Note: The differences are computed based on the estimated coefficients of the quality index model for the AMAs listed.

4.2.4 Analysis of Quality Differences across Valuation Methods Using a Quality Index

In this section, we analyze the relationship between the fed cattle quality index and valuation method, while controlling for seasonality and the fixed effects of slaughter plants. The model is specified as

$$qindex_{ti} = \beta_0 + \beta_1 D\_VALUATION_{ti} + \beta_2 D\_SEASON_t + \beta_3 D\_PLANT_{ti} + u_{ti} \tag{4.8}$$

and

$$Var(u_{ti}) = \exp(\delta_0 + \delta_1 D\_VALUATION_{ti} + \delta_2 D\_SEASON_t + \varsigma_{ti}). \tag{4.9}$$

$D\_VALUATION_{ti}$ is a vector of binary variables that indicates the valuation method used for purchasing each lot of fed cattle, including

- liveweight basis (*d_live*) (as the base group),
- carcass weight basis without grid (*d_carcass_nogrid*),
- carcass weight basis with grid (*d_carcass_grid*), and
- other valuation method (*d_other*).

The definitions of D_SEASON_{ti}, and D_PLANT_{ti} are the same as in Section 4.2.1. The summary statistics for *qindex* and *D_VALUATION* are listed in Table 4-9. The coefficient on $D\_VALUATION_{ti}$ in Eq. (4.8) indicates the relationship between each type of valuation method and higher or lower than average cattle quality. The coefficient on $D\_VALUATION_{ti}$ in Eq. (4.9) indicates the relationship between each type of valuation method and higher or lower cattle quality consistency across lots.

Table 4-9. Descriptive Statistics for the Quality Index Model in Terms of Valuation Methods ($/cwt Liveweight), October 2002–March 2005

Variable	Description	Mean	Std. Dev.	Min	Max
qindex	Quality index	78.90	3.85	55.57	91.52
d_live	Liveweight basis (1 = yes, 0 = no)	0.36	0.48	0.00	1.00
d_carcass_nogrid	Carcass weight basis without grid (1 = yes, 0 = no)	0.13	0.33	0.00	1.00
d_carcass_grid	Carcass weight basis with grid (1 = yes, 0 = no)	0.49	0.50	0.00	1.00
d_other	Other valuation method (1 = yes, 0 = no)	0.02	0.15	0.00	1.00

Table 4-10 reports the parameter estimates from Eqs. (4.8) and (4.9). The quality of cattle valued on a carcass weight basis was higher and more consistent than the quality of cattle valued on a liveweight basis. However, the quality improvement associated with carcass weight valuation appears to be modest. Compared with cattle valued on a liveweight basis, cattle valued on a carcass weight with grid basis were worth $0.46/cwt (liveweight) more because of better quality, and cattle valued on a carcass weight without grid basis were worth $0.15/cwt more (liveweight) because of better quality.

Table 4-10. OLS Parameter Estimates for the Quality Index Model in Terms of Valuation Method ($/cwt Liveweight), October 2002–March 2005

Variable	Quality Index Coefficient[a] (Robust Std. Error)	Var(u) Coefficient (Std. Error)
d_carcass_nogrid	0.15 (0.014)	–5.92 (0.14)
d_carcass_grid	0.46 (0.009)	–2.58 (0.09)
d_other	0.16 (0.026)	–5.64 (0.29)
Other variables[b]	Not reported	
No. of observations (lots)	571,608	571,608
F statistic	F(41,571566) = 9,563	F(14,571593) = 194
Prob > F	0.0000	0.0000
R^2	0.2744	0.0047

[a] All coefficients are significant at the 5% level.

[b] The "other variables" include an intercept, monthly (seasonality) binary variables, and plant binary variables.

4.3 RESULTS OF ANALYSIS OF QUALITY DIFFERENCES ASSOCIATED WITH ALTERNATIVE MARKETING ARRANGEMENTS USING MPR DATA

In addition to the analyses of quality using the individual transactions data, we also examined the effects of AMAs on quality using MPR data. MPR data provided by the Livestock Marketing Information Center (LMIC) include quality and yield grade information for fed slaughter cattle. MPR data also report the number of head slaughtered in each yield grade category.

Figure 4-1 presents cattle production by yield grades for the April 2001 through December 2005 period. According to these data, Yield Grades 2 and 3 dominate (84%) carcass beef production.

Quality grade data provided by LMIC include Prime, Choice, Select, and Other (i.e., Standard). Figure 4-2 presents the number of cattle slaughtered within each USDA quality grade from April 2001 through December 2005. These data indicate that Choice grade accounts for about 57% of graded slaughter cattle, while Select grade accounts for about 39%. Prime grade represents about 3% of graded slaughter cattle.

Figure 4-1. USDA Beef Yield Grade, by Number of Head Slaughtered, Using MPR Data, April 2001–December 2005

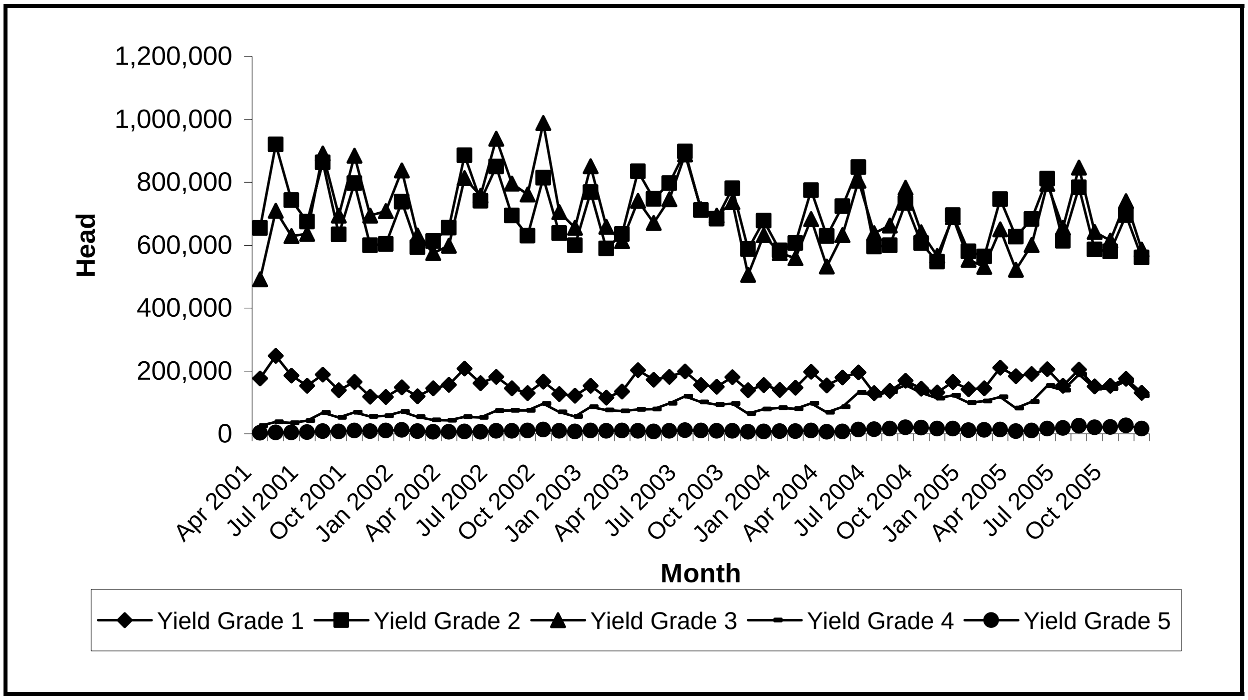
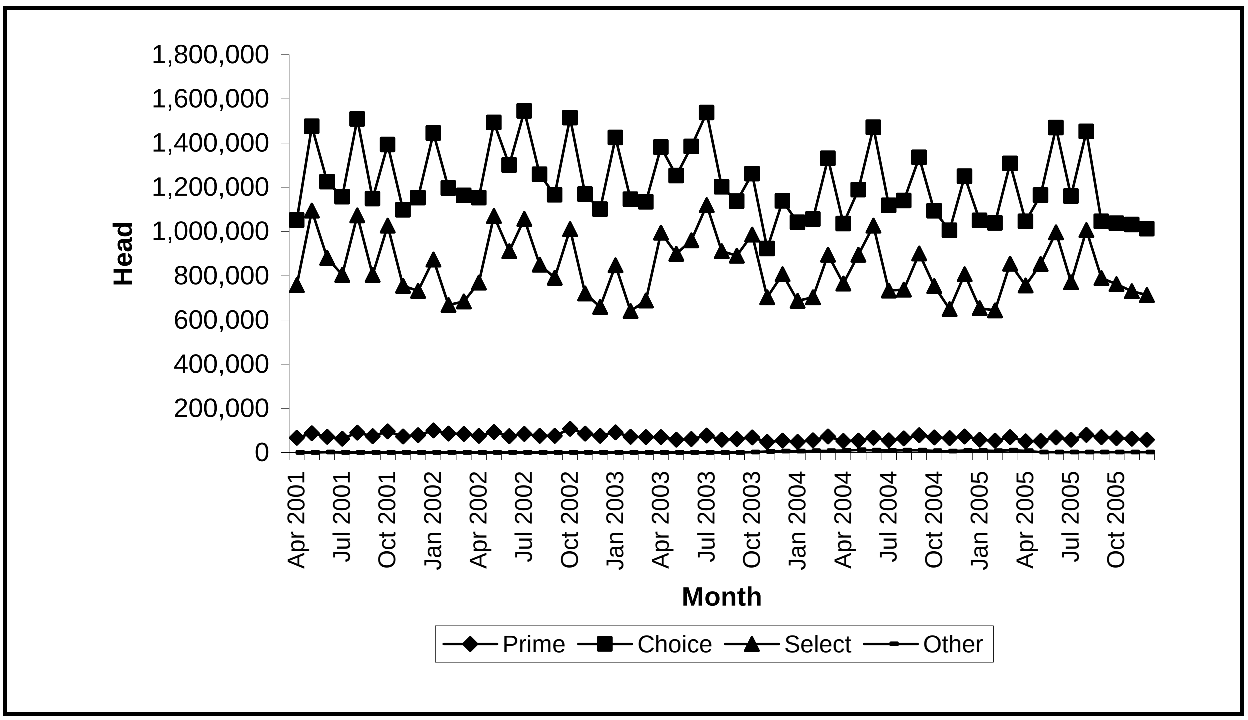


Figure 4-2. USDA Quality Beef Grade, by Number of Head Slaughtered, Using MPR Data, April 2001–December 2005



We use average quality grade as a quality indicator of slaughter cattle and quantify the relationship between this variable, other exogenous factors, and procurement methods.[4] Quality grades are reported as categorical data in MPR data. Our modeling strategy requires that numerical values for quality be developed for use as dependent variables in the regression analyses. In addition, an increase in the value of this dependent variable should reflect increased quality that would be manifest in increased retail demand.

Similar to the procedure used for transactions data described in Section 4.2.2, a numerical quality variable was calculated based on the monthly number of fed cattle slaughtered within each categorical quality grade (Prime, Choice, Select, and Other), using MPR data. A numerical value for each categorical grade was developed based on average reported premiums and discounts for fed slaughter cattle (relative to Choice grade) during the sample period. Specifically, the variable is calculated using the following procedure:

1. The premium for Prime relative to Choice grade fed cattle over the sample period (April 2001 to December 2005) averaged $6.57/cwt. The average discounts for Select and Other grade fed cattle relative to Choice grade cattle over the sample period were –$9.41/cwt and –$17.68/cwt, respectively.
2. The average premium and discounts were then applied to the average Choice grade nominal fed steer price ($79.15/cwt) that occurred over the sample period. Thus, the average value of Choice grade fed steers equals $79.15/cwt. The average value of Prime grade fed steers equals $85.72/cwt ($79.15 + $6.57). Applying this procedure to Select and Other grade fed cattle results in average values of $69.74/cwt and $61.47/cwt, respectively.
3. An index for Prime, Select, and Other quality grades relative to Choice grade is then constructed using the above-average fed steer values. Thus, the Prime/Choice index (1.083) is calculated as $85.72 / $79.15. The Select/Choice index (0.881) is calculated as $69.74 / $79.15. The Standard/Choice index equals 0.777. Note that the index is equal to 1.000 for Choice grade fed cattle, is larger than 1.000 for higher quality

[4] Quality grade was selected over yield grade because the former is associated with meat tenderness and provides an indicator of retail beef quality.

fed cattle, and is smaller than 1.000 for lower quality fed cattle.

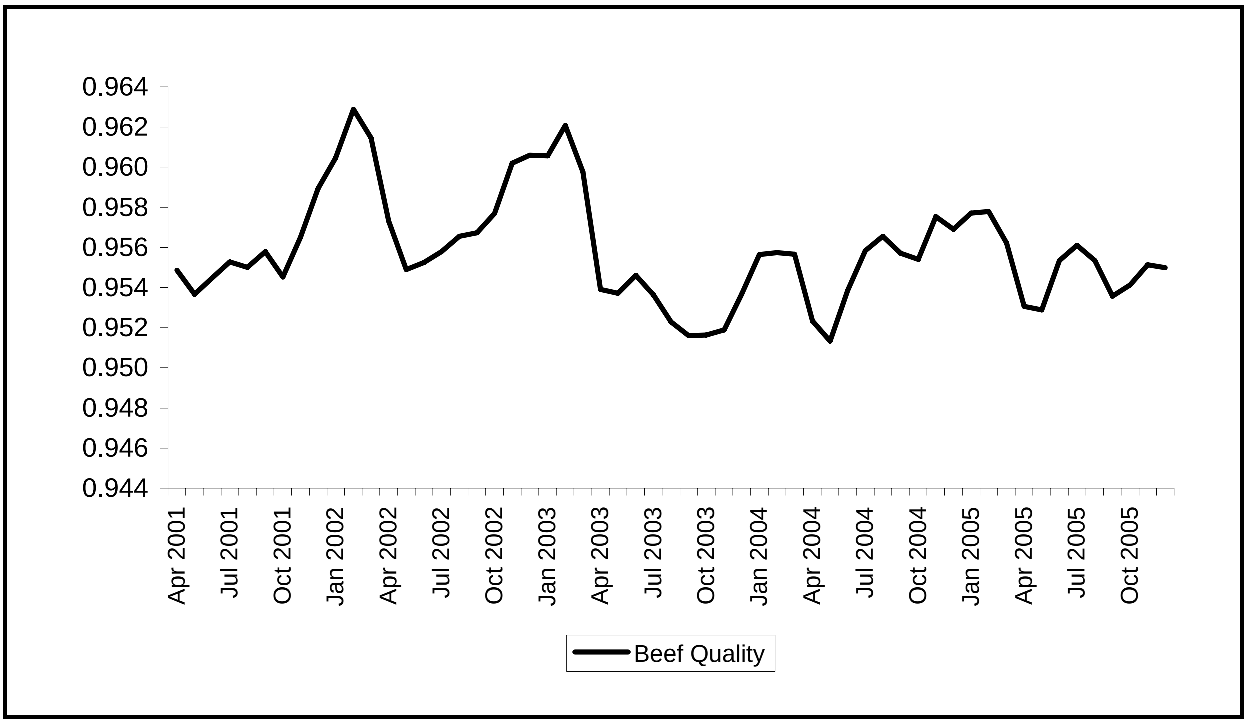
4. The final monthly numerical quality variable is calculated as a weighted average of the monthly numbers of fed cattle slaughtered in each quality grade. The index values created above are used as the weights. Specifically,

$$QG_t = \left[1.083(qprime) + 1.000(qchoice) + 0.881(qselect) + 0.777(qother)\right] / \left[qprime + qchoice + qselect + qother\right], \tag{4.10}$$

where q(•) is the number of head slaughtered that graded Prime, Choice, Select, or Other in each month. These data were obtained from the Livestock Marketing Information Center (LMIC, 2006). The use of fixed weights is appropriate when considering composite products that include quality changes (Nelson, 1991; Theil, 1952-53). Quality changes within a composite category are captured entirely by an index that uses fixed relative prices as weights for individual components.

Figure 4-3 presents the average quality grade (*QG*) for the April 2001 through December 2005 period.

Figure 4-3. USDA Average Beef Quality Grade Using Aggregate Data, April 2001–December 2005



Our constructed average quality grade variable decreased slightly during the period, which corresponds to a slight decrease in the percentage of cattle graded Choice or better. A linear regression of *QG* onto a time trend indicated that the quality grade number decreased by about 0.005% per month. The coefficient of variation for *QG* was relatively small (0.003%). The Jarque-Bera statistic failed to reject the null hypothesis of a normal distribution for *QG*. The Augmented Dickey-Fuller (ADF) unit root test failed to reject the null hypothesis of a unit root in the quality grade variable at the α = 0.05 level. The results of these tests have implications for the modeling approach described below.

4.3.1 Model Development Using MPR Data

Average beef quality grade is expected to be influenced by several factors, including feedlot profitability, technology, inventory levels, wholesale demand, and procurement methods. We specify this relationship as

$$QG_t = \zeta_1\left(PS / PN, T, IF, WB, pf, po, pc, s_2, s_3, s_4\right) + \mu_t. \quad (4.11)$$

Table 4-11 presents the variable definitions and descriptive statistics. Average quality grade number (*QG*) is hypothesized to be a function of the slaughter steer/corn price ratio (*PS / PN*); a linear trend term that is a proxy for technological change in the beef sector (*T*); cattle on feed inventories (*IF*); wholesale demand for beef (*WB*); formula (*pf*), packer ownership (*po*), and cash (*pc*) procurement methods; and seasonality (*s*). The disturbance term (μ_t) is assumed to possess white noise properties.

The price ratio (*PS / PN*) represents the expected profitability of cattle feedlots. The effect of this variable is difficult to assess *a priori.* An increase in this ratio would represent an increase in expected profitability, which could lead to longer cattle feeding periods and may result in more carcasses grading Choice rather than Select. However, increased profitability could also encourage contemporaneous fed cattle marketings and result in lower average live weight of slaughter cattle and reduce quality. Technology (*T*) captures improved genetics that could increase carcass quality. Because a specific measure of technological change is not available, a linear trend term is used as a proxy.

Table 4-11. Variable Definitions for the Slaughter Beef Quality Model, Using MPR Data

Symbol	Definition	Mean	Standard Deviation
QG	Weighted average quality grade index of slaughter cattle	0.956	0.003
PS/PN	Price of slaughter steers divided by the price of corn	34.660	5.010
T	Technological change (linear trend)	28.000	16.600
IF	Cattle on feed monthly, seven states, thousand head	9,390.210	435.360
WB	Real price of boxed beef	71.070	8.430
pf	Cattle procurement by formula methods, percentage	41.430	10.160
Po	Cattle procurement by packer ownership, percentage	6.400	2.550
Pc	Cattle procurement by cash methods, percentage	48.880	10.020
S_2	Binary variable for the second quarter	0.310	0.470
S_3	Binary variable for the third quarter	0.230	0.430
S_4	Binary variable for the fourth quarter	0.230	0.430

Cattle on feed inventories (*IF*) represents the availability of fed slaughter cattle. Increases in inventories are often positively correlated with longer cattle feeding periods. Hence, one might expect that larger inventories may be associated with higher quality grades. Wholesale beef demand (*WB*), as measured by the boxed beef price, is determined by retail consumer demand. As wholesale demand increases, slaughter cattle producers are likely to reduce the length of feeding programs to take advantage of higher cattle prices. Hence, quality grades are likely to decline because shorter feeding periods may result in fewer cattle reaching Choice grade. Quality grades may also be influenced by seasonal factors. Thus, seasonality is represented by quarterly binary variables (s_2, s_3, s_4).

The beef procurement variables *pf*, *po*, and *pc* represent the percentage of cattle procured by formula, packer ownership, and cash methods.[5] Procurement methods may affect beef quality. For example, formula and packer ownership procurement methods may increase beef quality because both

[5] AMA methods in MPR data on cattle procurement include formula, forward contract, and packer ownership. Cash methods include negotiated and auction procurement, while imports are excluded from procurement identification. Thus, forward contracts were excluded from the AMA specification in Eq. (4.11) to avoid a singular matrix in the regression. Forward contracts account for only 3.3% of procurement volumes.

methods allow for packers to acquire beef supplies that meet specific customer demands. We tested whether each procurement method significantly influences average quality grade. In addition, if the procurement variables are significantly different from zero, we test whether the coefficients (marginal impacts) differ between the three procurement methods.

4.3.2 Beef Quality Empirical Results Using MPR Data

The sample period for the quality model consists of monthly data from April 2001 through December 2005, which corresponds to the availability of MPR data. All data used in Eq. (4.11) were obtained from the LMIC, various issues of the *USDA Red Meats Yearbook,* and various issues of the *USDA Feed Yearbook*. The boxed beef price (*WB*) was deflated by the consumer price index (CPI) (1982–1984 = 100).

Eq. (4.11) was initially estimated with two-period (t and $t-1$) distributed lags to account for expectations and rigidities in beef quality adjustments. Because of collinearity between wholesale demand price (*WD*) and the feedlot profitability variable (*PS / PN*), the former was omitted from the final specification. Lags on all of the independent variables, however, were not statistically significant based on the Wald coefficient restriction test. A Koyck term was significantly different from zero at the $\alpha = 0.05$ level. Thus, exogenous shocks to independent variables cause average quality grade to adjust along a geometric time path.

The Breusch-Godfrey Lagrangian Multiplier (LM) test indicated the existence of serial correlation of order one. Thus, Eq. (4.11) was estimated using nonlinear least squares. The final regression results (estimated in double logs) of the beef quality equation are presented in Eq. (4.11) with t-ratios in parentheses:

$$\ln QG_t = -0.271 - 0.003 ln(PS / PN)_t - 0.0001 \ln T_t + 0.028 \ln IF_t$$
$$(-4.456) \quad (-1.146) \quad (-0.799) \quad (3.978)$$

$$+ 0.009 \ln pf_t + 0.002 \ln po_t + 0.008 \ln pc_t - 0.003s2 - 0.001s3$$
$$(1.755) \quad (1.741) \quad (1.320) \quad (-4.547) \quad (-1.707) \tag{4.12}$$

$$- 0.002s4 + 0.805\mu_{t-1}$$
$$(-3.381) \quad (8.512)$$

$$\bar{R}^2 = 0.826 \quad S.E. = 0.001 \quad \overline{QG}(\log mean) = -0.045.$$

The critical t-values at the α = 0.05 level and α = 0.10 level are 2.021 and 1.684, respectively, with 42 degrees of freedom.

The lagged dependent variable was not significantly different from zero and, therefore, was omitted from the specification. The modulus of the single inverted autoregressive root equaled 0.805. Thus, the stochastic error structure had a stable pattern. Excluding the autoregressive error structure, the cumulative sum of squares (CUSUM) test of Eq. (4.12) indicated that the estimated coefficients were stable at the α = 0.05 level.

All variables except feedlot profitability (*PS / PN)*, trend, and the cash procurement variable (*pc*) were statistically different from zero at either the α = 0.05 or α = 0.10 level. The regression results indicate that increases in cattle on feed inventories are associated with improved beef quality, perhaps because of lengthier feeding periods. Specifically, a 1% increase in inventories causes a 0.028% improvement in beef quality (Table 4-12).

Table 4-12. Elasticity Estimates for the Slaughter Beef Quality Model, Using MPR Data

Exogenous Variables	Elasticity
Technological change (*T*)	0.000
Cattle on feed (*IF*)	0.028
Feedlot profitability (*PS / PN*)	0.000
Formula cattle procurement (*pf)*	0.009
Cash cattle procurement (*pc*)	0.000
Packer ownership procurement (*po*)	0.002

Cash procurement was not statistically different from zero. However, formula and packer ownership procurement methods are associated with improved beef quality. Their elasticity estimates, however, are small. For example, a 1% increase in formula procurement increases quality by 0.009%. A 1% increase in packer ownership procurement increases beef quality by 0.002%.

4.4 EFFECT OF BEEF QUALITY ON RETAIL BEEF DEMAND

The demand for beef at the retail level depends on the price of beef, the price of meat substitutes, income, and tastes and preferences. The latter is likely associated with product quality, habits, health, nutrition, and food safety attributes (Capps and Schmitz, 1991; Pollack, 1970). In this section, we estimate the impacts of changes of beef quality on retail demand. The results are later used to estimate the impacts of AMAs on beef product quality, and are subsequently included in the equilibrium displacement model to estimate changes in producer and consumer surplus that may result from changes in AMAs (see Section 6).

4.4.1 A Reduced-Form Retail Model of Beef Quality

We develop a reduced-form price equation for beef at the retail level that incorporates product quality through the inclusion of USDA quality grades, as established at the wholesale level. If changes in AMAs influence fed cattle quality, then retail-level beef quality also will be affected. *A priori*, if a change in procurement method improves product quality, then one would expect the demand for beef at the retail level to increase.

To estimate these effects, we developed a monthly structural model of primary retail demand and derived retail supply. The primary demand specification is based on utility maximization principles. The derived retail supply is based on profit maximization principles of firms producing retail beef products (Varian, 1992). Because we assume that monthly beef supplies are fixed, the model is specified with inverse demand and supply equations.

The structural specification of the beef model is as shown below.

Retail beef demand:

$$PB_r^d = f_1\left(QB_r^d, PP_r, PY_r, Y, QG\right) \tag{4.13}$$

Retail beef supply:

$$PB_r^s = f_2\left(QB_r^s, PBX, RC, S_i\right) \tag{4.14}$$

Market-clearing quantity:

$$QB_r^d = QB_r^s = QB_r \tag{4.15}$$

Market-clearing price:

$$PB_r^d = PB_r^s = PB_r \tag{4.16}$$

Table 4-13 provides variable definitions and descriptive statistics. Error terms have been suppressed but are assumed to have white noise characteristics.

Table 4-13. Variable Definitions for the Retail Beef Quality Model, Using Aggregate Data

Symbol	Definition	Mean	Standard Deviation
PB_r	Real retail beef price, cents/pound	201.380	13.890
QB_r	Per capita beef consumption, retail weight, quarterly, pounds	16.640	0.600
PP_r	Real retail pork price, cents/pound	147.280	4.070
PY_r	Real retail poultry price, cents/pound	57.580	3.110
Y	Real per capita consumption expenditures, dollars	14,600.470	429.960
QG	Weighted average quality grade index of slaughter cattle	0.956	0.003
PBX	Real boxed beef price, dollars/hundredweight	71.910	7.440
RC	Real costs of retail beef processing, food marketing processing cost index (1987 = 100)	306.200	5.980
S_2	Second quarter seasonal binary variable	0.286	0.457
S_3	Third quarter seasonal binary variable	0.214	0.415
S_4	Fourth quarter seasonal binary variable	0.214	0.415

Eq. (4.13) indicates that the inverse retail demand price for beef (PB_r^d) is a function of the per capita retail beef demand quantity (QB_r^d), retail price of pork (PP_r), retail price of poultry (PY_r), per capita consumption expenditures (Y), and beef quality (QG).

Eq. (4.14) indicates that the inverse retail supply price of beef (PB_r^s) is a function of the per capita retail supply quantity of beef (QB_r^s), the price of wholesale boxed beef (PBX), retail food marketing costs (RC), and seasonality (S_i). Eqs. (4.15) and (4.16) are market-clearing quantities and price relations.

Using Eqs. (4.13) and (4.14), Eqs. (4.15) and (4.16) can be written in a reduced form as

$$PB_r = f_3\left(QB_r, PP_r, PY_r, Y, QG, PBX, RC, S_i\right). \qquad (4.17)$$

Thus, retail beef price is a function of structural demand and supply arguments. *A priori*, the marginal impact of quality preference (QG) on retail price (PB_r) is expected to be positive. That is, an increase in quality grade number indicates an increase in quality and retail beef demand.

4.4.2 Data and Estimation of the Reduced-Form Retail Beef Quality Model

Data for the estimation of Eq. (4.17) were obtained from the LMIC, USDA, and the *Economic Report of the President*. Beef quantity data were obtained from the USDA's *Red Meat Yearbook*. Per capita consumption expenditures and CPI were obtained from the *Economic Report of the President*. All dollar values were deflated by the CPI. The price variables and USDA quality grades were obtained from the LMIC. Retail food marketing costs were obtained from the USDA's *Agricultural Outlook*. Retail food marketing costs and per capita consumption expenditures were available only on a quarterly basis. Therefore, each of 3 months within any quarter was assigned the same value (the quarterly observation) for these two variables.

The sample period included April 2001 through December 2005. The null hypothesis of no unit roots was rejected for the dependent variable and several independent variables at the $\alpha = 0.05$ level based on ADF unit root tests. An ADF test of the residuals of Eq. (4.17) indicated that the equation was cointegrated. Therefore, the equation was estimated with the data in levels but with natural logarithm transformations.

Because of potential market dynamics, Eq. (4.17) was estimated as an infinite distributed lag approximated by an autoregressive distributed lag (ARDL) structure (Greene, 2003). One-period lags on each of the independent variables and on the dependent variable were also included. We used the Wald test as a criterion for omitting insignificant estimated coefficients. The Breusch-Godfrey LM test failed to reject the null hypothesis of no autoregressive errors of orders one and two. Thus, the OLS regression results of Eq. (4.17) are

$$\begin{aligned}
\ln PB_r = {} & \underset{(-1.444)}{-4.107} - \underset{(-1.700)}{0.131} \ln QB_{r,t-1} + \underset{(2.234)}{0.244} \ln PP_{r,t} + \underset{(1.732)}{0.177} \ln PY_{r,t} \\
& - \underset{(-2.768)}{0.279} \ln PY_{r,t-1} + \underset{(1.623)}{0.402} \ln Y_{t-1} + \underset{(1.930)}{0.471} \ln QG_t - \underset{(-1.326)}{0.328} \ln QG_{t-1} \\
& + \underset{(1.507)}{0.067} \ln PBX_t + \underset{(3.414)}{0.177} \ln PBX_{t-1} + \underset{(1.566)}{0.226} \ln RC_t \\
& + \underset{(1.571)}{0.011} s_2 + \underset{(2.043)}{0.015} s_3 + \underset{(2.861)}{0.018} s_4 + \underset{(7.447)}{0.550} \ln PB_{r,t-1}
\end{aligned} \tag{4.18}$$

$$\bar{R}^2 = 0.965 \qquad S.E. = 0.013 \qquad \overline{PB_r}(\log\ mean) = 5.303$$

The critical t-values at the α = 0.05 and α = 0.10 levels are 2.021 and 1.684, respectively (42 degrees of freedom).

The CUSUM test for parameter stability failed to reject the null hypothesis of parameter stability at the α = 0.05 level. The first-order difference equation implies geometric distributed lags in retail beef prices. Equilibrium adjustments (95%) occur in about 5 months. The modulus of the single root (absolute value of the 0.550 coefficient) is less than unity, indicating dynamic stability of retail prices.

Most of the signs of the estimated coefficients are consistent with theoretical expectations. From the demand perspective, the coefficients on per capita beef consumption and consumer expenditures are negative and positive, respectively. The coefficient for retail pork price is positive, while the sum of the two coefficients on retail poultry price is negative, which is contrary to expectations for consumption substitutes.

From a supply perspective, the estimated coefficients for the price of boxed beef and food marketing costs are positive. Increases in either of these inputs into producing retail beef would be expected to shift supply to the left and increase retail beef price.

The primary purpose of estimating Eq. (4.18) is to obtain an estimate of the impact of quality on retail demand. The two coefficients on the quality variable sum to 0.143, which indicates that an increase in the quality grade index increases retail beef price because of an increase in retail beef demand. For example, a 10% increase in the quality grade index increases retail beef price by 1.43% in the short run and 3.18% in the long run.[6]

4.5 SUMMARY OF THE EFFECTS OF ALTERNATIVE MARKETING ARRANGEMENTS ON BEEF QUALITY

Based on the results of the industry interviews and survey, beef producers and packers believe that AMAs are important for beef quality. Producers indicated that AMAs allow them to better market higher quality cattle. Packers reported that they used AMAs to procure higher quality cattle and to better meet downstream customer demand. Both believed that signals for attributes of quality beyond simply quality grade would be difficult in a cash-only marketing system.

A summary of the fed cattle purchase transactions data indicates that the percentage of higher quality grade cattle differs across the procurement methods. Although very small in number, the percentage of Choice or better cattle bought through dealers and brokers and auction markets was higher than the percentages of other purchase methods. Marketing agreement cattle had the next highest percentage of Choice or better, followed by forward contract, direct trade purchases, and packer-owned cattle. Overall, 61% of cattle were graded Choice or better, with slightly more cash or spot market cattle than AMA cattle grading Choice or better.

[6] The long-run elasticity estimate of 0.318 is calculated by dividing the sum of the two estimated coefficients for quality (0.143) by one minus the coefficient estimate on the lagged dependent variable, or 0.45.

Using transactions data, we estimated three quality models. These models and their key results were as follows:

- First, we estimated the effect of procurement method on various individual measures of quality and found that, after controlling for seasonal and plant effects, cattle sold through marketing agreements had a higher percentage of Choice and Prime carcasses without increases in the percentage of Yield Grade 4 and 5 carcasses, and only a modestly lower percentage of Yield Grade 1 and 2 carcasses. Other procurement methods had larger trade-offs between quality grade and yield grade.
- Second, we estimated the effect of procurement method on a quality index that combines several measures of quality and found that, after controlling for seasonal and plant effects, the relatively small volume of cattle procured through auction barns were associated with the highest quality relative to other methods, but also with the highest quality variation. Cattle procured through marketing agreements or packer ownership were of higher quality and had lower quality variances than cattle procured through direct trade. Forward contracts were associated with the lowest quality cattle relative to other methods.
- Third, we estimated the effect of valuation method on the quality index and found that, after controlling for seasonal and packing plant effects, carcass weight valuation with a grid was associated with higher quality relative to liveweight valuation. Carcass weight valuation without a grid also was associated with higher quality relative to liveweight valuation, but the magnitude of the effect was smaller than for carcass weight valuation with a grid.
- Finally, using MPR data, we estimated a monthly model to determine if AMAs influence beef quality. USDA quality grade was used as a proxy for beef quality. A quality grade variable based on premium and discounts relative to Choice grade was constructed such that an increase in the variable is associated with an increase in quality. Technological change did not appear to affect beef quality during the sample period. Feedlot profitability did not have a statistically significant effect on quality. Formula and packer ownership procurement methods increased beef quality, although the effects were relatively small. However, beef quality was not influenced by cash procurement. These results are consistent with anecdotal evidence that AMAs have

positive, although small, impacts on beef quality. Finally, we estimated a model that quantified the effects of beef carcass quality on retail beef demand. The statistical results indicate that increases (and decreases) in carcass beef quality grades directly affect retail beef prices positively (negatively).

5 Risk Shifting Associated with Alternative Marketing Arrangements

In this section, we present a discussion of the effects of AMAs on risk shifting in the fed cattle and beef industries. The results presented in this section are based, in part, on the industry survey described in Volume 2 and on beef packer purchase transactions data.

5.1 RISK SHIFTING IN MARKETING ARRANGEMENTS

In this section, we discuss the types of risk in the fed cattle and beef industries and the role AMAs play in mitigating each type of risk. We then discuss the risk-related reasons for using AMAs cited by respondents to the industry survey.

5.1.1 Types of Risk and the Role of AMAs in Risk Mitigation

Beef industry participants face multiple types of risk, and the sources of risk vary by the stage of production. Most risks faced by producers and packers can be categorized as production, price, or market access risks. We describe each type below, followed by a discussion of how marketing arrangements do or do not mitigate each type of risk.

Production Risk

Sources of production risk can vary significantly across stages of beef production. For example, cow-calf producers and stockers use pasture and open range to sustain their herds; therefore, they are subject to considerable risks from the availability and quality of natural vegetation. Conversely, cattle feeders maintain confined operations and feed their cattle a high-energy ration in which the variability of natural vegetation is replaced with cultivated crops. Despite technological differences, cattle producers at all stages face some level of risk from feed availability and quality, animal health, and weather.

Two additional sources of production risk that affect beef producers are yield and grading risks. Yield risk refers to the variation in the proportion of a live animal that produces a usable carcass. Grading risk is related to yield risk in that it includes the amount of saleable cuts that can be produced from a carcass (i.e., yield grade), but it also incorporates the overall quality of the meat (i.e., quality grade).

The sources of production risk differ as fed cattle move downstream to the packer. Beef packers face multiple sources of production risk as they employ labor, capital, and live cattle resources for the production of fresh, frozen, or processed beef products.

AMAs provide very little opportunity to shift production risk among market participants. For example, in a forward contract or marketing agreement, the individual producer maintains all of the production risk while raising cattle for delivery. Exceptions to this include custom feeding arrangements, in which the cattle owner (e.g., a cow-calf producer or packer) retains some portion of the production risk, or shared ownership arrangements, which shift some risk to the feedlot that is partnering in ownership of the cattle.

Some valuation methods for cattle provide an avenue to transfer production risk among market participants. However, each valuation method can be associated with a number of different types of AMAs. Thus, the effect of the valuation method in shifting production risk is not necessarily directly attributable to a specific AMA.

Carcass weight valuation, relative to liveweight, transfers yield risk from the packer to the producer. Furthermore, carcass weight valuation with a grid (grade and yield) transfers both yield risk and grading risk from the packer to the producer. Therefore, to the extent that carcass or grade and yield valuation are associated with a particular AMA, the AMA shifts yield and grading risk from packers to producers.

Price Risk

Price risk stems from increases and decreases in both input (e.g., feeder cattle, feed) and output (e.g., fed cattle) prices. Similar to production risk, the specific source or degree of price risk is dependent on the stage of production. Research by Mark, Schroeder, and Jones (2000) found fed cattle and feeder cattle prices, followed by corn prices, to be the largest contributors to variability in feedlot profits. Similarly, Lawrence, Wang, and Loy (1999) attributed more than 50% of the variation in feedlot profits to fed cattle prices and another 20% to feeder cattle prices.

Packers also face considerable price risk as a margin-based business. Beef packers are subject to variation in live cattle prices on the input side and meat and by-product prices on the output side (Ward, 2002).

Futures markets for feeder cattle and live cattle are available to industry participants regardless of the use of AMAs and provide a method to shift price risk to a third party through organized futures exchanges. The degree to which AMAs can shift price risk among market participants depends on the type of arrangement and the specific terms of the arrangement. In custom feeding arrangements, all of the market price risk is borne by the owner of the cattle. The feedlot raising the cattle is paid based on cattle performance or yardage, regardless of market conditions.

Forward contracts allow producers to lock in a price while their cattle are still on feed, effectively shifting price risk to the packer. However, packers can take an offsetting position in the futures market to mitigate the additional price risk associated with futures prices, although they still hold the basis risk.

Marketing agreements do not inherently shift price risk among the participants. Marketing agreements using a negotiated (flat) price can shift the fed cattle price risk to the packer, but the input (feeder cattle and corn) price risk remains. However, this type of agreement is likely to have a mechanism to adjust for market conditions. Most marketing agreements that use formula pricing do not shift price risk between packers and producers, because the transaction price is determined based on a current market price.[1] However, producers and packers in a marketing agreement of this type can use the futures market to offset price risk from the market price.

Market Access Risk

In the context of cattle markets, market access risk typically refers to the availability of a timely and appropriate market outlet. As perishable commodities, live cattle and beef products must be sold within a fairly narrow time frame. Cattle held beyond the optimal marketing period begin to decrease in value because of excessive fat gain and the rising cost of gain. Fresh beef products with a limited shelf life must be sold at significant discounts, frozen, or discarded; all of which lead to decreased total value.

AMAs between producers and packers eliminate market access risk for both parties to the transaction. The specific terms of an AMA may vary as to which participant chooses the exact day of delivery, but the nature of the arrangements ensure a market outlet. Upstream producers using AMAs to facilitate retained ownership (i.e., custom feeding) guarantee a spot for their cattle in the feedyard, but not with a packer. These producers would need an additional agreement with a packer to mitigate market access risk for their fed cattle.

5.1.2 Risk-Related Reasons for Use of Alternative Marketing Arrangements

Survey responses presented in Volume 2 provide insight into producers' and packers' risk-related reasons for using AMAs. We describe these responses below.

Producer Survey Responses

Most cattle producers did not explicitly state that they used AMAs to reduce their risk exposure. However, many of the reasons why producers use AMAs can be interpreted as methods to mitigate price, production, or market access risk.

[1] One exception is the use of marketing agreements that use a formula price based on the cost of production. This type of marketing agreement shifts price risk to the packer and locks in a profit margin for the producer.

Three of the top five reasons producers use AMAs to procure cattle are related to production risk. The response items were as follows:

- Secures higher quality calves and cattle (95.0% of producers)
- Improves week-to-week supply management (51.2% of producers)
- Improves efficiency of operations due to animal uniformity (46.2% of producers)

Collectively, these reasons indicate that AMAs facilitate the procurement of a reliable supply of consistent, high-quality cattle. The benefits of securing consistent, high-quality cattle for a feedlot likely includes a lower average cost of production through more efficient operations and improved capacity utilization.

Examining producers' motivations for using AMAs to sell cattle clearly shows their desire to alleviate risk. The most direct example of this desire is that "Reduces risk exposure" was one of the top five responses for both small and large producers (34.5%). Other risk-related responses by small and large producers centered on market access. These responses were as follows:

- Allows for sale of higher quality calves and cattle (51.6% of producers)
- Facilitates or increases market access (19.7% of producers)
- Secures a buyer for calves and cattle (26.5% of producers)

Ensuring a timely market outlet for cattle enables producers to focus their resources on production as opposed to marketing and increases their likelihood of being financially rewarded for their efforts.

Packer Survey Responses

Beef packers have the same motivations to use AMAs as cattle producers. Three of the top five reasons packers use AMAs to procure fed cattle are the same reasons producers use AMAs for procurement:

- Improves week-to-week supply management (57.7% of packers)

- Secures higher quality fed cattle (53.8% of packers)
- Improves efficiency of operations due to animal uniformity (42.3% of packers)

The similarity of these responses indicates that despite the fundamental differences in production of live cattle compared with beef, both packers and producers have a desire to decrease production variability and procure a reliable supply of consistent, high-quality cattle.

The other top reasons packers use AMAs for procurement are related to market access risk. Specifically, these reasons were as follows:

- Allows for product branding in retail sales (46.2% of packers)
- Allows for market access (42.3% of packers)

The response to "Allows for market access" does not indicate whether packers use AMAs to guarantee access to input or output markets. However, the response "Allows for product branding in retail sales" implies that packers use AMAs to guarantee access to both input and output markets. In other words, for packers to ensure that they can provide retailers with a sufficiently consistent product to carry a brand label, they procure cattle through AMAs.

5.2 EVIDENCE OF RISK SHIFTING ASSOCIATED WITH ALTERNATIVE MARKETING ARRANGEMENTS

In this section, we compare price differences and volatility for beef packer purchase transactions by type of marketing method and discuss the implications for risk management.

5.2.1 Fed Cattle Transactions Prices

We calculated weekly average prices by purchase method from the beef packer purchase transactions data. The purchase methods included in this analysis are listed below:

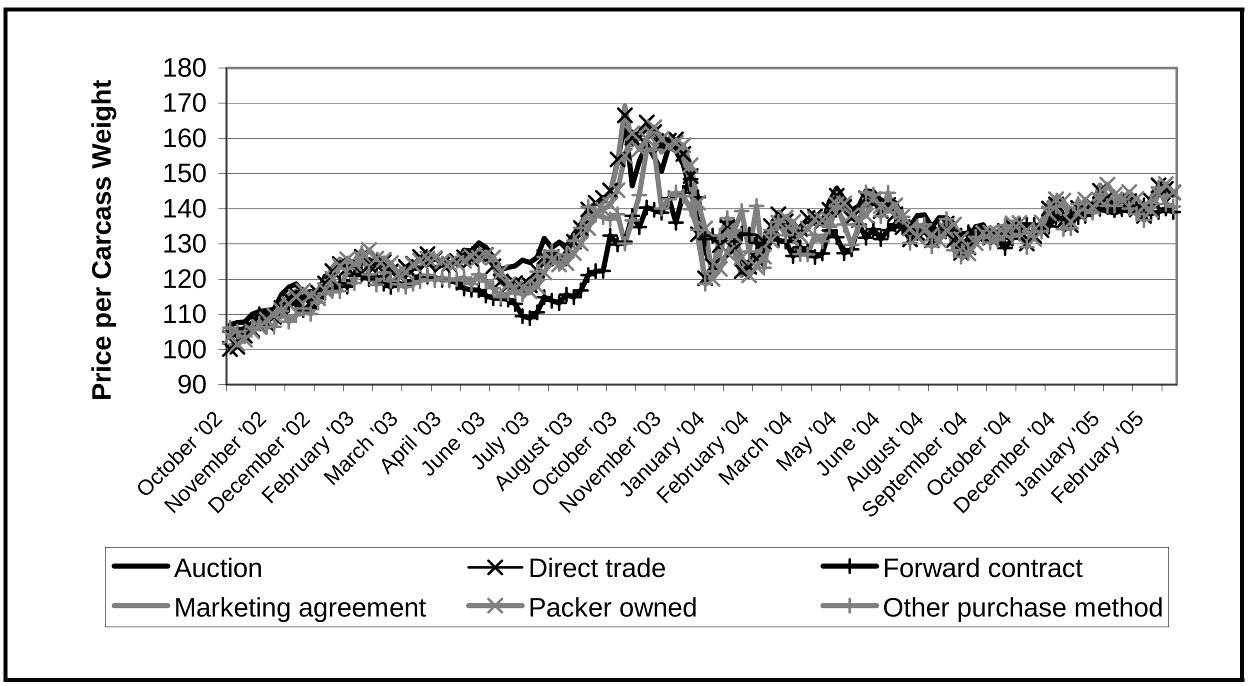
- auctions—purchases from auction barns
- direct trade—purchases through direct trade or through a dealer or broker[2]

[2] Most of these transactions are direct trade; very few transactions occurred through dealers and brokers.

- forward contracts—the future purchase of a specified quantity of livestock through an oral or written agreement that was entered into at least 2 weeks prior to kill date
- marketing agreement—purchases in which a packer agreed to purchase livestock through a long-term oral or written arrangement with specific terms
- packer owned—the transfer of packer-owned livestock from either a custom feedlot or packer-owned or controlled feedlot
- other—purchases not captured in other categories

For comparison purposes, all prices were calculated as the price per hundred pounds in carcass weight.[3] In addition, only lots with 60% or greater Choice and Select or Yield Grade 2 and 3 were included to minimize the price variation attributable to quality characteristics. Figure 5-1 shows the constructed average weekly prices from October 2002 through March 2005.

Figure 5-1. Average Weekly Price of Cattle from Lots with 60% or More Choice/Select Quality Grade or Yield Grade 2 or 3, by Purchase Method, October 2002–March 2005



[3] Note that prices for packer-owned cattle are internal transfer prices, as reported by the packer. These prices often are based on external market prices.

The mean price of each purchase method differed by less than $6.00/cwt during this period (Table 5-1). Auctions had the highest mean price at $132.60/cwt, and forward contracts had the lowest mean price of $127.00/cwt. Direct trade transactions had the highest variance and the highest average weekly volume, while forward contracts had the lowest variance and a relatively low average weekly volume during this period. The lower mean and variance of forward contracts was due, in part, to foregoing higher prices that the others received because the market moved higher after producers established the contract price during the period of the data. Interestingly, auction barn sales had a relatively low variance among the types of marketing arrangements; however, the average weekly volume through auction barns also was relatively low.

Table 5-1. Average Weekly Prices per Hundred Pounds Carcass Weight, by Fed Cattle Purchase Method, October 2002–March 2005

	Fed Cattle Prices				Approximate Average Head per Week
Purchase Method	**Mean**	**Max**	**Min**	**Variance**	
Auction	$132.60	$164.72	$107.04	122.43	20,000
Direct trade and dealer/broker	$132.04	$166.56	$100.17	167.41	260,000
Forward contract	$127.00	$148.43	$103.81	111.30	20,000
Marketing agreement	$132.25	$169.08	$101.11	162.84	130,000
Packer owned	$131.86	$163.22	$101.61	160.65	20,000
Other purchase method	$129.17	$156.78	$103.73	129.51	2,000

5.2.2 Fed Cattle Price Volatility Testing

Measuring the volatility of prices provides an indicator of the risk market participants face. In this context, risk refers to both upside and downside risk; that is, risk due to price increases and decreases. Comparing the volatility of price series by type of fed cattle purchase method provides some indication of the relative risk of each type of purchase method. We describe the results of price volatility testing below.

Testing Procedure

A Wald statistic derived by Knoeber and Thurman (1995) was used to test the null hypothesis of equal variance across purchase methods. Knoeber and Thurman proposed this test statistic as a way of testing for equal variance among two correlated price series.

The test statistic is calculated as

$$T = \frac{s_1^2 - s_2^2}{\left[\frac{2}{n}\left(s_1^4 + s_2^4 - 2s_{12}^2\right)\right]^{\frac{1}{2}}}, \tag{5.1}$$

where s_1^2 and s_2^2 are the sample variances of the two price series being compared, s_{12} is the sample covariance, and n is the number of observations. Under the null hypothesis, T is asymptotically standard normal.

The null and alternative hypotheses used in the pairwise tests are

$$\begin{aligned} H_0 &= var(PM_i) = var(PM_j) \\ H_1 &= var(PM_i) > var(PM_j) \end{aligned}, \tag{5.2}$$

where PM_i and PM_j are the average weekly price series for fed cattle purchase method i and j ($i \neq j$).

Empirical Results

Using a pairwise approach to testing the variance of the six different fed cattle marketing arrangements, ranked by variance, results in 15 unique comparisons. The Wald test statistics and corresponding P values are reported in Table 5-2.

Based on these comparisons, purchase methods fall into two categories. The variances of the three marketing arrangements with the highest variances (direct trade, marketing agreement, and packer owned) are not statistically different from each other at the 95% confidence level. Of the three marketing arrangements with the lowest variances, other purchase method and auctions are not statistically different from each other and auctions are not statistically different from forward contracts. However, the variance of other purchase method is statistically different from the variance of forward contracts.

Table 5-2. Pairwise Tests of Equal Variances, by Fed Cattle Purchase Method, October 2002–March 2005

$Variance_i$ vs. $Variance_j$	Wald Test Statistic	P Value
Direct trade[a] vs. marketing agreement	1.08	0.1393
Direct trade[a] vs. packer owned	0.86	0.1950
Direct trade[a] vs. other purchase method	2.91	0.0018
Direct trade[a] vs. auction	5.38	0.0000
Direct trade[a] vs. forward contract	3.44	0.0003
Marketing agreement vs. packer owned	0.27	0.3931
Marketing agreement vs. other purchase method	2.62	0.0045
Marketing agreement vs. auction	4.92	0.0000
Marketing agreement vs. forward contract	3.25	0.0006
Packer owned vs. other purchase method	2.43	0.0076
Packer owned vs. auction	3.98	0.0000
Packer owned vs. forward contract	3.46	0.0003
Other purchase method vs. auction	0.68	0.2494
Other purchase method vs. forward contract	1.61	0.0535
Auction vs. forward contract	0.86	0.1957

[a] Direct trade includes a small volume of dealer/broker transactions.

Individually, the null hypothesis of equal variance is rejected when comparing direct trade, marketing agreement, and packer owned prices to other purchase method, auction, and forward contract prices. Therefore, results of the pairwise variance test, using average weekly prices, imply that fed cattle prices under direct trade, marketing agreements, or packer ownership are essentially equally risky. While producers do not face price risk with packer-owned cattle, those using direct trade and marketing agreements face more risk than producers using other purchase methods, auctions, and forward contracts.

We conducted two additional sets of pairwise variance tests to investigate the potential to shift risk through different valuation methods. Using the same methodology as described above, we calculated the average weekly price of cattle sold using liveweight, carcass weight without grade and yield adjustments (i.e., nongrid), and carcass weight with grade and yield adjustments (i.e., grid) valuation methods.

A preliminary analysis of differences in prices between marketing arrangements for lots where 60% or more were Choice and Select or Yield Grade 2 and 3 indicated very little difference by valuation method. This implies that, if any differences in prices occurred, they may be offsetting. Therefore, we calculated prices for low- and high-quality cattle lots and conducted additional statistical tests. Low-quality lots were defined as those with 60% or more of the cattle having a quality grade of Select or lower (regardless of yield grade), or Yield Grade 4 and 5 (regardless of quality grade). High-quality lots were defined as those with 60% or more of the cattle grading Prime (regardless of yield grade) or Yield Grade 1 and 2 (regardless of quality grade). Figures 5-2 and 5-3 show the relative comparisons of averages prices for low- and high-quality cattle lots by type of valuation method.

The results of the pairwise variance tests indicate that producers selling low-quality cattle face more risk if they sell using carcass weight grade and yield valuation methods relative to liveweight or carcass weight without grade and yield (Table 5-3). This result is fairly intuitive in that grade and yield valuation transfers the packer's production risk of yield and grading to producers. Interestingly, the variance tests also indicate that selling low-quality cattle on a liveweight basis is more risky than selling on a carcass weight basis without grade and yield. This result implies that yield risk was not effectively transferred from packer to producers using carcass weight without grade and yield valuation for low-quality cattle sold during this time frame.

The results of tests of differences in the variance of prices for high-quality cattle met with prior expectations regarding the ranking of variances by valuation method. Specifically, carcass weight with grade and yield and carcass weight without grade and yield valuation methods individually had higher variances than liveweight valuation (Table 5-4). Furthermore, we are unable to reject the null hypothesis of equal variances between carcass weight with grade and yield and carcass weight without grade and yield valuation methods.

Figure 5-2. Average Weekly Price of Low-Quality Cattle, by Valuation Method, October 2002–March 2005

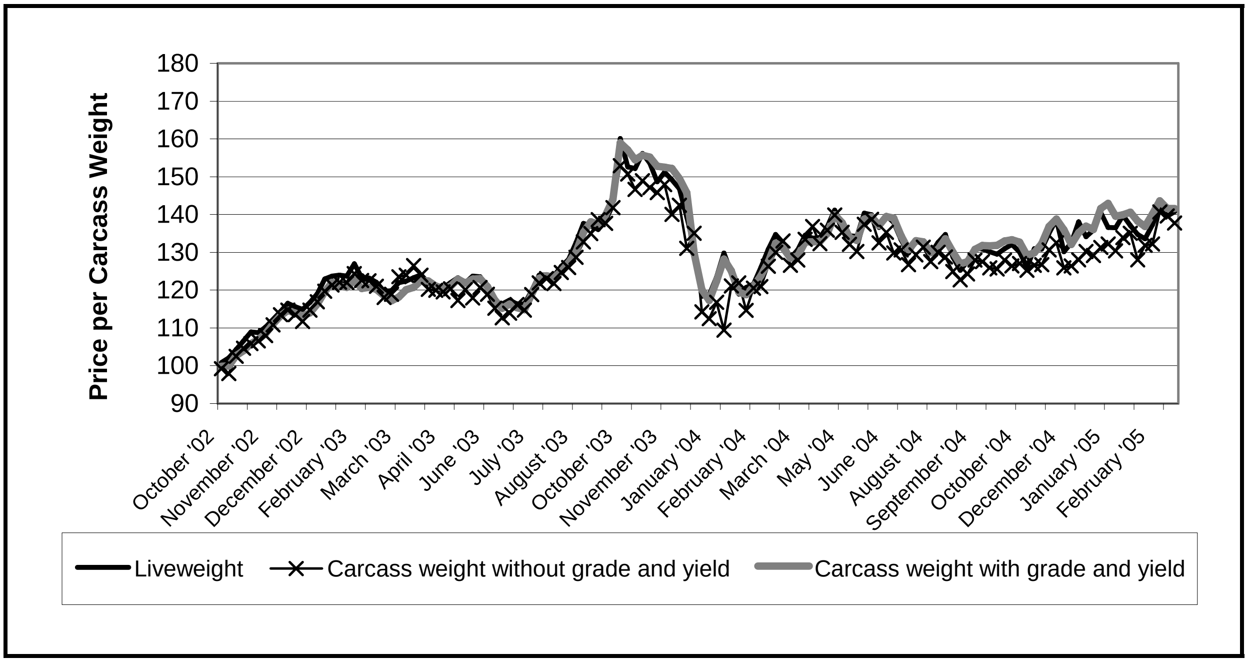


Figure 5-3. Average Weekly Price of High-Quality Cattle, by Valuation Method, October 2002–March 2005

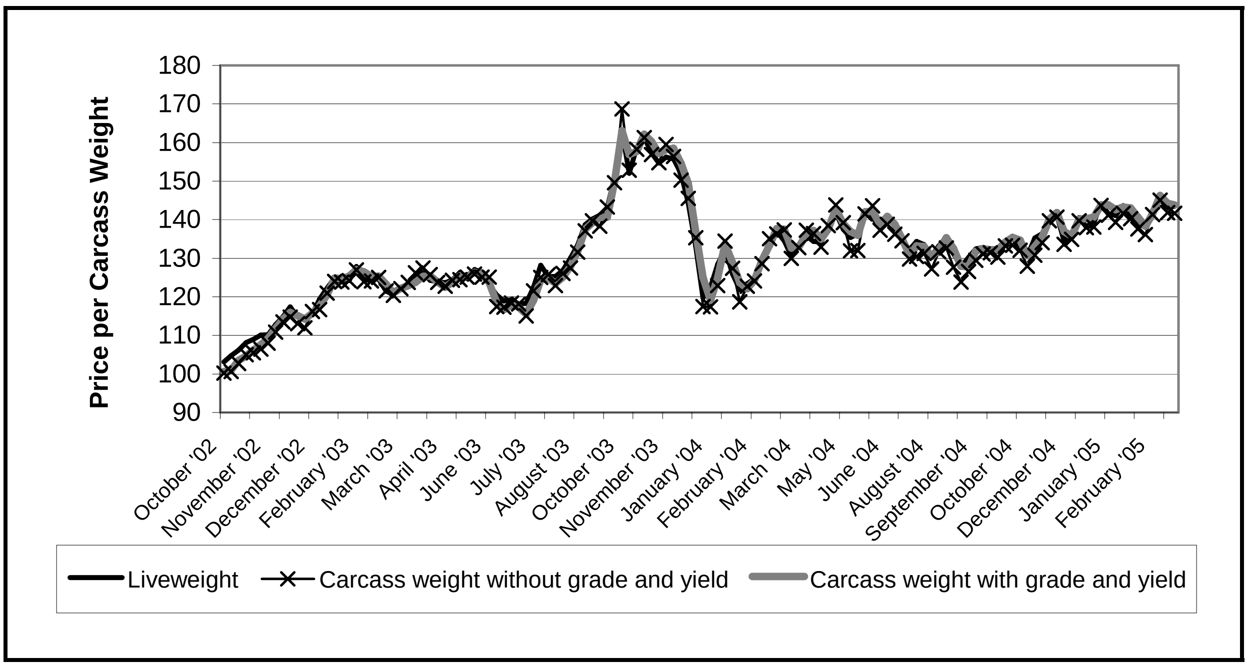


Table 5-3. Pairwise Tests of Equal Variances for Low-Quality Fed Cattle, by Valuation Method, October 2002–March 2005

Variance$_i$ vs. Variance$_j$	Wald Test Statistic	P Value
Carcass weight, grade and yield vs. liveweight	4.56	0.0000
Carcass weight, grade and yield vs. carcass weight, not grade and yield	4.24	0.0000
Liveweight vs. carcass weight, not grade and yield	1.88	0.0304

Table 5-4. Pairwise Tests of Equal Variances for High-Quality Fed Cattle, by Valuation Method, October 2002–March 2005

Variance$_i$ vs. Variance$_j$	Wald Test Statistic	P Value
Carcass weight, grade and yield vs. liveweight	0.65	0.2580
Carcass weight, grade and yield vs. carcass weight, not grade and yield	4.11	0.0000
Liveweight vs. carcass weight, not grade and yield	3.51	0.0002

5.2.3 Regression Analysis Results on Fed Cattle Price Risk

In this section, we explore the same research question as in Section 5.2.2—whether and how transaction price volatility differs across marketing arrangements—using a different methodology. First, we use individual transactions data, rather than the *aggregated* market-level data. Second, we take into account several cattle characteristics and seasonality, while analyzing the relationship between price volatility and the choice of marketing arrangement.

The empirical model is the same as that described in Section 2.2.2, but now our focus is on the heteroskedasticity model (Eq. [2.4]) in this section. The notations and summary statistics of the explanatory variables are presented in Section 2.2.2 and Table 2-19. The parameter estimates (the δs in Eq. [2.4]) are reported in the last column of Table 2-20. The primary conclusions regarding volatility from these results are as follows:

- Compared with direct trade, the price variances are much higher for auction barn transactions and forward contracts and slightly lower for packer owned and marketing agreement transactions, holding cattle characteristics (variable *CATTLE_CH*) and month of sale (variable *D_MONTH*) fixed. These results are opposite to those indicated in Table 5-1, because the heteroskedasticity model accounts for the variability caused by differences in quality of cattle and month of sale across individual transactions.

- Other parameter estimates suggest that price volatility is
  - lower for fed beef cattle than fed dairy cattle,
  - lower for cattle that are eligible for a branded and certification program,
  - lower for cattle of higher yield grade (i.e., a lower yield grade number) and quality grade,
  - lower for cattle within the regular weight range, and
  - lower for cattle sold in large lots.

To summarize, cattle that have desirable characteristics (such as beef breed, high yield grade, high quality grade, eligible for a branded or certification program, and within the regular weight range) obtain not only higher average prices but also lower price volatility (see Table 2-20).

The estimated differences (percentage higher or lower) in price variance among marketing arrangements for fed beef cattle and for fed dairy cattle are reported in Tables 5-5 and 5-6, respectively. All the difference estimates are individually significant at the 5% level based on Wald tests. Among the five marketing arrangements, auction barn transactions are associated with the highest average price and highest price volatility. It appears that selling through auction barns should appeal more to less risk-averse cattle feeders. Like auction markets, forward contract transaction prices are determined in a competitive environment. After accounting for quality and sales month, forward contracts are more risky than direct trade or marketing agreements. The average price difference between auction barn transactions and forward contracts ($0.06/lb carcass weight for beef cattle and $0.16/lb carcass weight for fed dairy cattle) could be considered a risk premium to compensate feeders who sell their cattle in auction barns for bearing more price volatility (46% higher variance for beef cattle and 43% higher variance for fed dairy cattle) and market access risk. Packer-owned fed dairy cattle have slightly lower average prices (1.2 cents per pound carcass weight) and

Table 5-5. Estimated Price Variance Differences (Percentage Higher or Lower) among Marketing Arrangements Used for Purchasing Fed Beef Cattle, October 2002–March 2005

Marketing Arrangement	Auction	Direct Trade and Dealer/Broker	Forward Contract	Marketing Agreement	Packer Owned
Auction	0%	331%	46%	426%	376%
Direct trade and dealer/broker	–77%	0%	–66%	22%	11%
Forward contract	–32%	194%	0%	260%	225%
Marketing agreement	–81%	–18%	–72%	0%	–10%
Packer owned	–79%	–10%	–69%	11%	0%

Note: The differences are computed as the price variance of each AMA listed in the left column divided by each listed in the top row minus one.

Table 5-6. Estimated Price Variance Differences (Percentage Higher or Lower) among Marketing Arrangements Used for Purchasing Dairy Breed Fed Cattle

Marketing Arrangement	Auction	Direct Trade and Dealer/Broker	Forward Contract	Marketing Agreement	Packer Owned
Auction	0%	151%	43%	213%	246%
Direct trade and dealer/broker	–60%	0%	–43%	25%	38%
Forward contract	–30%	75%	0%	118%	141%
Marketing agreement	–68%	–20%	–54%	0%	11%
Packer owned	–71%	–27%	–59%	–10%	0%

Note: The differences are computed as the price variance of each AMA listed in the left column divided by each listed in the top row minus one.

slightly lower price variance (20% lower) than direct trade. Packer-owned fed beef cattle have slightly higher average price (0.1 cent per pound carcass weight) and slightly lower price variance (10% lower) than direct trade. This is consistent with the fact that internal transfer prices for packer-owned cattle are usually based on an average cash market price. Transactions through marketing agreements are associated with slightly lower price volatility (18% lower variance for fed beef cattle and 27% lower for fed dairy cattle) than those through direct trade. Given that average prices for marketing agreement cattle and direct trade cattle are very close and that marketing agreements help secure market access while direct trade does not, it appears that a risk-averse feeder has less incentive to choose direct trade when marketing agreements are available.

However, marketing agreements require a strong bilateral relationship between feeder and packer and might not be available for all feeders.

5.3 SUMMARY

Beef market participants face production, price, and market access risk. The survey of producers and packers indicates that those that use AMAs value them as a method of dealing with these risks. The AMAs allow them to secure or sell better quality cattle and calves and improve operational management and efficiency. Interviews with feedlots and packers identified packer ownership specifically as an important risk management strategy to improve capacity utilization without excess financial leverage. Packers also identified AMAs an important element of branded products and meeting consumer demand by producing a higher quality, more consistent product.

Transactions data were analyzed to evaluate the price levels and variability during the data collection period. The data were aggregated by procurement method for transactions that were 60% Choice or Select or Yield Grade 2 and 3, which are the bulk of the fed cattle traded. The differences in average prices can be explained partly by the fact that prices were generally trending upward during the time period of the data set. Based on these averages, auction markets had the highest average price and the second lowest variance of prices. Forward contracts had the lowest average price, partly because these prices are set further in advance of delivery compared with the other types of AMAs and because prices were rising, and forward contracts had the lowest variance partly because these contracts missed out on high prices that occurred during the time period of the data set. Marketing agreement and packer-owned cattle had a mean and variance of prices similar to direct trade cattle in the aggregated data. Results of pairwise variance tests, using average weekly prices, imply that fed cattle prices under direct trade, marketing agreements, or packer ownership are essentially equally risky. In addition, producers using direct trade and marketing agreements appear to face more price risk than producers using other purchase methods, auctions, and forward contracts.

In contrast to the summary statistics, regression analysis accounting for cattle quality and sales month found substantially different results. When controlling for seasonality and plant effects, prices for auction barn fed cattle were more volatile than all other purchase methods. Prices for direct trade fed cattle were less volatile than auction barn and forward contract cattle, but slightly more volatile than marketing agreement and packer-owned cattle. Note that prices for packer-owned cattle are internal transfer prices that are based on external market prices, so comparisons with packer-owned cattle prices are less relevant than the other comparisons. Prices for forward contract cattle were less volatile than auction sales, but much more volatile than all other types. Finally, prices for marketing agreement cattle were less volatile than all other procurement methods other than packer ownership. The results for fed beef and fed dairy cattle were generally similar.

Therefore, AMAs help reduce production risk and market access risk, as identified by respondents to the survey, and, based on the transactions data, AMAs also reduce price variability compared with direct trade in some cases. Furthermore, in the future, if AMAs are used to facilitate traceability programs, they may help reduce quality variation, which, in turn, would contribute to reduced price volatility under AMAs.

6 Measurement of the Economic Effects of Restricting Alternative Marketing Arrangements

In this section, we estimate short- and long-run changes in equilibrium prices and quantities of live cattle and beef that would result from hypothetical changes in current fed cattle procurement methods. We develop an equilibrium displacement model that incorporates estimated procurement costs, and potential changes in product quality at the retail level and accounts for interrelationships along the beef marketing chain. In addition, we estimate cumulative changes in consumer surplus at the retail level and producer surplus at each level of the beef marketing chain to determine the economic effects of changes in procurement methods on consumers, producers, and importers of live cattle and beef. Then, we incorporate the potential for cattle processing market power and estimate the effects of changes in that power resulting from changes in livestock procurement methods. Finally, we contrast the model simulation results with qualitative information obtained through interviews with producers and packers.

6.1 MODEL DEVELOPMENT

This section describes the modeling strategy for estimating the economic effects of changes in procurement methods on consumers, producers, and importers of live cattle and beef. An equilibrium displacement model is presented and used as the primary approach to estimating changes in producer and consumer surplus. Later sections describe the parameterization of the model and its simulation results.

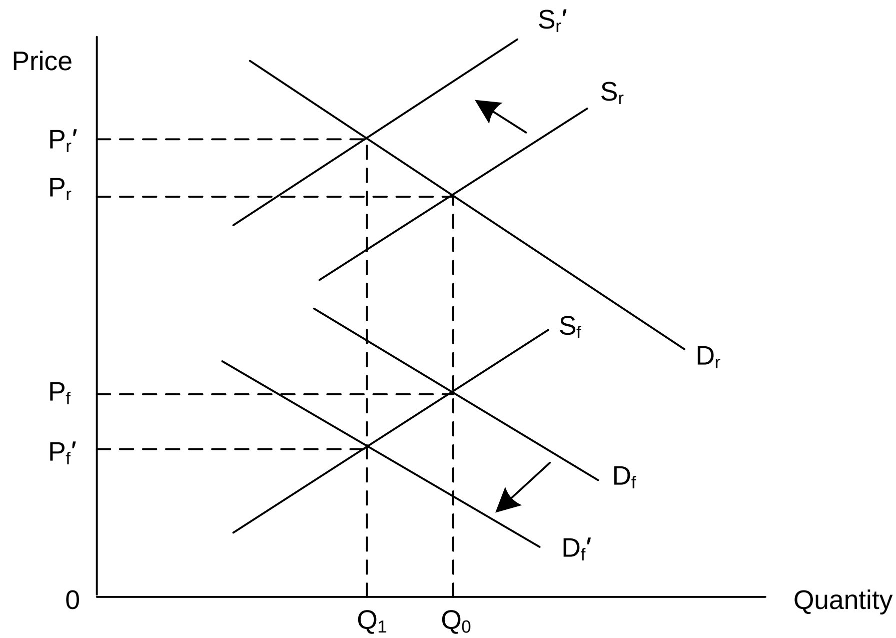
6.1.1 Modeling Strategy

We develop an equilibrium displacement model assuming that limits on current procurement methods will impose additional marketing costs on suppliers at each market level. Conceptually, such costs shift relevant supply functions upward and to the left in each affected sector. A reduction in supply at the retail level causes a reduction in quantity demanded at that level. Concurrently, this change causes reductions in derived demand at each prior level in the marketing chain. In a competitive market, the impacts and distribution of added marketing costs on prices and quantities at each market level are determined by the size of cost impacts and relative supply and demand elasticities at each level.

Figure 6-1 illustrates the relevant market linkages for a simplified case in which the beef industry marketing chain is separated into retail and farm sectors. To simplify the illustration, fixed input proportions between the farm input (feeder cattle) and marketing services are assumed. Retail demand (D_r) and farm (feeder) supply (S_f) are considered the “primary” relations, while the demand for feeder cattle (D_f) and the retail supply of beef (S_r) are considered “derived” relations (Tomek and Robinson, 1990). The intersection of demand and supply at each level determines relative market-clearing prices (P_r) and (P_f) and market-clearing quantity (Q_o). In this case, the farm-level market-clearing quantity is represented graphically on a retail weight equivalent basis. The difference in equilibrium prices ($P_r – P_f$) represents the farm–retail price spread or marketing margin.

If changes in AMAs increased costs only at the retail level, retail supply would shift from S_r to S_r', and the farm-level derived demand for feeder cattle would decline to D_f' (Figure 6-1). Retail price would increase to P_r' and farm price would decline to P_f'. Marketing cost increases would be reflected by a larger marketing margin ($P_r' – P_f'$), and a new equilibrium quantity would be established at Q_1. If retail demand were relatively

Figure 6-1. Effects on the Beef Sector of Imposing Additional Procurement Costs on the Retail Level

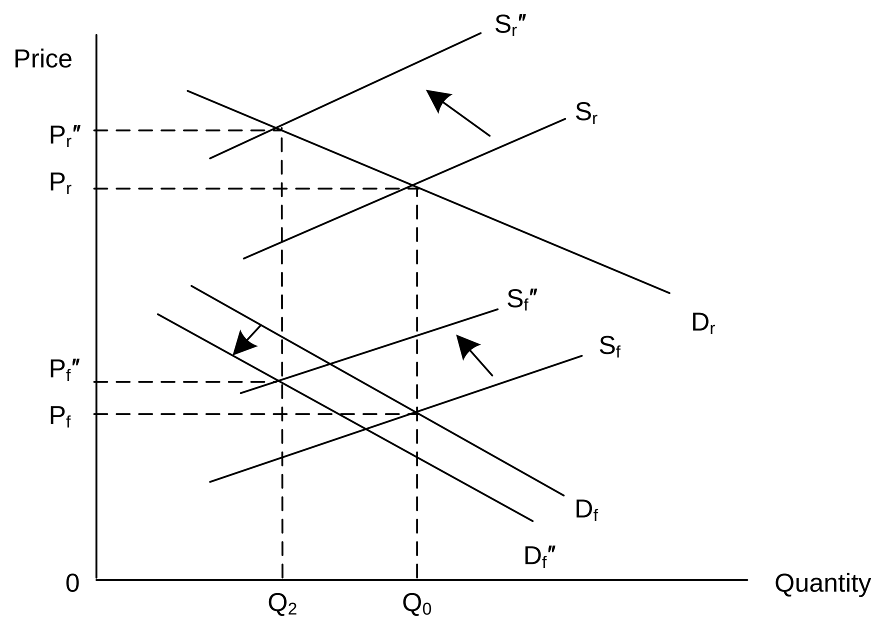


inelastic, consumer expenditures would increase, but farm revenues and producer surplus would decline, along with farm price and quantity.

Figure 6-2 extends this simplified case by illustrating a situation in which procurement costs increase at both the retail and farm levels. The initial equilibrium occurs at P_r, P_f, and Q_0. Increased procurement costs associated with AMAs are reflected in reductions in both derived retail supply (S_r'') and primary farm supply (S_f''). The derived demand for feeder cattle declines to D_f''. The new equilibrium prices are at P_r'' and P_f'', and the new equilibrium quantity is Q_2. Whether P_f'' is higher or lower than P_f depends on relative supply and demand shifts and elasticities at each level. However, Q_2 is unambiguously less than Q_o. That is, the quantity of cattle traded decreases because of increased procurement costs.

In Figure 6-2, the new equilibrium farm price P_f'' is higher than the original farm price of P_f. Nonetheless, the higher farm price does not mean that producers are better off because of associated declines in farm output. Producer surplus effects can be measured by the change in producer surplus that results

Figure 6-2. Effects on the Beef Sector of Imposing Additional Procurement Costs on the Retail and Farm Levels



from moving from the original equilibrium (P_f, Q_o) to the new equilibrium (P_f'', Q_2). In Figure 6-3, shaded area *A* represents farm-level producer surplus at the original equilibrium price and quantity, and shaded area *B* represents farm-level producer surplus as a result of increased procurement costs that affect the retail and farm levels. Assuming linear supply and demand functions, elasticity estimates and equilibrium prices and quantities can be used to calculate the sizes of the shaded areas. Absent a consumer demand increase, the change in producer surplus illustrated in Figure 6-3 must be negative and is expressed as

$$\Delta PS = B - A = \left[1/2\left(P_f'' - \alpha_1\right)Q_2\right] - \left[1/2\left(P_f - \alpha_0\right)Q_0\right], \quad (6.1)$$

where ΔPS represents the change in producer surplus.

Figure 6-4 illustrates the case in which a third market (slaughter cattle) has been added between the farm and retail levels. Beef processors have a derived demand for slaughter cattle (D_s). Cattle feedlots provide a derived supply (S_s) of slaughter cattle. In addition, suppose that beef processors are able to use market power to drive a wedge between the

Figure 6-3. Changes in Farm-Level Producer Surplus Resulting from Imposing Additional Procurement Costs on the Retail and Farm Levels

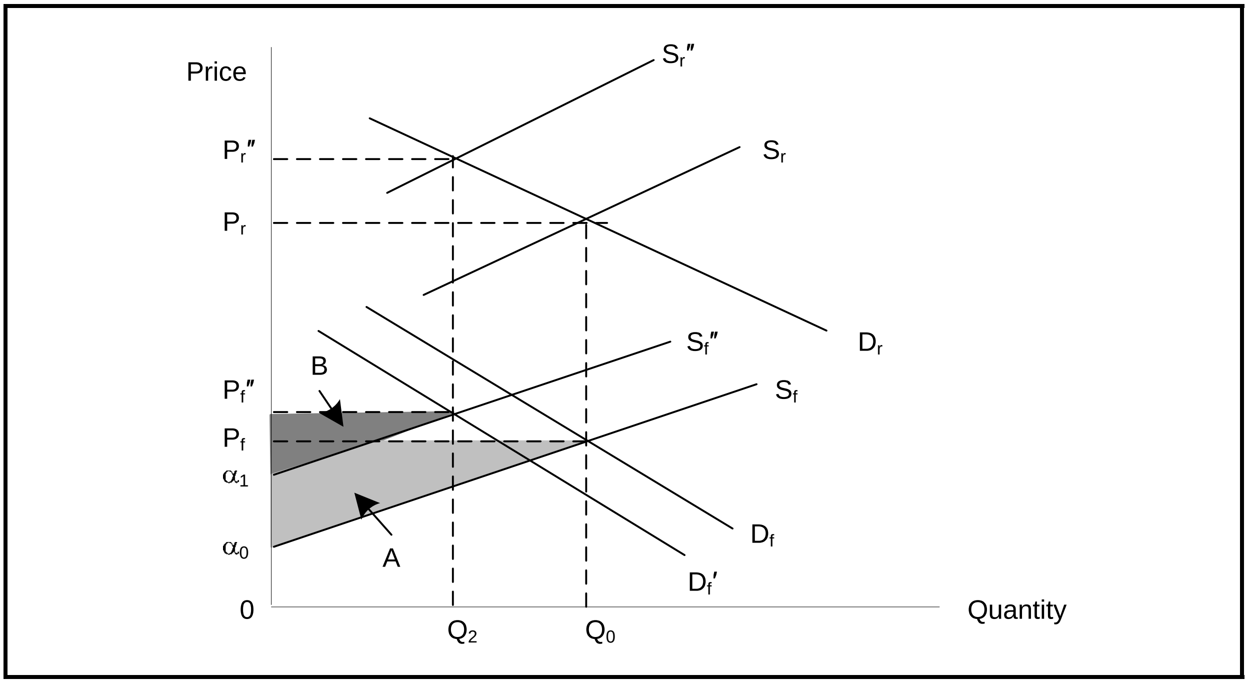
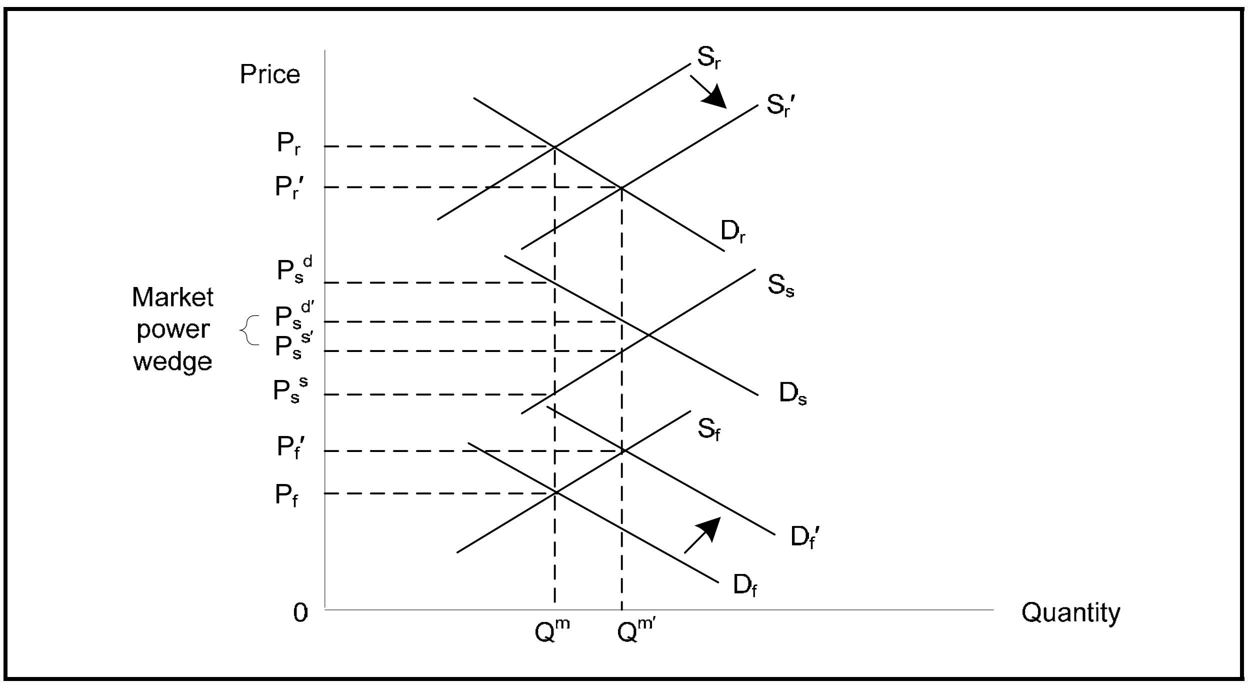


Figure 6-4. Effects of Market Power and Changes in Market Power on Equilibrium Quantities and Prices in the Retail, Slaughter, and Farm Levels



slaughter cattle demand price (P_s^d) and the slaughter cattle supply price (P_s^s) at equilibrium quantity Q^m. This results in an equilibrium retail price of P_r and an equilibrium farm price of P_f. A restriction on formula, contracted, or packer ownership marketing arrangements could reduce the market power of processors. In this case, the wedge between P_s^d and P_s^s would narrow, say to $P_s^{d\prime}$ and $P_s^{s\prime}$. Quantity equilibrium would be established at $Q^{m'}$. This requires an increase in the retail derived supply function to S_r' and an increase in the farm-level derived demand function to D_f'. The size of these shifts depends on the relative sizes of the absolute value of the primary retail-level own-price elasticity of demand and the primary farm-level own-price elasticity of supply (Tomek and Robinson, 1990).

Figures 6-1 through 6-4 illustrate only the cost-side effects of changes in procurement methods on retail- and farm-level prices and quantities. However, based on analyses presented in Section 4, changes in procurement methods also may be detrimental to product quality. If so, consumer demand for domestically produced beef products would decline and be represented by a downward shift in the primary demand curve.

6.1.2 An Equilibrium Displacement Model of the Beef Industry

An equilibrium displacement model is a linear approximation to a set of underlying and unknown demand and supply functions. The model's accuracy depends on the degree of nonlinearity of the true demand and supply functions and the magnitude of deviations from equilibrium being considered. If these deviations are relatively small, then a linear approximation of the true demand and supply functions should be relatively accurate (Brester, Marsh, and Atwood, 2004; Brester and Wohlgenant, 1997; Wohlgenant, 1993). Although total producer surplus measurements obtained from linear supply functions may or may not reflect actual values, changes in producer surplus caused by shifts in linear supply or demand functions should approximate actual changes, provided that such shifts are relatively small.

A general structural model of supply and demand relationships in the beef industry provides the framework for an equilibrium displacement model. The beef industry is modeled as a series of primary and derived demand and supply relations and associated equilibria within the farm–retail marketing chain.

The model incorporates variable input proportions among live cattle, beef, and marketing service inputs by allowing production quantities to vary across market levels (Tomek and Robinson, 1990; Wohlgenant, 1993). The use of variable input proportions permits input substitution in response to changing output and input prices (Wohlgenant, 1989).

We modeled the domestic beef marketing chain by considering four distinct sectors: retail (consumer), wholesale (processor), slaughter (cattle feeding), and farm (feeder cattle). Live cattle imports at the slaughter level are incorporated into the model because changes in AMAs are expected to affect the purchase of both domestic and imported slaughter cattle. We also assume that beef packers may be able to exert oligopsony power in the purchase of slaughter cattle.[1]

In general terms, the structural supply and demand model is given by the following (error terms have been omitted):

Retail Beef Sector

Retail beef primary demand:

$$Q_B^{rd} = f_1\left(P_B^r, \boldsymbol{Z}_B^r\right) \tag{6.2}$$

Retail beef derived supply:

$$Q_B^{rs} = f_2\left(P_B^r, Q_B^w, \boldsymbol{W}_B^r\right) \tag{6.3}$$

Wholesale Beef Sector

Wholesale beef derived demand:

$$Q_B^{wd} = f_3\left(P_B^w, Q_B^{rd}, \boldsymbol{Z}_B^w\right) \tag{6.4}$$

Wholesale beef derived supply:

$$Q_B^{ws} = f_4\left(P_B^w, Q_B^{dss}, Q_B^{iss}, \boldsymbol{W}_B^w\right) \tag{6.5}$$

Slaughter Beef Sector

Domestic slaughter cattle derived demand:

$$Q_B^{dsd} = f_5\left(P_B^{dsd}, Q_B^{wd}, \boldsymbol{Z}_B^{ds}\right) \tag{6.6}$$

[1] The potential for market power is included in this model to make the specification and results as general as possible, rather than to directly test for whether such market power exists.

Domestic slaughter cattle derived supply:

$$Q_B^{dss} = f_6\left(P_B^{dss}, Q_B^{fs}, \boldsymbol{W}_B^{ds}\right) \tag{6.7}$$

Domestic slaughter cattle market power price wedge:

$$P_B^{dsd} = f_7\left(P_B^{dss}, \theta\right) \tag{6.8}$$

Imported slaughter cattle derived demand:

$$Q_B^{isd} = f_8\left(P_B^{isd}, Q_B^{w}, P_B^{dsd}, \boldsymbol{Z}_B^{is}\right) \tag{6.9}$$

Imported slaughter cattle derived supply:

$$Q_B^{iss} = f_9\left(P_B^{iss}, \boldsymbol{W}_B^{is}\right) \tag{6.10}$$

Imported slaughter cattle market power price wedge:

$$P_B^{isd} = f_{10}\left(P_B^{iss}, \theta\right) \tag{6.11}$$

Feeder Cattle Sector

Feeder cattle derived demand:

$$Q_B^{fd} = f_{11}\left(P_B^{f}, Q_B^{dsd}, \boldsymbol{Z}_B^{df}\right) \tag{6.12}$$

Domestic feeder cattle primary supply:

$$Q_B^{fs} = f_{12}\left(P_B^{f}, \boldsymbol{W}_B^{df}\right) \tag{6.13}$$

Variable definitions are presented in Table 6-1. The four beef market sectors are linked by upstream quantity (weight) variables among the demand equations and downstream quantity (weight) variables among the supply equations (Wohlgenant, 1993). Each $\boldsymbol{Z}_B^{ij}$ and $\boldsymbol{W}_B^{ij}$ (i = domestic [d] or imported [i] beef or cattle and j = market levels [r—retail, w—wholesale, s—slaughter, f—farm]) represent vectors of demand and supply shifters. These shifters are defined in Section 6.2.4, where we describe the structural model and empirical results.

The equilibrium displacement model was developed by assuming the existence of market-clearing quantities (e.g., Q_B^{rd} = Q_B^{rs} = Q_B^{r}). Eqs. (6.2) through (6.13) were then totally differentiated, and log differentials were used to express the relations in elasticity form. This results in the following equilibrium displacement model that was used to approximate changes from initial equilibrium in the U.S. beef industry:

Table 6-1. Variable Definitions for the Beef Equilibrium Displacement and Structural Models

Symbol	Definition	Mean	Standard Deviation
Q_B^{rd}	Quantity (per capita) of domestic retail beef, pounds (retail weight)	74.26	8.50
Q_B^{wd}	Quantity of wholesale domestic beef, billion pounds (carcass weight)	23.92	1.54
Q_B^{ds}	Quantity of domestic slaughter beef, billion pounds (liveweight)	40.44	2.53
Q_B^{is}	Quantity of imported slaughter beef, billion pounds (liveweight)	0.79	0.56
Q_B^{df}	Quantity of domestic feeder cattle, billion pounds (liveweight)	26.08	2.43
P_B^{dr}	Real price of domestic retail beef, cents per pound	224.66	40.93
P_p^{dr}	Real price of domestic retail pork, cents per pound	170.56	31.82
P_y^{r}	Real price of domestic retail broilers, cents per pound	76.45	20.04
P_L^{dr}	Real price of domestic retail lamb, cents per pound	271.66	56.13
P_B^{dw}	Real price of domestic wholesale (boxed) beef, cents per pound	99.01	29.46
P_B^{ds}	Real price of domestic slaughter beef, \$/cwt	59.67	17.50
P_p^{ds}	Real price of domestic slaughter pork, \$/cwt	43.72	20.84
P_B^{df}	Real price of domestic feeder cattle, \$/cwt	63.48	17.11
$\mathbf{Z}_B^{ij}$	Demand shifters for the *i*th market (import/domestic) at the *j*th market level	—[a]	—[a]
$\mathbf{W}_B^{ij}$	Supply shifters for the *i*th market at the *j*th market level	—[a]	—[a]
θ	Beef processor market power wedge	—[a]	—[a]
z_B^{dr}	Change in consumer demand for domestic beef caused by changes in procurement method	—[a]	—[a]
w_B^{dr}	Changes in costs of supplying domestic retail beef caused by changes in procurement method	—[a]	—[a]
w_B^{dw}	Changes in costs of supplying domestic wholesale beef caused by changes in procurement method	—[a]	—[a]
w_B^{ds}	Changes in costs of supplying domestic slaughter cattle caused by changes in procurement method	—[a]	—[a]
w_B^{df}	Changes in costs of supplying domestic feeder cattle caused by changes in procurement method	—[a]	—[a]

(continued)

Table 6-1. Variable Definitions for the Beef Equilibrium Displacement and Structural Models (continued)

Symbol	Definition	Mean	Standard Deviation
ρ	P_B^{dsd} / P_B^{dss} and P_B^{isd} / P_B^{iss}	—[a]	—[a]
Q_{bc}	Quantity of domestic breeding cattle, million head	36.14	3.55
P_k^w	Real price of wholesale pork, cents per pound	58.56	24.84
P_L^w	Real price of wholesale lamb, cents per pound	123.75	30.36
P_y^w	Real price of wholesale broilers, cents per pound	50.15	17.50
M_e	Real per capita red meat and poultry consumption expenditures, billion dollars	329.16	51.86
M_c	Index of food marketing costs (1987 = 100)	312.29	24.90
L_c	Index of food labor costs (1987 = 100)	324.30	26.96
W_b	Real meat packing wage rate, dollars per hour	7.92	1.85
P_{bp}	Real price of beef by-products, cents per pound	15.55	4.76
E_x	Real U.S./Canadian exchange rate	1.35	0.36
K	Beef packer four-firm concentration ratio	59.54	22.27
P_n	Real price of no. 2 yellow corn, dollars per bushel	2.52	1.38
P_{hy}	Real price of hay, dollars per ton	66.76	17.52
T_B	Technology in cattle feeding, average dressed weight of beef, pounds	740.38	45.15
BE	Binary variable for North American BSE occurrences, 2003–2005 = 1.0; 0 otherwise	0.09	0.29

[a] Variables without means and standard deviations are inputs to the model and thus do not have data values.

$$EQ_B^r = \eta^r EP_B^r + Ez_B^r \tag{6.14}$$

$$EQ_B^r = \in^r EP_B^r + \tau_s^{rw} EQ_B^w + Ew_B^r \tag{6.15}$$

$$EQ_B^w = \eta^w EP_B^w + \tau_d^{wr} EQ_B^r \tag{6.16}$$

$$EQ_B^w = \in^w EP_B^w + 0.97\tau_s^{ws} EQ_B^{ds} + 0.03\tau_s^{ws} EQ_B^{is} + Ew_B^w \tag{6.17}$$

$$EQ_B^{ds} = \eta^{ds} EP_B^{dsd} + \tau_d^{sw} EQ_B^w \tag{6.18}$$

$$EQ_B^{ds} = \in^{ds} EP_B^{dss} + \tau_s^{sf} EQ_B^{df} + Ew_B^s \tag{6.19}$$

$$EP_B^{dsd} = \left(1/\rho\right) EP_B^{dss} + \left(1/\rho\right) E\theta \tag{6.20}$$

$$EQ_B^{is} = \eta^{is} EP_B^{isd} + 0.03\tau_d^{sw} EQ_B^{w} + \eta^{id} EP_B^{dss} \quad (6.21)$$

$$EQ_B^{is} = \in^{is} EP_B^{iss} + Ew_B^{s} \quad (6.22)$$

$$EP_B^{isd} = \left(1/\rho\right) EP_B^{iss} + \left(1/\rho\right) E\theta \quad (6.23)$$

$$EQ_B^{df} = \eta^{df} EP_B^{df} + \tau_d^{fs} EQ_B^{ds} \quad (6.24)$$

$$EQ_B^{df} = \in^{df} EP_B^{df} + Ew_B^{df} \quad (6.25)$$

The term E represents a relative change operator (e.g., $EQ_B^r = dQ_B^r / Q_B^r = d \ln Q_B^r$). Table 6-2 provides definitions for all parameters. In addition, each z_B^{ij} and w_B^{ij} represent single elements of the demand ($\boldsymbol{Z}_B^{ij}$) and supply ($\boldsymbol{W}_B^{ij}$) shifters. Specifically, these elements represent percentage cost or quality changes from initial equilibria, caused by changes in procurement methods. That is, z_B^{dr} represents potential quality shifters for consumer demand resulting from changes in cattle procurement practices. Similarly, w_B^{ij} represents cost shifters for the primary and derived cattle and beef supply functions, which may result from changes in procurement practices. All other elements of $\boldsymbol{Z}_B^{ij}$ and $\boldsymbol{W}_B^{ij}$ are assumed to remain constant as a result of changes in procurement practices.

The equilibrium displacement model was implemented by placing all of the endogenous variables in Eqs. (6.14) through (6.25) onto the left-hand side of each equation:

$$EQ_B^{r} - \eta^{r} EP_B^{r} = Ez_B^{r} \quad (6.26)$$

$$EQ_B^{r} - \in^{r} EP_B^{r} - \tau_s^{rw} EQ_B^{w} = Ew_B^{r} \quad (6.27)$$

$$EQ_B^{w} - \eta^{w} EP_B^{dw} - \tau_d^{wr} EQ_B^{r} = 0 \quad (6.28)$$

$$EQ_B^{w} - \in^{w} EP_B^{w} - 0.97\tau_s^{ws} EQ_B^{ds} - 0.03\tau_s^{ws} EQ_B^{is} = Ew_B^{w} \quad (6.29)$$

$$EQ_B^{ds} - \eta^{ds} EP_B^{dsd} - \tau_d^{sw} EQ_B^{w} = 0 \quad (6.30)$$

$$EQ_B^{ds} - \in^{ds} EP_B^{dss} - \tau_s^{sf} EQ_B^{f} = Ew_B^{s} \quad (6.31)$$

$$\rho EP_B^{dsd} - EP_B^{dss} = E\theta \quad (6.32)$$

$$EQ_B^{is} - \eta^{is} EP_B^{isd} - 0.03\tau_d^{sw} EQ_B^{w} - \eta^{id} EP_B^{dss} = 0 \quad (6.33)$$

$$EQ_B^{is} - \in^{is} EP_B^{iss} = Ew_B^{s} \quad (6.34)$$

Table 6-2. Parameter Definitions, Short-Run and Long-Run Elasticity Estimates Used in the Equilibrium Displacement Model, and Standard Deviations of Beef Model Elasticities

Parameter	Definition	Estimate[a] Short Run	Estimate[a] Long Run	Short-Run Standard Deviation[a]
η^r	Own-price elasticity of primary demand for retail domestic beef	–0.864	–1.173	0.113
η^{dw}	Own-price elasticity of derived demand for wholesale domestic beef	–0.584	–0.936	0.105
η^{ds}	Own-price elasticity of derived demand for domestic slaughter cattle	–0.401	–0.529	0.150
η^{is}	Own-price elasticity of derived demand for imported slaughter cattle	–3.212	–6.049	1.033
η^{id}	Cross-price elasticity of derived demand for imported slaughter cattle with respect to U.S. slaughter cattle	1.196	2.252	0.566
η^{df}	Own-price elasticity of derived demand for domestic feeder cattle	–0.135	–0.754	0.045
$\in^r$	Own-price derived supply elasticity of retail beef	0.349	2.154	0.068
$\in^{dw}$	Own-price derived supply elasticity of wholesale beef	0.424	0.591	0.132
$\in^{ds}$	Own-price derived supply elasticity of domestic slaughter cattle	0.133	0.496	0.047
$\in^{is}$	Own-price derived supply elasticity of imported slaughter cattle	10.000	10.000	n.a.
$\in^{df}$	Own-price primary supply elasticity of feeder cattle	0.103	0.240	0.013

n.a. = not applicable

[a] Short-run standard deviations for each elasticity are obtained from the structural model that is presented later in the report. Long-run standard deviations are not needed for the analysis.

$$\rho EP_B^{isd} - EP_B^{iss} = E\theta \tag{6.35}$$

$$EQ_B^f - \eta^f EP_B^f - \tau_d^{fs} EQ_B^{ds} = 0 \tag{6.36}$$

$$EQ_B^f - \in^f EP_B^f = Ew_B^f \tag{6.37}$$

For any given set of elasticity estimates, Eqs. (6.26) through (6.37) can be used to determine the relative changes in endogenous quantities and prices for any given exogenous changes in costs, market power, or consumer demand. In matrix notation, Eqs. (6.26) through (6.37) can be written as

$$\boldsymbol{A} \bullet \boldsymbol{Y} = \boldsymbol{B} \bullet \boldsymbol{X}, \tag{6.38}$$

where ***A*** is a 12x12 nonsingular matrix of elasticities; ***Y*** is a 12x1 vector of changes in the endogenous price and quantity variables; ***B*** is a 12x6 matrix of parameters associated with the exogenous variables; and ***X*** is a 6x1 vector of percentage changes in the exogenous cost, demand, and market power shift variables. Relative changes in the endogenous variables (***Y***) caused by relative changes in marketing (procurement) costs and benefits (***X***) are calculated by solving Eq. (6.38) as

$$\boldsymbol{Y} = \boldsymbol{A}^{-1} \bullet \boldsymbol{B} \bullet \boldsymbol{X}. \tag{6.39}$$

6.2 ESTIMATING DEMAND AND SUPPLY ELASTICITIES IN THE BEEF INDUSTRY

Solutions for ***Y*** in Eq. (6.39) require elasticity estimates for elements of the matrix ***A***. The extant literature reports various demand and supply elasticity estimates for the beef industry. In some cases, dozens of estimates have been reported. For other elasticities, however, only a few are available. In addition, reported elasticity estimates tend to vary in magnitude because of differing sample periods, estimation methods, modeling procedures, and research objectives.

Consequently, we estimated a system of structural demand and supply equations in the domestic beef sector so that resulting elasticity estimates are consistent with respect to sample period and model specification, data generation, methodology, and evaluation procedures.

U.S. beef trade equations are not explicitly estimated because changes in AMAs are not expected to significantly affect these sectors. However, U.S. demand for slaughter cattle imports is estimated because such purchases could be affected by changes in AMAs.

Most of the estimates of U.S. demand elasticities for beef have focused on the retail level, while supply elasticity estimates have focused on the live cattle sector (Brester and Wohlgenant, 1991; Chavas, 1983; Dahlgran, 1987; Eales, 1994; Eales and Unneveher, 1988, 1993; Marsh, 1994, 1999; Moschini and

Meilke, 1989; Ospina and Shumway, 1979; Rucker, Burt, and LaFrance, 1984; Rosen, Murphy, and Scheinkman, 1994).

Researchers often include vertical relationships when estimating demand and supply elasticities in the livestock/beef marketing sector (Brester and Marsh, 1983; Marsh, 1983, 2003; Shonkwiler and Hinckley, 1985; Wohlgenant, 1989). Primary and derived demand and supply elasticity estimates in the live cattle industry also show substantial variation in magnitude because of differing sample periods and research methodologies. In some cases, reported supply elasticity estimates are inconsistent with expected signs.

6.2.1 Structural Model Required for Econometric Estimates

To effectively evaluate economic effects of marketing arrangements in the beef sector, vertical relationships among demand and supply sectors in the cattle/beef marketing channel should be estimated jointly (Arzac and Wilkinson, 1979; Brester and Marsh, 1983; Brester, Marsh, and Atwood, 2004; Gardner, 1975; Marsh, 2003; Tomek and Robinson, 1990; Wohlgenant, 1989). For our structural analysis, the market levels of the beef industry considered are

1. feeder calf production, noted as the feeder cattle level;
2. feedlot production for slaughter, noted as the slaughter cattle level;
3. live cattle imports at the slaughter level;
4. carcass beef production, noted as the wholesale level;
5. retail beef production, noted as the retail level.

The implied demand and supply relationships are characterized by variables unique to each level and also by variables specific to other vertical sectors. For example, meat packer demand for slaughter cattle depends on cattle slaughter price, carcass price at the wholesale level, marketing costs, and the potential for meat packer market concentration.

The advantages of specifying multimarket levels in an econometric model rest with properties of the parameter estimates and comprehensiveness of the comparative statics. A system of demand and supply equations allows parameter estimates to account for vertical market information and stochastic error processes that improve the consistency and asymptotic efficiency of parameter estimates (Greene, 2003).

For example, parameter estimates of a single-demand equation at the feeder cattle level ignore endogenous, exogenous, and error term information implicit in a demand system that includes downstream slaughter, wholesale, and retail levels (Marsh, 2003; Wohlgenant, 1989).

In a systems model, the comparative statics are contingent on model stability and total elasticities. These elasticities measure direct and indirect changes in equilibrium prices and quantities at all market levels from arbitrary shocks (Marsh, 2003; Wohlgenant, 1989). Beef market constituents (buyers and sellers) at these levels have vested interests in public and private policy changes, which can be evaluated using comparative statics. Examples include beef quality changes that may shift consumer preferences (retail demand) or government restrictions on contracting arrangements that could affect cattle finisher and meat packer transaction and plant utilization costs. The result could be a shift in the feedlot supply of and the packer demand for slaughter cattle. Moreover, the relative elasticities of primary demand and primary supply, the nature of marketing margins, and the source of market shock(s) determine the distribution of price, quantity, and consumer and producer changes between the marketing levels (Brester, Marsh, and Atwood, 2004; Gardner, 1975; Tomek and Robinson, 1990).

6.2.2 Previous Research on Beef Industry Elasticities

Research involving demand, supply, and price determination in the beef industry has been extensive because of the importance of red meat and poultry consumption in the United States (Babula, 1996). For example, 2005 retail per capita consumption of all red meats (beef, veal, pork, and lamb) and poultry (broilers and turkey) was 221 pounds (USDA, ERS, 2006). Per capita beef consumption was 65.5 pounds in 2005, or about 39% of total meat consumption. In 1970, red meat and poultry per capita consumption was 190.5 pounds, and beef represented 84.6 pounds or 44% of total meat consumption.

The decline in per capita beef consumption has been attributed to declining beef demand since the mid-1970s (Marsh, 2003; Purcell, 1989). The demand for beef declined by almost 70% between 1976 and 1997 (Marsh, 2003). Changing consumer preferences for red meats, inconsistent product quality, relative meat prices, and lack of product innovation contributed to this decline. However, from 1998 to 2005, beef demand increased an average of 1.5% per year (LMIC, 2006). During this period, the demand for pork remained constant, lamb demand declined, and poultry demand increased (USDA, ERS, 2006).

The U.S. beef industry consists of several sectors, including cow-calf (feeder cattle) and yearling (backgrounding) production, cattle finishing, meat packing and processing, and wholesaling and retailing. Cow-calf producers supply feeder cattle to the cattle finishing sector and, thus, represent the primary supply for the beef industry. Research related to this sector has included estimated cyclical feeder cattle production (Foster and Burt, 1992; Jarvis, 1974; Marsh, 1999, 2003; Nerlove, Fornari, and Tanizaki, 1992; Rosen, Murphy, and Scheinkman, 1994; Rucker, Burt, and LaFrance, 1984). Supply responses have generally been related to changes in input and output price expectations and the dynamics of biological factors involved in herd expansion and contraction. Feeder cattle supply response also involves imports from Mexico and Canada, which represent 2% to 4% of total U.S. feeder cattle supplies (Cockerham, 1995; Marsh, 2001; Peel, 1996). Feedlots provide the derived demand for feeder cattle at this level. This demand is conditional on slaughter cattle prices, feed costs, and technological change (Anderson and Trapp, 1997; Brester and Marsh, 1983; Buccola, 1980; Marsh, 2001; Shonkwiler and Hinckley, 1985).

At the slaughter level, meat packers represent the derived demand for slaughter cattle and feedlots represent the derived slaughter cattle supply. These responses have been analyzed extensively (Arzac and Wilkinson, 1979; Brester and Marsh, 1983, 2001; Freebairn and Rausser, 1975; Marsh, 1994; Hayenga and Hacklander, 1970; Nelson and Spreen, 1978; Wohlgenant, 1989). Slaughter supply generally has been estimated as a dynamic relationship with respect to slaughter cattle prices, feed costs, and technological change using various distributed lags (Marsh, 2003). Meat packer demand for slaughter steers and heifers has been estimated as a function of wholesale carcass prices, slaughter by-product values, marketing costs, and consumer income. Wohlgenant (1989) has shown that variable input proportions exist in this sector because processors have some ability to substitute between slaughter cattle and marketing inputs to produce table cuts of beef.

Relatively less econometric modeling has occurred in the wholesale level of the beef sector (Brester and Marsh, 1983; Crom, 1970; Marsh, 1988; Marsh and Brester, 1985). Meat processors produce boxed beef and represent the derived supply at this level. Derived supply has been estimated as a function of wholesale beef prices, packer carcass by-product values, marketing costs, and technological change. Retailers represent the derived demand for boxed beef at the wholesale level. Derived demand has been estimated as a function of wholesale beef prices, marketing costs, and various retail-level factors.

The retail level consists of retailers who represent derived supply and consumers who represent primary demand. A plethora of studies have estimated retail demand elasticities in the red meat industry (Braschler, 1983; Chavas, 1983; Dahlgran, 1987; Eales, 1994; Eales and Unneveher, 1988; George and King, 1971; Huang, 1993; Huang and Haidacher, 1983; Moschini and Meilke, 1984; Wohlgenant, 1985, 1989). These studies considered a variety of research issues, including the estimation of direct price, indirect price, and expenditure elasticities; testing of economic restrictions; testing for structural change; and forecasting retail meat prices and quantities. Again, retail beef demand elasticity estimates vary considerably. Little research has been conducted with the goal of estimating derived retail supply elasticities.

International trade has become an increasingly important aspect of the U.S. beef industry (Capps, Tasi, Kirby, and Williams, 1994). In 1975, U.S. cattle and beef imports (on a carcass weight basis) totaled 7.8% of total U.S. beef supplies. By 2005, the import share had increased to 15.8% (USDA, ERS, 2006). The United States imports feeder cattle from Canada and Mexico for backgrounding and finishing and slaughter cattle from Canada for processing. The United States also imports ground beef and trimmings from Australia, New Zealand, and Canada and imports boxed beef from Canada (Brester, Marsh, and Plain, 2003). Research on this sector has centered on the effects of meat import regulations and trade liberalization agreements on U.S. cattle and beef prices

(Brester, 1996; Brester, Marsh, and Smith, 1999; Cockerham, 1995; Freebairn and Rausser, 1975; Peel, 1996; Marsh, 1998).

The United States primarily exports table cut beef to the Pacific Rim (Japan and South Korea), Mexico, and Canada. Small quantities of breeding cattle are exported to Canada and Mexico, and a relatively small number of feeder cattle are exported to Canada under the Restricted Feeder Cattle Program (Young and Marsh, 1998). In 2002, U.S. beef exports totaled 2.45 billion pounds, 31% of which was exported to Japan, 26% to South Korea, 24% to Mexico, and 10% to Canada (USDA/ERS, 2004a). Beef and live exports as a percentage of U.S. beef supplies increased from less than 1% in 1975 to 9.2% in 2002. In 2005, however, exports declined to 2.5% of U.S. supplies because of the U.S. 2003 BSE case. Overall, strong increases in export demand have resulted from increased incomes in importing countries, greater demands for animal-source protein, and increased trade liberalization (Miljkovic, Marsh, and Brester, 2004). Increased foreign demand for U.S. beef has offset some of the reductions in domestic beef demand (Marsh, 1994).

Research on U.S. beef exports has focused primarily on the effects of foreign beef demand on U.S. cattle prices (Brester and Marsh, 1999; Capps, Kirby, and Williams, 1994; Gorman, Mori, and Lin, 1990; Miljkovic, Marsh, and Brester, 2002). The price elasticity of Japanese demand for U.S. beef exports was estimated as –0.215 (Miljkovic, Marsh, and Brester, 2002) and –0.210 (Capps, Kirby, and Williams, 1994). Research also has shown that U.S. beef exports and prices are sensitive to changes in foreign incomes, tariffs, and exchange rates (Miljkovic, Marsh, and Brester, 2002).

6.2.3 Conceptual Beef Model for Estimating Elasticities

This current research requires information on primary and derived demand and supply structures and related price elasticities. Thus, an econometric model of vertical demand and supply relationships in the beef farm-to-retail marketing system is required. U.S. import demand for slaughter cattle is also econometrically estimated to obtain direct and substitute elasticities.

According to Gardner (1975) and Tomek and Robinson (1990), integrating marketing-chain relationships improves the estimation accuracy of upstream and downstream demand and supply responses. For example, the derived demand elasticity for cattle at the farm level is jointly a function of the primary demand elasticity, marketing margins, factors specific to other market levels, net imports, and factors specific to the farm level such as feed costs (Marsh, 2003; Wohlgenant, 1989).

A crucial aspect of our econometric model is the estimation of primary demand and primary supply because shifts in these functions affect derived demand and supply functions. Moreover, the effects of initial conditions or shocks in the marketing sector also depend on primary-level elasticities. For example, increased costs incurred by meat packers shift derived slaughter demand and wholesale and retail supply functions. Subsequently, the distribution of these cost changes on prices and quantities at the retail and farm levels is conditional on elasticities of retail demand and farm supply (Brester, Marsh, and Atwood, 2004; Lusk and Anderson, 2004).

The microeconomic theory underlying the behavioral relations of primary consumer demand for beef and primary producer supply of beef are derived from first-order conditions of constrained utility maximization and firm profit maximization, respectively (Varian, 1992). Moreover, the derived (input) demands and derived (output) supplies in the marketing chain are a function of first-order conditions of firm profit maximization. This optimization principle can be demonstrated by considering a cattle feeding firm that purchases 700- to 800-pound feeder cattle and grain finishes them to 1,200 to 1,400 pounds for sale to meat packers. The firm's unconstrained profit function would be

$$\pi = P_B Q_B - P_f Q_f - \sum_{i=1}^{p} r_i q_i \,, \tag{6.40}$$

where π is the feeding firm's profit; P_B is the price of slaughter cattle; Q_B is liveweight quantity of slaughter cattle; P_f is price of feeder cattle; Q_f is liveweight quantity of feeder cattle purchased; and r_i and q_i are prices and quantities of other inputs such as feed, labor, medical, and other supplies in the finishing operation. Following Varian (1992), the finisher's supply function for slaughter cattle is based on solving the first-order condition of profit maximization:

$$\frac{\partial \pi\left(P_B, P_f, r_i\right)}{\partial P_B} = Q_B\left(P_B, P_f, r_i\right). \tag{6.41}$$

Eq. (6.41) indicates that the supply function of slaughter cattle depends on the output price of slaughter cattle (P_B), input price of feeder cattle (P_f), and other input costs (r_i).

Similarly, the demand function for feeder cattle is based on solving first-order conditions of profit maximization:

$$\frac{-\partial \pi\left(P_B, P_f, r_i\right)}{\partial P_f} = Q_f\left(P_f, P_B, r_i\right), \tag{6.42}$$

which indicates that the input demand function for feeder cattle depends on the input price of feeder cattle, output price of slaughter cattle, and other input costs. Because π is a convex function, the second-order derivatives of the left-hand sides of Eqs. (6.41) and (6.42) ensure a nonnegative slope of output supply and a nonpositive slope of input demand.

The optimization principle holds for any profit-maximizing (or cost-minimizing) firm in competitive marketing channels. Thus, aggregating the relevant micro-level functions of cattle feeder producers, cattle finishers, beef packers and processors, and meat retailers yields the appropriate primary and derived market-level functions. The input price vector, r_i, in Eq. (6.42) also could include marketing costs, a relevant proxy for the effects of marketing margins in vertically related agricultural demand and supply functions (Tomek and Robinson, 1990).

6.2.4 Model Specification

The structural beef model of primary-to-derived vertical relationships is an improvement over more limited specifications. For purposes of estimating elasticities, we assume that the beef market is competitive. Hence, individual sellers face infinitely elastic demands and individual buyers face infinitely elastic supplies. This assumption may be questioned because of increased meat packing and retail grocery concentration since the 1980s. However, studies have indicated meat and livestock price distortions from potential market power in these markets are relatively minor (Azzam and Anderson, 1996; Azzam and Schroeter, 1991; Brester and Marsh, 2001; Marsh and Brester, 2004; Morrison-Paul, 2001). Cross-equation parametric restrictions are not imposed because of the disaggregate nature of the vertical marketing structure.

The structural specifications of the beef model are as follows:

Retail Beef Sector

Retail beef demand:

$$Q_B^{rd} = h_1\left(P_B^{rd}, P_L^r, P_K^r, P_Y^r, Me, BE\right) \tag{6.43}$$

Domestic retail beef supply:

$$Q_B^{rs} = h_2\left(P_B^{rs}, P_B^w, L_c, P_L^r, P_K^r, P_Y^r\right) \tag{6.44}$$

Market-clearing quantity:

$$Q_B^{rd} = Q_B^{rs} = Q_L^r \tag{6.45}$$

Market-clearing price:

$$P_B^{rd} = P_B^{rs} = P_B^r \tag{6.46}$$

Wholesale Beef Sector

Wholesale beef demand:

$$Q_B^{wd} = h_3\left(P_B^{wd}, P_B^r, P_L^w, P_K^w, P_Y^w, L_c\right) \tag{6.47}$$

Wholesale beef supply:

$$Q_B^{ws} = h_4\left(P_B^{ws}, P_B^{ds}, P_{bp}, M_c, P_L^w, P_K^w\right) \tag{6.48}$$

Market-clearing quantity:

$$Q_B^{wd} = Q_B^{ws} = Q_B^w \tag{6.49}$$

Market-clearing price:

$$P_B^{wd} = P_B^{ws} = P_B^w \tag{6.50}$$

Domestic Slaughter Cattle Sector

Domestic slaughter cattle demand:

$$Q_B^{dsd} = h_5\left(P_B^{dsd}, P_B^{dw}, W_B, P_{bp}, P_K^{dsd}, K\right) \tag{6.51}$$

Domestic slaughter cattle supply:

$$Q_B^{dss} = h_6\left(P_B^{dss}, P_B^f, P_n, T_B, BE\right) \tag{6.52}$$

Market-clearing quantity:

$$Q_B^{dsd} = Q_B^{dss} = Q_B^{ds} \tag{6.53}$$

Market-clearing price:

$$P_B^{dsd} = P_B^{dss} = P_B^{ds} \tag{6.54}$$

Import Slaughter Cattle Sector

Import slaughter cattle demand:

$$Q_B^{isd} = h_7\left(P_B^{isd}, P_B^{dsd}, W_B, P_B^w, P_{bp}\right) \tag{6.55}$$

Import slaughter cattle beef supply:

$$Q_B^{iss} = h_8\left(P_B^{iss}, C_B^s, E_x\right) \tag{6.56}$$

Market-clearing quantity:

$$Q_B^{isd} = Q_B^{iss} = Q_B^{is} \tag{6.57}$$

Market-clearing price:

$$P_B^{isd} = P_B^{iss} = P_B^{is} \tag{6.58}$$

Feeder Cattle Sector

Feeder cattle demand:

$$Q_B^{fd} = h_9\left(P_B^{fd}, P_B^{dsd}, P_N, T_B\right) \tag{6.59}$$

Feeder cattle supply:

$$Q_B^{fs} = h_{10}\left(P_B^{fs}, P_{hy}, Q_{bc}\right) \tag{6.60}$$

Market-clearing quantity:

$$Q_B^{fd} = Q_B^{fs} = Q_B^f \tag{6.61}$$

Market-clearing price:

$$P_B^{fd} = P_B^{fs} = P_B^f \tag{6.62}$$

Table 6-1 provides variable definitions for the beef model. The demand and supply equations are expressed with quantities as the dependent variables. At all market-level sectors, prices and quantities are assumed to be in equilibrium within annual time periods.

Eqs. (6.43) and (6.44) represent primary retail demand and derived retail supply of beef, respectively. Retail demand per capita is a function of domestic retail beef price (P_B^{rd}); retail prices of lamb, pork, and poultry (P_L^r, P_K^r, P_Y^r); per capita meat expenditures (*Me*); and a binary variable (*BE*) representing the 2003 U.S. BSE case. Retail supply is a function of retail beef price (P_B^r); wholesale beef price (P_B^w); food labor costs (L_c); and the retail prices of lamb (P_L^r), pork (P_K^r), and poultry (P_Y^r).

Wholesale demand and supply of beef are given by Eqs. (6.47) and (6.48). Wholesale demand is a function of wholesale domestic beef price (P_B^{dw}), retail beef price (P_B^r), wholesale prices of competitive meats (P_L^w, P_K^w, P_Y^w), and food labor costs (L_c). Wholesale beef supply is a function of wholesale domestic beef price (P_B^{dw}), input price of domestic slaughter cattle (P_B^{ds}), beef by-product value (P_{bp}), food marketing cost (M_c), and wholesale prices of lamb (P_L^w) and pork (P_K^w).

Domestic beef slaughter demand and supply are given in Eqs. (6.51) and (6.52). Domestic slaughter (meat packer) demand is a function of domestic slaughter cattle price (P_B^{ds}), domestic wholesale price of beef (P_B^{dw}), wages in meat packing plants (W_B), beef by-product value (P_{bp}), and beef packer concentration (*K*). Domestic slaughter supply (by cattle feeders) is a function of domestic slaughter cattle price (P_B^{ds}), input price of feeder cattle (P_B^f), the input price of feed corn (P_n), feedlot technology (T_B), and a binary variable representing the 2003 U.S. BSE case (*BE*).

Eqs. (6.55) and (6.56) provide specifications for import demand and supply of slaughter cattle. U.S. import demand for slaughter cattle is a function of import slaughter cattle price (P_B^{isd}), domestic slaughter cattle price (P_B^{dsd}), wages in meat packing plants (W_B), price of wholesale beef (P_B^w), and beef by-product values (P_{bp}). The import supply of slaughter cattle is a function of the price of imported slaughter cattle (P_B^{is}), cost of producing imported slaughter cattle (C_B^s), and the U.S./Canadian exchange rate (E_x).

Domestic demand for feeder cattle (by cattle finishers) and the supply of feeder cattle (by cow-calf producers) is presented in Eqs. (6.59) and (6.60). The derived demand for feeder cattle is a function of feeder cattle price (P_B^f), the price of slaughter cattle (P_B^{ds}), the price of corn (P_N), and feedlot technology (T_B). The primary supply of feeder cattle is a function of the price of feeder cattle (P_B^f), the price of hay (P_{hy}), and the quantity of breeding cattle (Q_{bc}).

6.2.5 Other Model Considerations

The structural model includes a variety of economic factors, such as feed prices, prices of competitive meats, consumer expenditures on meat, meat packer concentration, input prices, food marketing costs, and exchange rates. The sample period includes several decades during which other factors may also be of potential significance. Two specific events include (1) structural change in meat demand and the meat price freeze of the early 1970s (Knutson, Penn, and Boehm, 1990; Moschini and Meilke, 1989) and (2) the 2003 Canadian and U.S. cases of BSE.

Comprehensive price and wage controls imposed by the Nixon Administration in August 1971 for 90 days included ceilings on meat prices. Immediately after the controls were lifted in November 1971, food prices, especially meat prices, increased substantially. Per capita beef consumption declined precipitously in the late 1970s. The decline was thought to be the result of a variety of factors, including real price declines of competing meats, changes in consumer income distributions, changing demographics, increased demand for convenience foods, and changing consumer preferences (Moschini and Meilke, 1989). Tests for structural changes in beef demand in the mid-1970s have generated mixed results. Moschini and Meilke (1989) found that structural change negatively affected beef, positively affected poultry, and did not affect pork demand. However, other studies either did not find structural change or were able to attribute declines in beef demand to other factors.

Initial outbreaks of BSE in Canada (May 2003) and the United States (December 2003) are potentially important market events in that demand and price expectations of consumers and producers may have been altered. Therefore, a BSE binary variable is included in the primary retail demand and derived slaughter supply of fed cattle.

To formally test for impacts of the meat price freeze and structural change in beef demand, binary variables for 1971, 1972, and 1975 through 2005 were included in the retail beef demand equation. The regression results failed to reject the null hypotheses of no influence of either market shock at the $\alpha = 0.05$ level.

A binary variable for 2003 through 2005 was included in the primary retail demand and derived slaughter supply equations in the final specification to account for BSE occurrences.

6.2.6 Model Dynamics

Conceptually, the U.S. beef model represents a set of economically integrated demand and supply relations in the farm–retail marketing chain. The static form of the model can be represented in general matrix notion as

$$\beta Y_t + \Gamma Z_t = \mu_t \,, \tag{6.63}$$

where Y_t is a Gx1 vector of endogenous variables, Z_t is a Kx1 vector of exogenous variables, μ_t is a Gx1 vector of disturbance terms, β is a GxG matrix of coefficients for the Y_t vector, and Γ is a GxK matrix of coefficients for the Z_t vector. The model assumes nonzero, off-diagonal terms for the β matrix, rank identification of the Γ matrix, and a nondiagonal covariance matrix for μ_t, or contemporaneously correlated errors (Johnston and DiNardo, 1997). The μ_ts within each equation are assumed to be normally distributed with zero mean and constant variance; however, their time-series properties may be autoregressive (Greene, 2003).

Because of the nonzero, off-diagonal terms of the β matrix, testing for equation cointegration is not necessary (Johnston and DiNardo, 1997). Thus, the model is estimated in data-level form by three-stage least squares (3SLS). The estimator yields consistent and asymptotically efficient coefficient distributions (Greene, 2003).

The presence of biological lags, technical production constraints production, and buyer and seller expectations likely generate dynamic responses in livestock and meat supply and demand behavior (Brester and Marsh, 1983; Marsh, 2003; Rucker, Burt, and LaFrance, 1984; Tomek and Robinson, 1990; Whipple and Menkhaus, Whipple, and Ward, 1989). Thus, Eq. (6.83) is modified to account for partial adjustment processes in the behavioral relations through autoregressive distributed lags (ARDL) or ARMAX models (i.e., ARDL with autocorrelated errors) (Greene, 2003; Marsh, 2003). In this context, the model can be rewritten as

$$\beta(L)Y_t + \Gamma(L)Z_t = \mu_t \,, \tag{6.64}$$

where $\beta(L)$ and $\Gamma(L)$ are polynomial lag operators that impose finite lag structures on the endogenous (Y_t) and exogenous (Z_t) vectors. The lag operators are given as

$$\beta(L) = 1 - \beta_1 L - \beta_2 L^2 - \beta_3 L^3 \ldots \beta_p L^p \tag{6.65}$$

and

$$\Gamma(L) = \Gamma_0 + \Gamma_1 L + \Gamma_2 L^2 + \Gamma_3 L^3 \ldots \Gamma_q L^q . \tag{6.66}$$

Thus, the polynomial form $\beta(L)Y_t$ of Eq. (6.65) gives $L^p Y_t = Y_{t-p}$, and the polynomial form $\Gamma(L)Z_t$ of Eq. (6.66) gives $L^q Z_t = Z_{t-q}$. Solving for the Y_T vector of Eq. (6.64) gives

$$Y_t = \frac{\Gamma(L)}{\beta(L)} Z_t + \frac{1}{\beta(L)} \mu_t , \tag{6.67}$$

which conceptually gives Y_t as an infinite distributed lag function of Z_t and μ_t (Greene, 2003). The implied set of polynomial coefficient weights for Z_t are formed by the rational generating function, $\Gamma(L) / \beta(L)$. The infinite moving average (MA) error structure for μ_t is restricted by the polynomial weights of $\beta(L)$. The rational generating function allows for short-run flexibility in the distributed lag patterns of the exogenous variables. However, the long-run behavior of each Z variable is conditioned by $\beta(L)$ (Greene, 2003).

Pragmatically, for annual models, empirical lags on the dependent variables (p in Eq. [6.65]) and the independent variables (q in Eq. [6.66]) for livestock and meat are usually of order 1 or 2 (Marsh, 2003). Several researchers have examined the cyclical nature of beef cattle inventories (Rosen, Murphy, and Scheinkman, 1994; Rucker, Burt, and LaFrance, 1984). Because of cattle inventory cycles on the supply side of the beef market, p is initially specified in the polynomial denominator as order 2 (permitting complex roots or cycling), and q is initially specified as order 1 in the polynomial numerator. For the demand side of the market, p and q of the polynomials are initially set at lag order 1. Setting q to an order of 1 implies geometric distributed lags in demand behavior.

The number of parameters for empirical estimation is relatively large using the initial lag order specifications. To achieve a more parsimonious set of parameters and improve estimation efficiency, higher order lags are truncated if they are found to be statistically insignificant. However, for any given variable, if contemporaneous and lag values are all found to be insignificant, the parameter value with the largest t-statistic is retained in the model to maintain theoretical consistency.

6.3 DATA CONSIDERATIONS

The sample period consists of annual data for the years 1970 through 2005. Cattle and beef price and quantity data, beef by-products, food marketing and labor costs, meat packer wages, substitute meat prices, corn and hay prices, and trade data were obtained from various USDA sources, including *Agricultural Statistics*; *Livestock, Dairy and Poultry Situation and Outlook* reports; *Red Meats Yearbook*; *Dairy, Livestock, and Poultry: U.S. Trade and Prospects*; and the American Sheep Industry Association. Other data were obtained from the *Economic Report of the President*, international financial statistics of the International Monetary Fund (various issues), and USDA, GIPSA (2006). Complete data series were available for most variables included in the model, with the exception of retail lamb prices and wholesale lamb cut-out values. Missing observations for these series were imputed as described in Volume 5, Section 6.

6.4 STATISTICAL AND ESTIMATION PROCEDURE CONSIDERATIONS

We assume that beef price is jointly determined with beef quantity in the retail beef demand function (Eales and Unneveher, 1993). Therefore, unit root and cointegration tests are not conducted because nonstationarity would not alter estimation procedures or inferences if data are simultaneously determined (Johnston and DiNardo, 1997). In addition, the model is estimated in data-level form, with all variables (except the binary variables) transformed into natural logarithms.

Specification of group expenditures (rather than consumer income or total expenditures) in conditional demand systems (i.e., weakly separable) is a common procedure in applied demand models (LaFrance, 1991). However, group expenditures must be uncorrelated with error terms to avoid biased and inconsistent parameter estimates. Therefore, the current model uses total consumer meat expenditures (i.e., expenditures on beef, pork, lamb, broilers, and turkey) as an income variable in the retail beef demand function. A Wu-

Hausman test failed to reject the null hypothesis of no simultaneous equation bias at the $\alpha = 0.05$ level.

Based on the beef model assumptions and statistical tests, the Eviews 5.1 3SLS estimator was used because of the potential for a nondiagonal covariance matrix of autoregressive (AR) errors (Quantitative Micro Software, 2004). Because the model is specified with equilibrium quantities as dependent variables, the demand and supply equations are estimated in separate blocks to reduce demand and supply identification problems.

In applied agricultural economics research, demand and supply equations often are econometrically estimated using a combination of inverse and ordinary demand and supply functions to aid in identifying each equation (Eales and Unneveher, 1993; Eales, 1996; Marsh, 2003; Babula, 1997). However, the equilibrium displacement model for beef is specified such that estimates of elasticities (rather than flexibilities) of demand and supply are required. Theoretically, the inverses of price flexibilities obtained from inverse demand and/or supply functions provide lower-bound estimates for elasticities. Empirically, these inverses often generate unreasonably large and inconsistent elasticity estimates. We investigated this issue by estimating the beef demand functions as price-dependent relations in conjunction with ordinary supply functions. This approach yielded several inconsistencies among elasticity estimates across the model. Therefore, we ameliorated the identification issues by estimating ordinary demand functions and ordinary supply functions in separate regression blocks.

The rational distributed lag model also could be estimated using quarterly data. However, many observations on some of the key variables were not reported on a quarterly basis.

Finally, BSE events in Canada and the United States resulted in trade restrictions in 2003, 2004, and 2005 between the two countries. Hence, we could not estimate the U.S. import demand for Canadian slaughter cattle along with the other demand functions. Therefore, the function was estimated separately, and the results are reported in the following section.

6.5 EMPIRICAL RESULTS

The demand and supply functions of the beef model were estimated in separate blocks using 3SLS to avoid identification problems. The domestic demand and supply elasticities and the imported fed cattle demand elasticities are econometrically estimated. The imported slaughter supply elasticities are assumed to be highly elastic and arbitrarily set to 10.0.

In general, the empirical results support the rational lag hypotheses because each equation contains a significant parameter estimate of a first-order lagged dependent variable, or geometric (Koyck) distributed lags (Pindyck and Rubinfeld, 1998). The modulus of the single root in each difference equation is less than unity, implying stable dynamic structures. Based on Durbin h tests, the demand and supply equations did not require AR error corrections in the 3SLS estimator.

The 3SLS blocks indicated contemporaneously correlated errors, with zero-order correlations as high as 0.81 within the demand block and as high as 0.73 within the supply block. The systems estimator also provided the standard errors and covariances of the parameter (elasticity) estimates required for the equilibrium displacement model (Brester, Marsh, and Atwood, 2004). The adjusted R^2s and standard errors of 3SLS regression are presented but should be interpreted with caution because of the generalized least squares (GLS) error covariance transformations of the product moment matrices (Greene, 2003).

Estimating theoretically specified supply and demand models is necessary to obtain consistent and efficient estimates of the elasticities needed to implement the equilibrium displacement model. Many of the estimated elasticities, however, are not directly used in the equilibrium displacement model.

6.5.1 Demand

A 3SLS estimator is used to obtain consistent and efficient elasticity estimates for use in the equilibrium displacement model. All of the estimates of interest (own-price and cross-price elasticities) are significantly different from zero at the $\alpha = 0.05$ level.[2] The price elasticities follow two patterns that are consistent with stable difference equations and marketing

[2] Some of the parameter estimates (elasticities) in the demand block were not statistically different from zero at the $\alpha = 0.05$ level.

margin behavior (Griliches, 1967; Tomek and Robinson, 1990). First, the short-run elasticities are considerably smaller than the long-run elasticities. This suggests that consumers and intermediate purchasers are influenced by habit formations and institutional rigidities (Pollack, 1970). These expectations are manifest in partial adjustment processes, as evidenced by significant coefficient estimates on the lagged dependent variables. Second, the absolute value of demand elasticity coefficients decreases from the retail level to the farm level. This is consistent with relative price spreads and primary and derived demand theory (Gardner, 1975; Tomek and Robinson, 1990; Wohlgenant, 1989).

Table 6-2 summarizes the demand elasticity estimates obtained from the 3SLS estimates presented in Tables 6-3 through 6-5. The long-run elasticities are calculated by dividing the short-run elasticities by 1.0 minus the estimated coefficients of the appropriate lagged dependent variables. The short-run and long-run retail demand elasticities for beef are –0.864 and –1.793, respectively. Previous studies have reported various own-price retail beef demand elasticity estimates. For example, Alston and Chalfant (1991) reported several elasticity estimates ranging from –0.66 to –1.04 using annual data from 1960 through 1988. Eales and Unneveher (1988) estimated a beef demand elasticity of –0.57 and a retail demand elasticity for table cuts of –0.684 using annual data from 1965 through 1985. Moschini and Meilke (1989) reported a pre-structural change elasticity of –0.983 and a post-structural change estimate of –1.050. Brester and Schroeder (1995) reported a retail own-price elasticity of demand of –0.56.

The short- and long-run beef demand elasticities at the wholesale level were –0.584 and –0.936, respectively. Both were more inelastic than the retail demand elasticities, which is consistent with Gardner’s (1975) relative price spread theory. Marsh (1992) reported wholesale elasticities consistent with margin theory that ranged from –0.469 to –0.567 using quarterly data. Marsh and Brester (1985) reported a long-run beef wholesale own-price demand elasticity of –0.990 using monthly data from 1970 through 1981.

Table 6-3. 3SLS (Double Log) Estimates of Domestic Retail Beef Demand

Regressors	Dependent Variable: Domestic Retail Beef Demand $\left(Q_B^{dr}\right)$
Constant	–1.131 (–3.211)
Domestic retail beef price $\left(P_B^{dr}\right)$	–0.864 (–7.762)
Retail lamb price $\left(P_L^{r}\right)$	0.006 (1.181)
Retail pork price $\left(P_K^{r}\right)$	–0.112 (–1.895)
Retail poultry price $\left(P_Y^{r}\right)$	–0.103 (–1.575)
Meat expenditures $\left(M_e\right)$	1.195 (5.075)
Lagged meat expenditures $\left(M_{et-1}\right)$	0.337 (3.914)
BSE binary variable $\left(BE\right)$	–0.002 (–0.100)
Lagged domestic retail beef demand $\left(Q_{Bt-1}^{dr}\right)$	0.518 (7.692)
Regression statistics	
Adjusted R^2	0.959
Standard error of the regression	0.022
Log mean of the dependent variable	4.305

At the domestic slaughter level, the short- and long-run derived demand elasticities were both inelastic. For fed slaughter cattle, the elasticities were –0.401 and –0.529. Wohlgenant (1989) reported a slaughter-level demand elasticity of –0.50, under the assumption of fixed input proportions, and –0.76, assuming variable input proportions technology using annual data from 1956 through 1983. Marsh (1992) reported an own-price elasticity of demand for slaughter cattle ranging from –0.506 through –0.657 using 1975 through 1989 annual data. Brester and Marsh (1983) report an elasticity of –0.348 using 1960 to 1980 annual data.

Table 6-4. 3SLS (Double Log) Estimates of Wholesale Beef Demand

Regressors	Dependent Variable: Wholesale Beef Demand $\left(Q_B^{dw}\right)$
Constant	1.446 (1.716)
Domestic wholesale beef price $\left(P_B^{dw}\right)$	–0.584 (–5.586)
Domestic retail beef price $\left(P_B^{dr}\right)$	0.384 (2.484)
Wholesale lamb price $\left(P_L^{w}\right)$	0.057 (1.078)
Wholesale pork price $\left(P_K^{w}\right)$	0.014 (0.429)
Wholesale poultry price $\left(P_Y^{w}\right)$	0.070 (1.235)
Food labor costs $\left(M_c\right)$	–0.003 (–0.024)
Lagged domestic wholesale beef demand $\left(Q_{Bt-1}^{dw}\right)$	0.376 (2.797)
Regression statistics	
Adjusted R^2	0.691
Standard error of the regression	0.036
Log mean of the dependent variable	3.170

Because of data limitations, the U.S. demand for imported slaughter cattle was estimated separately from the system of demand equations. Annual data from 1970 through 2002 were used. The ADF test failed to reject the null hypothesis of unit roots in all variables at the α = 0.05 level. However, the augmented ADF test indicated that the function was cointegrated at the α = 0.05 level. A Hausman test failed to reject the null hypothesis of no simultaneous equation bias for both U.S. and Canadian slaughter cattle prices at the α = 0.05 level. Because of the high correlation between these two prices (correlation coefficient of 0.89), the price of U.S. feeder cattle was used as an instrument for the price of U.S. slaughter cattle. The Breusch-Godfrey LM test failed to reject the null hypothesis of no first- or second-order serial correlation in the residuals. The CUSUM test for parameter stability failed to

Table 6-5. 3SLS (Double Log) Estimates of Domestic Slaughter and Feeder Cattle Demand, and OSL (Double Log) Estimates of Import Slaughter Cattle Demand

Regressors	Dependent Variables		
	Domestic Slaughter Cattle Demand $\left(Q_B^{ds}\right)$	Imported Slaughter Cattle Demand $\left(Q_B^{is}\right)$	Feeder Cattle Demand $\left(Q_B^{df}\right)$
Constant	4.222 (7.896)	1.298 (0.731)	–2.607 (–2.289)
Domestic slaughter cattle price $\left(P_B^{ds}\right)$	–0.401 (–2.670)	1.196 (2.114)	0.238 (3.591)
Wholesale beef price $\left(P_{Bt-1}^{dw}\right)$	0.053 (0.368)	1.423 (1.678)	
Meat packer wages (W)	0.045 (0.523)	–1.139 (–1.624)	
Beef by-product price (P_{bp})	0.040 (1.260)		
Beef packer concentration (K)	–0.086 (–1.708)		
Price slaughter hog $\left(P_K^{ds}\right)$	0.030 (1.339)		
Lagged domestic slaughter beef demand $\left(P_{Bt-1}^{ds}\right)$	0.242 (3.383)		
Imported slaughter cattle price $\left(P_B^{is}\right)$		–3.212 (–3.110)	
Lagged imported slaughter cattle demand $\left(Q_{Bt-1}^{is}\right)$		0.469 (3.198)	
Domestic feeder cattle price $\left(P_B^{df}\right)$			–0.135 (–3.015)
Price of corn $\left(P_n\right)$			0.002 (0.106)
Technology $\left(T_f\right)$			0.420 (2.992)
Lagged domestic feeder cattle demand $\left(Q_{Bt-1}^{df}\right)$			0.821 (8.626)
Regression statistics			
Adjusted R^2	0.852	0.837	0.945
Standard Error of the Regression	0.024	0.296	0.021
Log Mean of the Dependent Variable	3.695	–0.410	3.261

reject the null hypothesis of stable parameters. Table 6-2 indicates that the short-run own-price derived demand elasticity for imported slaughter cattle is –3.212. The long-run elasticity was calculated to be –6.049 (Table 6-2). The short-run, cross-price elasticity of demand for imported Canadian slaughter cattle with respect to the price of U.S. slaughter cattle is 1.196, and the long-run estimate is 2.252 (Table 6-2). These elastic demand responses indicate that Canadian slaughter cattle are close substitutes for U.S. slaughter cattle.

The derived demand for feeder cattle represents the major input demanded by cattle finishers. The estimated short- and long-run demand elasticities at this level are relatively inelastic (–0.135 in the short run and –0.754 in the long run). Brester and Marsh (1983) reported an own-price elasticity of demand for cattle placements of –0.622 using annual data from 1960 through 1980. Shonkwiler and Hinckley (1985) used a rational expectations model to estimate a cattle placement demand elasticity of –0.909. Marsh (2001) used a reduced-form model to obtain an estimate of the own-price elasticity of demand for feeder cattle of –0.644 using 1970 through 1999 annual data.

6.5.2 Demand Quantity Transmission Elasticities

Estimates of quantity transmission elasticities are used in the equilibrium displacement model to provide linkage between the vertically connected demand sectors. These estimates are obtained from the SUR estimation of four equations separate from the structural model. The transmissions elasticity estimates are summarized in Table 6-6. Table 6-7 provides the complete SUR estimation results of regressing the appropriate quantity variable at each level onto the appropriate upstream quantity variable. Double log specifications are used so that resulting parameter estimates are interpreted as transmission elasticities.

6.5.3 Supply

The supply block of the 3SLS beef model consists of equations for feeder cattle, slaughter cattle, wholesale beef, and retail beef (Tables 6-8 through 6-10). Several of the slope coefficients were not statistically different from zero. However, all own-price supply elasticities are significant at the $\alpha = 0.05$ level. The rational lag structure was stable in that the modulus of each of the single roots of the difference equation coefficient estimates was less than unity. The dynamics resulted in

Table 6-6. Parameter Definitions and Quantity Transmission Elasticity Estimates

Parameter	Definition	Estimate[a]	Standard Deviation[a]
τ_d^{wr}	Percentage change in wholesale beef quantity given a 1% change in retail beef quantity	0.978	0.097
τ_d^{sw}	Percentage change in domestic and imported slaughter cattle quantity given a 1% change in wholesale beef quantity	0.936	0.043
τ_d^{fs}	Percentage change in feeder cattle quantity given a 1% change in domestic slaughter cattle quantity	0.834	0.084
τ_s^{rw}	Percentage change in retail beef quantity given a 1% change in wholesale beef quantity	0.715	0.081
τ_s^{ws}	Percentage change in wholesale beef quantity given a 1% change in domestic and imported slaughter cattle quantity	0.929	0.053
τ_s^{sf}	Percentage change in domestic slaughter cattle quantity given a 1% change in feeder cattle quantity	0.944	0.031

[a] These estimates are obtained from the structural model that is presented later in the report.

Table 6-7. SUR (Double Log) Demand Quantity Transmission Elasticities

Regressors	Dependent Variables		
	Wholesale Beef Quantity $\left(Q_B^{dw}\right)$	Domestic Slaughter Cattle Quantity $\left(Q_B^{ds}\right)$	Feeder Cattle Quantity $\left(Q_B^{df}\right)$
Constant	–1.918 (–3.791)	0.728 (5.361)	1.502 (2.763)
Domestic retail beef quantity $\left(Q_B^{dr}\right)$	0.978 (10.110)		
Imported live cattle quantity $\left(Q_B^{ir}\right)$			
Domestic wholesale beef quantity $\left(Q_B^{dw}\right)$		0.936 (21.871)	
Domestic slaughter beef quantity $\left(Q_B^{ds}\right)$			0.834 (9.973)
Regression statistics			
Adjusted R^2	0.864	0.955	0.984
Standard error of the regression	0.024	0.014	0.008
Log mean of the dependent variable	3.170	3.695	3.261

Note: Quantity transmission equations corrected for first-order autocorrelation in residuals.

Table 6-8. 3SLS (Double Log) Estimates of Feeder Cattle Supply

Regressors	Dependent Variable Feeder Cattle Supply $\left(Q_B^{df}\right)$
Constant	0.005 (0.041)
Breeding cow inventory $\left(Q_{bc}\right)$	0.350 (3.347)
Lagged domestic feeder calf price $\left(Q_{Bt-1}^{df}\right)$	0.103 (7.786)
Lagged hay price $\left(P_{hy\,t-1}\right)$	–0.068 (–3.296)
Lagged domestic feeder cattle supply $\left(Q_{bt-1}^{f}\right)$	0.570 (4.643)
Regression statistics	
Adjusted R^2	0.970
Standard error of the regression	0.016
Log mean of the dependent variable	3.261

Table 6-9. 3SLS (Double Log) Estimates of Domestic Slaughter Cattle Supply

Regressors	Dependent Variable Domestic Slaughter Cattle Supply $\left(Q_B^{ds}\right)$
Constant	–0.552 (–0.506)
Lagged domestic slaughter cattle price $\left(P_{Bt-1}^{ds}\right)$	0.133 (2.818)
Domestic feeder calf price $\left(P_B^{df}\right)$	–0.161 (–5.711)
Lagged corn price $\left(P_{n\,t-1}\right)$	–0.001 (–0.046)
Feedlot technology $\left(T_B\right)$	0.253 (1.677)
Lagged domestic slaughter cattle supply $\left(Q_{Bt-1}^{ds}\right)$	0.732 (8.424)
Regression statistics	
Adjusted R^2	0.829
Standard error of the regression	0.026
Log mean of the dependent variable	3.695

Table 6-10. 3SLS (Double Log) Estimates of Wholesale and Retail Beef Supply

	Dependent Variables	
Regressors	**Wholesale Beef Supply** $\left(Q_B^{dw}\right)$	**Retail Beef Supply** $\left(Q_B^{dr}\right)$
Constant	2.534 (5.514)	–0.605 (–1.504)
Domestic wholesale beef price $\left(P_B^{dw}\right)$	0.424 (3.214)	–2.248 (–5.090)
Domestic slaughter cattle price $\left(P_B^{ds}\right)$	–0.667 (–4.276)	
Beef by-product price $\left(P_{bp}\right)$	0.026 (0.768)	
Food marketing costs $\left(M_c\right)$	0.007 (0.107)	
Lagged domestic wholesale beef supply $\left(Q_{Rt-1}^{dw}\right)$	0.282 (3.373)	
Wholesale pork price $\left(P_K^{dw}\right)$	0.039 (2.165)	
Wholesale lamb price $\left(P_L^{dw}\right)$	0.054 (1.842)	
Lagged domestic retail beef price $\left(P_{Bt-1}^{dr}\right)$		0.349 (5.162)
Food labor cost $\left(L_c\right)$		–0.014 (–0.108)
Retail pork price $\left(P_K^{dr}\right)$		0.034 (0.612)
Retail poultry price $\left(P_Y^{dr}\right)$		0.092 (1.604)
Retail lamb price $\left(P_L^{dr}\right)$		0.009 (1.856)
Lagged domestic retail beef supply $\left(Q_{w\,t-1}^{dw}\right)$		0.839 (7.510)
Regression statistics		
Adjusted R^2	0.879	0.940
Standard error of the regression	0.023	0.027
Log mean of the dependent variable	3.170	4.305

substantial differences between short-run and long-run supply elasticities. For livestock production, biological rigidities are generally manifest in relatively inelastic short-run supply responses. However, in the long run, relaxed biological constraints and near constant-returns-to-scale technologies cause relatively large supply responses (Marsh, 2003; Wohlgenant, 1989).

The primary supply of beef is represented by the calf crop equation (6.80). Breeding cow inventories are included in the specification and represent the production base for producing calves. The short-run and long-run calf crop inventory elasticities are 0.103 and 0.240 (0.103 / [1 – 0.570]), respectively (Table 6-8). Estimates of the long-run supply price elasticities of breeding inventories have generally exceeded unity (Foster and Burt, 1992; Marsh, 1999; Rucker, Burt, and LaFrance, 1984). However, Buhr and Kim (1997) used quarterly data from 1970 through 1990 and estimated short-run and long-run own-price elasticities of supply for calf crops as 0.05 and 0.46. The relatively small long-run elasticity estimates are caused by the inclusion of breeding cow inventories in the econometric specification. Breeding cow inventories account for long-run cyclical behavior (Rosen, Murphy, and Scheinkman, 1994; Rucker, Burt, and LaFrance, 1984).

The domestic supply of slaughter cattle is positively affected by slaughter cattle price, with short-run and long-run own-price supply elasticities of 0.133 and 0.496 (0.133 / [1 – 0.732]), respectively (Table 6-9). Marsh (2003) estimated short-run and long-run supply elasticities for slaughter cattle of 0.264 and 0.593, respectively, using annual data from 1970 through 1990.

The own-price elasticity of supply for imported slaughter cattle was assumed to equal 10.0 in the short run and long run. That is, we assume that the Canadian cattle industry is able to supply the U.S. packing industry with additional cattle without requiring increases in price. This assumption is consistent with historical Canadian supply relationships with respect to the U.S. beef industry.

The domestic wholesale supply of beef (carcass weight) is derived from primary feeder cattle production and slaughter cattle dressed weights. The behavioral relationship indicates that beef packers positively respond to wholesale price changes and negatively respond to changes in the input price of slaughter cattle (Table 6-10). The coefficient for food labor costs was not statistically significant. The short-run and long-run own-price elasticities of wholesale beef supply are 0.424 and 0.591 (0.424 / [1 – 0.282]), respectively. Bedinger and Bobst (1988) estimated the long-run own-price elasticity of supply for wholesale beef as 0.200 using quarterly data from 1965 through 1983.

The retail beef supply elasticities are positive with respect to retail price and negative with respect to boxed beef price (Table 6-10). The short-run and long-run retail beef own-price elasticities of supply are 0.349 and 2.154 (0.349 / [1 – 0.839]). The relatively elastic long-run supply elasticity is consistent with Wohlgenant's (1989) argument that retail meat supply is a function of constant returns to scale production technologies. The cross-price elasticity of retail supply with respect to boxed beef price was –0.248 in the short run and –1.540 (–0.248 / [1 – 0.839]) in the long run.

6.5.4 Supply Quantity Transmission Elasticities

Estimates of quantity transmission elasticities are used in the equilibrium displacement model to provide a linkage between the vertically connected supply sectors. These estimates were obtained from the SUR estimation of four equations separate from the structural model. The supply quantity transmission elasticities are summarized in Table 6-6. Table 6-11 provides the complete SUR results of regressing the appropriate quantity variable at each level onto the appropriate downstream quantity variable. Double log specifications are used so that resulting parameter estimates are interpreted as transmission elasticities.

6.5.5 Elasticity Summary

3SLS estimation of annual rational distributed lag demand and supply equations in the beef marketing channel yielded statistically significant price elasticity estimates consistent with a priori expectations. That is, coefficient signs were consistent with theoretical constructs, and long-run elasticities were more elastic than short-run elasticities because technical, biological, and institutional constraints are less restrictive over time. Some of the market-level elasticities were comparable with other beef studies. For some of the beef and cattle data series, missing observations were imputed from observed data.

Table 6-11. SUR (Double Log) Supply Quantity Transmission Elasticities

Regressors	Dependent Variables		
	Retail Beef Quantity $\left(Q_B^{dr}\right)$	Wholesale Beef Quantity $\left(Q_B^{dw}\right)$	Domestic Slaughter Cattle Quantity $\left(Q_B^{ds}\right)$
Constant	2.944 (11.351)	–0.260 (–1.324)	–0.033 (–0.154)
Domestic wholesale beef quantity $\left(Q_B^{dw}\right)$	0.715 (8.860)		
Imported live beef quantity $\left(Q_B^{iw}\right)$			
Domestic slaughter beef quantity $\left(Q_B^{ds}\right)$		0.929 (17.504)	
Domestic feeder beef quantity $\left(Q_B^{df}\right)$			0.944 (30.837)
Regression statistics			
Adjusted R^2	0.836	0.959	0.987
Standard error of the regression	0.021	0.013	0.007
Log mean of the dependent variable	5.207	3.170	3.695

Note: Quantity transmission equations corrected for first-order serial correlation in residuals.

The estimated model also yielded price elasticities among vertical sectors that conform to relative price spreads and primary and derived demand and supply expectations. That is, whether agricultural markets are characterized by fixed or variable input proportions, margin theory would indicate smaller demand elasticities proceeding from primary demand to derived demands and larger supply elasticities proceeding from primary supply to derived supplies (Gardner, 1975; Wohlgenant, 1989). The consistency of these results lends credibility to the market-level measurements in the equilibrium displacement model (Brester, Marsh, and Atwood, 2004).

6.6 OLIGOPSONY MARKDOWN PRICING

Eqs. (6.20) and (6.23) in the equilibrium displacement model indicate that oligopsony power in the domestic wholesale processing sector may drive a price wedge between the derived demand and derived supply prices of domestic slaughter cattle and imported slaughter cattle. The parameter ρ represents the ratio P_B^{dsd} / P_B^{dss} and P_B^{isd} / P_B^{iss}. Thus, in the absence of oligopsony markdown power, the value of ρ equals 1 as $P_B^{dsd} = P_B^{dss}$ and $P_B^{isd} = P_B^{iss}$. The value of ρ increases as oligopsony power increases. As illustrated in Figure 6-4, increases in market power would cause a larger price wedge between P_B^{dsd} and P_B^{dss} and a reduction in quantity from the perfectly competitive market equilibrium. A similar result occurs for import slaughter cattle.

6.6.1 Estimates of Oligopsony Markdown Price Distortions

Published estimates of the degree of oligopsony markdown power are available for the beef industry and are used in the equilibrium displacement model. Schroeter (1988) extended Appelbaum's (1979, 1982) model for estimating monopoly market power to the problem of estimating monopsony price distortions in the slaughter cattle market. Using annual data from 1951 to 1983, Schroeter reported markdown price distortions ranging from 0.009% to 0.025% depending on the year. The average price distortion for the reported years was 0.013. This corresponds to an estimate of ρ of 1.013.

Azzam and Schroeter (1991) considered the degree of oligopsony price distortions across 13 regional slaughter cattle markets in 1986. Their estimate of markdown price distortions was less than 1%. This was a lower estimate of price distortions than the 1.2% to 2.5% estimates reported by earlier research (Menkaus, St. Clair, and Ahmaddaud, 1981; Quail et al., 1986; Ward, 1981). Koontz, Garcia, and Hudson (1993) used data from 1980 to 1986 and estimated slaughter cattle price distortions of 0.5% to 0.8% in a dynamic model of two-phase collusive pricing strategies. Muth and Wohlgenant's (1999) estimate of oligopsony markdown price behavior was not statistically different from zero using a variety of functional forms for the beef industry. Using quarterly data from 1978 to 1993, Weliwita and Azzam (1996) estimated oligopsony price distortions of 2.7% for fed cattle markets during a time of declining beef demand. Stiegert, Azzam, and Brorsen (1993) reported monopsony markdown pricing estimates ranging from 0.0% to 3.8% depending on the year considered. The average of their annual estimates was 1.31%.

6.6.2 Effects of Oligopsony Markdowns

The above estimates of oligopsony markdown price distortions in slaughter cattle prices range from 0.0% to 3.8%. This translates into an estimate of ρ that ranges from 1.000 to 1.038. Because the estimates vary and we want to include the most extreme estimates, the equilibrium displacement model will treat ρ as a random variable that ranges between 1.000 and 1.050 with most of the mass centered over 1.015 (the mean) for the domestic and imported slaughter cattle sector.

We assume that the data used in the model have been generated by a beef processing industry that has been able to exercise small amounts of oligopsony pricing power in the slaughter cattle industry. Therefore, although a restriction on the amount of a given AMA is likely to increase processing costs, it could also have an offsetting effect of reducing market power.

To illustrate this case, we use the elasticity estimates presented above to parameterize the equilibrium displacement model. Note that this is merely a simplified illustration. Simulations of the effects of potential changes in AMAs are presented in Section 6.10. For the current illustration, assume that a reduction in an AMA increases processing costs by 5%. We further assume that ρ is equal to 1.015. The short-run (Year 1) changes in equilibrium prices and quantities from a nonstochastic simulation are presented in the first column of Table 6-12. Prices and quantities change in the expected directions. For example, retail beef price increases by 2.81%, while retail beef quantity declines by 2.43%. Wholesale beef price increases and wholesale beef quantity declines. Domestic and imported slaughter cattle prices and quantities decline, as does feeder cattle price and quantity.

The second column of Table 6-12 presents changes in equilibrium prices and quantities caused by a 5% increase in processing costs coupled with a 0.005 percentage point reduction in market power (i.e., a reduction in ρ from 1.015 to 1.010). The accompanying reduction in market power offsets some of the effects of the cost increases. Note that price and quantity changes are slightly smaller in this second case. The only exception is that domestic and imported slaughter cattle demand price declines are larger than those presented in the first column. This is consistent with a reduction in market power.

Table 6-12. Short-Run Percentage Changes in Prices and Quantities Given a 5% Increase in Wholesale Processing Costs (a Decrease in the Wholesale Derived Beef Supply Function) and a 0.005 Percentage Point Reduction in Potential Oligopsony Market Power Using a Nonstochastic Simulation

Endogenous Variables	No Change in Potential Market Power	A Reduction in Potential Market Power
Retail beef price	2.81%	2.75%
Retail beef quantity	–2.43%	–2.38%
Wholesale beef price	4.10%	4.01%
Wholesale beef quantity	–4.77%	–4.67%
Domestic slaughter cattle demand price	–7.15%	–7.17%
Domestic slaughter cattle supply price	–7.25%	–6.77%
Domestic slaughter cattle quantity	–1.46%	–1.37%
Imported slaughter cattle demand price	–0.66%	–0.99%
Imported slaughter cattle supply price	–0.67%	–0.51%
Imported slaughter cattle quantity	–6.71%	–5.07%
Feeder cattle price	–5.13%	–4.79%
Feeder cattle quantity	–0.53%	–0.49%

6.7 QUALITY CHANGES CAUSED BY CHANGES IN PROCUREMENT METHODS

Restrictions on slaughter cattle procurement methods may potentially affect the quality of beef. Changes in AMAs may influence genetic development, cattle feeding, nutrition, logistics, and price incentives related to quality. Changes in beef quality are manifest in consumer demand. If beef quality is reduced, then consumer demand for beef will decline relative to other meat (i.e., pork, poultry, and lamb) substitutes. Such a decline is then transferred to upstream derived demands for wholesale beef, slaughter cattle, and feeder cattle. Although no direct measure of beef quality is available at the retail level, MPR data provide carcass quality measures. Therefore, the impacts of changes in AMAs on carcass quality grades are used to proxy changes in beef quality at the retail level.

Eq. (4.6) in Section 4.3.2 presented the estimates of the effects of AMAs on beef carcass quality, and Eq. (4.12) in Section 4.4.2 presented estimates of changes in beef carcass quality on retail demand price. The results indicated that the procurement of slaughter cattle through packer ownership and through formula procurement methods directly influenced quality. These results are combined in the next section to calculate the impacts of a 25% and a 100% reduction in the use of AMAs to procure slaughter cattle.

6.7.1 Changes in Retail Demand (Meat Quality) Resulting from a 25% Reduction in Formula and Packer Ownership Slaughter Cattle Procurement

A comparative statics procedure is used to estimate the impacts on retail demand of a reduction in formula and packer ownership cattle procurement. The impacts are obtained by using the product of elasticities presented in Eq. (4.6) and Eq. (4.12). Specifically, the reduction in retail demand is given by

$$\frac{\%\Delta p_r}{\%\Delta pf + \%\Delta po} = \left(\frac{\%\Delta p_r}{\%\Delta QG}\right)\left(\frac{\%\Delta QG}{\%\Delta pf} + \frac{\%\Delta QG}{\%\Delta po}\right) \times -25, \qquad (6.68)$$

where the left-hand term is the percentage change in inverse retail beef demand given additive percentage changes in formula and packer ownership procurement. The first term on the right side of Eq. (6.68) is the percentage change in retail price given a percentage change in quality (*QG*) that was estimated based on Eq. (4.12). The second term on the right side represents the percentage change in quality grade caused by a percentage change in formula procurement and the percentage change in quality grade caused by a percentage change in packer ownership procurement, as presented in Eq. (4.6). The last term on the right represents a 25% reduction in formula and packer ownership procurement.

Using estimates presented in Sections 4.2 and 4.3, a reduction in formula and packer ownership procurement is estimated to reduce retail beef demand by 0.039%, as calculated in Eq. (6.69):

$$0.143 \times (0.009 + 0.002) \times (-25.0) = -0.039\%. \qquad (6.69)$$

6.7.2 Changes in Retail Demand (Meat Quality) Resulting from a 100% Reduction in Formula and Packer Ownership Slaughter Cattle Procurement

Eq. (6.68) is also applied to the case in which formula and packer ownership cattle procurement is reduced by 100% (i.e., eliminated). Eq. (6.70) indicates that this scenario would result in a reduction of retail demand for beef of 0.157%:

$$(0.143) \times (0.009 + 0.002) \times (-100.0) = -0.157\%. \qquad (6.70)$$

6.8 COST CHANGES CAUSED BY CHANGES IN PROCUREMENT METHODS

Restrictions on fed cattle slaughter procurement methods would impose additional costs on beef packers. Costs would increase because of increased transactions costs and decreased efficiencies in slaughtering and processing. These changes in costs would likely be reflected in changes in output prices for wholesale beef or input prices for fed cattle.

The estimation of the cost changes resulting from restrictions on AMAs for fed cattle purchases was presented in Section 3 of this volume. The specific estimates used in the simulations (see Table 3-4) are as follows:

- For a 25% reduction in the use of AMAs for procurement of fed cattle, we assume a 0.86% increase in costs.
- For a 100% reduction in the use of AMAs for procurement of fed cattle, we assume a 4.68% increase in costs.

6.9 ESTIMATED CHANGES IN POTENTIAL MARKET POWER CAUSED BY CHANGES IN PROCUREMENT METHODS

If present, oligopsony power in the beef packing sector is likely manifest in downward pressure on domestic and imported slaughter cattle prices. Figure 6-4 illustrates the market power impacts as a wedge between slaughter cattle demand price and slaughter cattle supply price. The size of this wedge depends on the relative size of oligopsony power. Nonetheless, if oligopsony market power is related to AMAs, then reductions in formula and packer ownership procurement should reduce market power and narrow the difference between slaughter cattle demand and supply prices.

Several methods exist to directly estimate the degree of oligopsony market power (Appelbaum, 1982; Muth and Wohlgenant, 1999; Crespi, Gao, and Peterson, 2005; Schroeter, 1988; Stiegert, Azzam, and Brorsen, 1993). However, data limitations in the beef processing industry for the MPR period prevent the direct application of these approaches.

6.9.1 Monthly Model for Estimating Oligopsony Market Power

Because of data limitations, the following beef market power equation is specified:

$$BM_t = \psi\left(MC_t, TB_t, QB_t, PB_t, s_2, s_3, s_4\right) + \mu_t, \tag{6.71}$$

where *BM* is the four firm concentration ratio of steer and heifer slaughter; *MC* represents food marketing processing costs; *TB* represents technological change in the beef processing industry (trend); *QB* is wholesale beef production; *PB* is retail beef price; s_2, s_3, and s_4 represent seasonal binary variables for the second, third, and fourth quarters of each calendar year; and μ_t is a random error term with white noise properties. Table 6-13 presents the variable definitions and descriptive statistics. The variable BM_t is assumed to include potential market power along with other processor profitability factors. Given that Eq. (6.71) is properly specified (i.e., processing costs, technology, production volume, and retail demand price are expected to affect the concentration ratio), the estimated residuals (i.e., the difference between the actual and predicted values of BM_t) could plausibly represent an estimate of potential market power. Of course, it is likely that the residuals of Eq. (6.71) contain other factors beyond those associated with potential market power. However, the estimated residuals would represent the largest potential market power effects possible.

To the extent that the residuals of Eq. (6.71) represent (the largest possible) effects of potential market power, we regress those residuals onto the percentage of AMA cattle procurement. That is, formula or packer ownership procurement methods could reduce competition for fed cattle and lower prices below those that would occur in a perfectly competitive market (Schroeder et al., 1991). Therefore, we estimate the following equation:

$$MBF_t = f\left(pf_t, po_t, pc_t, s_2, s_3, s_4\right) + \varepsilon_t, \tag{6.72}$$

where *MBF* is potential beef market power (i.e., the residuals from Eq. [6.71]), *pf* is the proportion of cattle procured by formula methods, *po* is the proportion of cattle procured by packer ownership, *pc* is the proportion of cattle procured through cash methods, s_i represent quarterly seasonal binary variables, and ϵ_t is a white noise error term.

Table 6-13. Variable Definitions for the Beef Potential Market Power Model

Symbol	Definition	Mean	Standard Deviation
BM	Four firm concentration ratio, steer and heifer slaughter	81.310	0.400
MC	Real food marketing processing cost index (1987 = 100.0)	306.200	5.980
TB	Beef processing technology (trend)	28.000	16.600
QB	Quantity of wholesale beef production, billion pounds	2.150	0.180
PB	Real retail beef price, cents/lb	201.380	13.890
MBF	Beef potential market power, residuals of Eq. (6.71)	0.000	0.002
pf	Beef procurement by formula, share (%)	41.430	10.160
po	Beef procurement by packer ownership, share (%)	6.410	2.380
pc	Beef procurement by cash methods, share (%)	48.890	10.020
S_2	Second quarter seasonal binary variable	0.286	0.457
S_3	Third quarter seasonal binary variable	0.214	0.415
S_4	Fourth quarter seasonal binary variable	0.214	0.415

Eq. (6.72) permits measuring the marginal impacts of AMAs on potential market power. For example, if beef packers are constrained on the amount of cattle they purchase through AMAs, this may reduce processing efficiencies. However, such an action may also reduce potential oligopsony market power.

6.9.2 Data Development and Estimation of the Monthly Potential Market Power Model

The sample period for the estimation of the potential market power model (Eq. 6.71) consists of monthly observations from April 2001 (the beginning of MPR) through December 2005. Annual data for the beef concentration ratio were obtained from the USDA/GIPSA Packers and Stockyards Statistical Report, and monthly observations were obtained by linear interpolation. Monthly wholesale beef production and retail beef prices were obtained from LMIC. Food marketing costs were obtained on a quarterly basis from Agricultural Outlook (USDA, various issues). The AMA beef procurement data were obtained from the USDA's Mandatory Price Reporting Datamart (http://mpr.datamart.ams.usda.gov). The retail beef price and food marketing cost variables were deflated by the CPI. The CPI data were obtained from the *Economic Report of the President*.

Eq. (6.71) is estimated in double log form. The OLS results are as follows:

$$\underset{}{\ln BM_t} = \underset{(41.528)}{4.943} - \underset{(-8.286)}{0.143\ln MC_t} + \underset{(1.423)}{0.008\ln QB_t}$$

$$+ \underset{(6.857)}{0.041\ln PB_t} - \underset{(-2.407)}{0.002s_2} - \underset{(-1.175)}{0.001s_3} - \underset{(-0.832)}{0.001s_4} \quad (6.73)$$

$$\bar{R}^2 = 0.771 \qquad S.E. = 0.002 \qquad \overline{BM}(\log mean) = 4.398.$$

The critical t-values at the α = 0.05 and α = 0.10 significance levels are 1.960 and 1.645 (50 degrees of freedom). The trend variable was omitted from the regression because of multicollinearity with several variables. The adjusted R^2 statistic is relatively small so that the residuals of the equation likely contain information beyond that attributable to potential market power effects. That is, the residuals should represent the largest possible market power effects.

The residuals of Eq. (6.73) are nonnormally distributed (using a Jacque-Bera test statistic) with a mean near zero and a standard deviation of 0.002. These residuals are used as the dependent variable in Eq. (6.72) of the monthly market power model as a proxy for *MBF*. Because this proxy likely contains information in addition to the effects of potential market power, the estimated parameters of Eq. (6.72) should be considered an upper bound of the potential market power effects resulting from changes in procurement methods.

6.9.3 Empirical Estimates of Procurement Methods on Potential Market Power

The market power equation (Eq. [6.72]) is estimated using monthly data from April 2001 through December 2005. The estimated equation includes distributed lag adjustments. In initial regressions, the contemporaneous monthly AMA values and the first-order lag on the dependent variable (Koyck term) were not statistically different from zero based on the Wald coefficient test. Hence, those coefficients were omitted in the final regression. The Breusch-Godfrey LM test indicated that AR(1) and AR(2) error components were required. Eq. (6.72) was estimated in double logs using nonlinear least squares and the residuals from Eq. (6.73) as the dependent variable. The regression results are

$$
\begin{aligned}
MBF_t = \; & \underset{(1.941)}{0.013} + \underset{(1.772)}{0.005 \ln pf_{t\text{-}1}} + \underset{(2.257)}{0.002 \ln po_{t\text{-}1}} + \underset{(1.551)}{0.005 \ln pc_{t\text{-}1}} \\
& + \underset{(4.784)}{0.003 s_2} + \underset{(4.062)}{0.002 s_3} + \underset{(1.905)}{0.001 s_4} + \underset{(5.677)}{0.914 \mu_{t\text{-}1}} - \underset{(-1.661)}{0.244 \mu_{t\text{-}2}} \qquad (6.74)
\end{aligned}
$$

$$\bar{R}^2 = 0.652 \qquad S.E. = 0.001 \qquad \overline{MBF}(mean) = 0.001.$$

The dependent variable is already in log form because it represents the residuals of Eq. (6.73). Therefore, a second logarithmic transformation is not used. The reported mean for the dependent variable differs slightly from that presented in Table 6-13 because the specified lags result in the loss of three degrees of freedom. The critical t-values at the $\alpha = 0.05$ and $\alpha = 0.10$ significance levels are 2.021 and 1.684 (42 degrees of freedom). The inverted AR roots are conjugate complex with a modulus of 0.498, which indicates that the stochastic error process is stable. The model explains about 65% of the variation in the dependent variable. The coefficient estimate for cash procurement is not statistically different from zero.

Results indicate that formula (*pf*) and packer ownership (*po*) procurement methods are statistically significant in determining potential market power. However, their economic effects are small. A 10% increase in formula procurement is associated with a 0.05% increase in potential market power, while a 10% increase in packer ownership procurement is associated with a 0.02% increase in potential market power. The relatively inelastic responses indicate that reductions in the use of AMAs would have only small impacts on potential market power.

The following two sections present the calculations needed to use these estimates of changes in potential market power in the equilibrium displacement model.

6.9.4 Estimated Changes in Potential Market Power Caused by a 25% Reduction in Formula and Packer Ownership Procurement

The empirical estimation of Eq. (6.74) required the use of the residuals from Eq. (6.73) as a proxy for potential market power. The results indicate that a 1% decrease in formula and packer ownership procurement is related to a 0.005 and a

0.002 percentage point decline in market power (ρ), respectively. Cash procurement did not statistically affect beef processor market power. Eq. (6.75) presents the calculations used to estimate the change in potential market power resulting from a 25% reduction in both formula and packer ownership procurement:

$$\left(\frac{\partial MBF}{\partial pf} \times -25.00\right) + \left(\frac{\partial MBF}{\partial po} \times -25.00\right) = \\ (0.005 \times -25.00) + (0.002 \times -25.00) = -0.175\%. \tag{6.75}$$

Thus, a 25% reduction in formula and packer ownership procurement is expected to reduce beef potential market power by 0.175 percentage points.

6.9.5 Estimated Changes in Potential Market Power Caused by a 100% Reduction in Formula and Packer Ownership Procurement

An analogous procedure is followed to estimate the impact of a 100% reduction (i.e., complete elimination) of formula and packer ownership procurement on potential market power. The 100% reduction in both methods yields

$$\left(\frac{\partial MBF}{\partial pf} \times -100.0\right) + \left(\frac{\partial MBF}{\partial po} \times -100.0\right) = \\ (0.005 \times -100.0) + (0.002 \times -100.0) = -0.700\%. \tag{6.76}$$

Thus, a 100% reduction in formula and packer ownership procurement is expected to reduce beef potential market power by 0.700 percentage points, a relatively small effect.

6.10 SIMULATION RESULTS

In this section, we present the results of simulations of potential changes in AMAs that would reduce or eliminate various procurement methods. The simulations are conducted using the inputs described in Sections 6.7, 6.8, and 6.9.

6.10.1 Results of a 25% Reduction in Formula and Packer Ownership Procurement

A 25% reduction in formula and packer ownership procurement is expected to have three initial effects on the beef sector. First, beef quality is expected to decline and decrease primary demand by 0.039% (Eq. [6.69]). Second, processing costs would increase because of changes in procurement methods. Thus, the wholesale derived supply function is expected to shift upwards and to the left by 0.86% (Section 6.8). Third, potential market power is expected to decline by 0.175 percentage points (Eq. [6.75]). These three inputs are used in the equilibrium displacement model to estimate price, quantity, and consumer and producer surplus changes resulting from a 25% reduction in formula and packer ownership procurement.

Table 6-14 reports simulated mean changes in the endogenous price and quantity variables and associated 95% confidence intervals for a 25% reduction in formula and packer ownership procurement. Most estimates are significantly different from zero at either the 5% or 10% level. The short-run time period represents changes in prices and quantities that occur at the end of Year 1.

In the short run, all prices decline with the exception of small increases in retail and wholesale beef prices. Retail beef price increases by 0.46%, wholesale beef price increases by 0.70%, domestic slaughter cattle supply price declines by 1.27%, and feeder cattle price declines by 0.10%. In addition, all quantities decline by a small amount. Essentially, these results reflect that the positive effect of reduced potential oligopsony processor market power is unable to offset the negative effects of increased processing costs and decreased retail demand.

To estimate long-run effects, we assume that the beef market would return to an equilibrium after 10 years of adjustments to changes in cattle procurement. We multiplicatively increase supply and demand elasticities between the short-run estimates (Year 1) and long-run estimates (Year 10). The long-run results represent changes in prices and quantities that would occur in Year 10 relative to initial levels. The long-run price effects follow the short-run results in terms of direction. However, the long-run changes in prices are generally smaller than the short-run changes because of increasing supply and demand elasticities. For example, domestic slaughter cattle supply price declines by 0.65%, and feeder cattle prices decline by 0.08% in the long run. With the exception of wholesale beef quantity and domestic slaughter cattle quantity, the long-run quantity declines are slightly smaller than the short-run declines because, again, of more elastic supply responses over time.

Table 6-14. Percentage Changes in Prices and Quantities Given a 25% Reduction in Formula and Packer Ownership Beef Procurement[a]

Endogenous Variables	Short Run	Long Run (Year 10)
Retail beef price	0.46% (0.26, 0.77)	0.17% (0.09, 0.29)
Retail beef quantity	–0.43% (–0.67, –0.27)	–0.24% (–0.38, –0.14)
Wholesale beef price	0.70% (0.43, 1.12)	0.66% (0.42, 1.05)
Wholesale beef quantity	–0.82% (–1.20, –0.59)	–0.84% (–1.30, –0.57)
Domestic slaughter cattle demand price	–1.43% (–3.17, –0.70)	–0.81% (–1.63, –0.44)
Domestic slaughter cattle supply price	–1.27% (–3.02, –0.53)	–0.65% (–1.46, –0.26)
Domestic slaughter cattle quantity	–0.25% (–0.62, –0.08)	–0.38% (–0.88, –0.14)
Imported slaughter cattle demand price	–0.25% (–0.48, –0.16)	–0.20% (–0.37, –0.13)
Imported slaughter cattle supply price	–0.08%[b] (–0.31, 0.01)	–0.03%[c] (–0.20, 0.05)
Imported slaughter cattle quantity	–0.75%[b] (–3.11, 0.13)	–0.28%[c] (–1.96, 0.45)
Feeder cattle price	–0.10% (–0.28, –0.02)	–0.08% (–0.21, –0.02)
Feeder cattle quantity	–0.94% (–2.66, –0.24)	–0.34% (–0.85, –0.10)

Note: All other values are significantly different from zero at the 5% level.

[a] This scenario corresponds to a 0.039% decrease in retail beef demand, a 0.86% decrease in the wholesale derived beef supply function, and a 0.175 percentage point reduction in beef packer potential oligopsony power.

[b] Significantly different from zero at the 10% level.

[c] Not significantly different from zero.

Table 6-15 presents changes in producer surplus at each level of the marketing chain and changes in consumer surplus at the retail level. Most estimates are at least significantly different from zero at the α = 0.10 level. Short-run results are presented in the first column, and long-run results are presented in the second column. Changes in producer surplus contain a dynamic element in that producer surplus increases or decreases occur over time. Therefore, it is appropriate to consider cumulative changes in producer surplus that accrue as an industry adjusts from a short- to a long-run equilibrium. To simulate these

Table 6-15. Changes in Producer and Consumer Surplus Given a 25% Reduction in Formula and Packer Ownership Beef Procurement, Billion $[a,b]

Surplus Measure	Short Run	Long Run (Year 10)	Cumulative	Cumulative Present Value	Percentage of Total Present Value Cumulative Surplus
Producer surplus					
Retail beef producer surplus	–$0.0980	–$0.0870	–$1.504	–$1.161	–0.36%
Wholesale beef producer surplus	–$0.1430	–$0.1910	–$1.654	–$1.261	–0.86%
Domestic slaughter cattle producer surplus	–$0.5580	–$0.2500	–$3.886	–$3.107	–1.35%
Import slaughter cattle producer surplus	–$0.0004[c]	–$0.0001[d]	–$0.003[d]	–$0.002[d]	–1.10%[d]
Feeder cattle producer surplus	–$1.0690	–$0.1740	–$5.141	–$4.273	–2.67%
Total change in domestic producer surplus	–$1.8670	–$0.7030	–$12.184	–$9.802	–1.14%
Total change in import producer surplus	–$0.0004[c]	–$0.0001[d]	–$0.003[d]	–$0.002[d]	–1.10%[d]
Total change in producer surplus	–$1.8670	–$0.7030	–$12.187	–$9.804	–1.14%
Consumer surplus					
Retail beef consumer surplus	–$0.3710	–$0.1510	–$2.539	–$2.037	–0.83%

[a] This scenario corresponds to a 0.039% decrease in retail beef demand, a 0.86% decrease in the wholesale derived beef supply function, and a 0.175 percentage point reduction in beef packer potential oligopsony power.

[b] Producer and consumer surplus are calculated relative to 2000–2003 average quantities and prices.

[c] Significantly different from zero at the 10% level.

[d] Not significantly different from zero.

cumulative effects, we assume that it takes 10 years to adjust from the short run to the long run in the meat industry.

The third column of Table 6-15 (labeled "Cumulative") presents the simple summation of producer and consumer surplus changes over 10 years for each market level. The fourth column (labeled "Cumulative Present Value") presents the present value of these changes in producer and consumer surplus, assuming a 5% discount rate. Over the 10-year adjustment period, all sectors lose surplus. Finally, percentage changes in the net present value of producer and consumer surplus with respect to total producer and consumer surplus over the 10-year period are presented in the last column of Table 6-15. The feeder cattle sector loses a higher percentage of producer surplus (2.67%) relative to all other beef production sectors.

6.10.2 Results of a 100% Reduction in Formula and Packer Ownership Procurement

A 100% reduction in formula and packer ownership procurement is expected to reduce retail beef demand by 0.157% (Eq. [6.70]), increase wholesale processing costs by 4.68% (Section 6.8), and reduce potential market power by 0.70 percentage points (Eq. [6.76]). Table 6-16 reports mean changes in the endogenous price and quantity variables and associated 95% confidence intervals for a 100% reduction in formula and packer ownership procurement. Most estimates are at least significantly different from zero at the 10% level.

With the exception of retail and wholesale beef prices, all prices and quantities decline in the short run. Retail beef prices increase by 2.57%, and retail beef quantities decline by 2.35%. Slaughter and feeder cattle prices decline by 7.12% and 0.54%, respectively.

The long-run price and quantity results follow the short-run results in terms of direction, with generally smaller price declines. Again, these results are consistent with increasing supply and demand elasticities over time. For example, domestic slaughter cattle supply prices decline by 3.68%, and feeder cattle prices decline by 0.47% in the long run. Domestic slaughter and feeder cattle quantities decline by 2.15% and 1.96% in the long run.

Table 6-17 presents changes in producer surplus at each level of the marketing chain and changes in consumer surplus at the retail level. In general, most estimates are at least significantly different from zero at the $\alpha = 0.10$ level. Short-run results are presented in the first column, and long-run results are presented in the second column. The third column of Table 6-17 (labeled “Cumulative”) presents the simple summation of producer and consumer surplus changes over 10 years for each market level.

The fourth column of Table 6-17 (labeled “Cumulative Present Value”) presents the present value of 10 years of changes in producer and consumer surplus, assuming a 5% discount rate.

Table 6-16. Percentage Changes in Prices and Quantities Given a 100% Reduction in Formula and Packer Ownership Beef Procurement[a]

Endogenous Variables	Short Run	Long Run (Year 10)
Retail beef price	2.57% (1.45, 4.27)	0.97% (0.52, 1.64)
Retail beef quantity	–2.35% (–3.64, –1.46)	–1.29% (–2.04, –0.75)
Wholesale beef price	3.87% (2.42, 6.17)	3.67% (2.39, 5.85)
Wholesale beef quantity	–4.51% (–6.59, –3.23)	–4.62% (–7.10, –3.12)
Domestic slaughter cattle demand price	–7.73% (–17.23, –3.78)	–4.33% (–8.73, –2.28)
Domestic slaughter cattle supply price	–7.12% (–16.71, –3.11)	–3.68% (–8.14, –1.60)
Domestic slaughter cattle quantity	–1.42% (–3.45, –0.45)	–2.15% (–4.84, –0.84)
Imported slaughter cattle demand price	–1.18% (–2.46, –0.69)	–0.96% (–1.91, –0.56)
Imported slaughter cattle supply price	–0.49% (–1.78, 0.005)	–0.27%[b] (–1.22, 0.13)
Imported slaughter cattle quantity	–4.90% (–17.77, 0.05)	–2.67%[b] (–12.21, 1.27)
Feeder cattle price	–0.54% (–1.54, –0.14)	–0.47% (–1.18, –0.13)
Feeder cattle quantity	–5.30% (–14.73, –1.41)	–1.96% (–4.80, –0.58)

[a] This scenario corresponds to a 0.157% decrease in retail beef demand, a 4.68% decrease in the wholesale derived beef supply function, and a 0.70 percentage point reduction in beef packer potential oligopsony power.

[b] Not significantly different from zero. All other values are significantly different from zero at the 5% level.

Over the 10-year adjustment period, all sectors lose producer surplus. The last column indicates that the feeder cattle sector loses a higher percentage of producer surplus (15.96%) relative to all other beef production sectors.

6.10.3 Results of a 100% Reduction in Formula and Packer Ownership Procurement, Assuming the Elimination of Potential Oligopsony Power

For illustration purposes, it is instructive to consider a case in which a 100% reduction in formula and packer ownership procurement would completely eliminate potential oligopsony market power. The research presented above does not support

Table 6-17. Changes in Producer and Consumer Surplus Given a 100% Reduction in Formula and Packer Ownership Beef Procurement, Billion $[a,b]

Surplus Measure	Short Run	Long Run (Year 10)	Cumulative	Cumulative Present Value	Percentage of Total Present Value Cumulative Surplus
Producer surplus					
Retail beef producer surplus	–$0.547	–$0.467	–$8.230	–$6.366	–2.00%
Wholesale beef producer surplus	–$0.838	–$1.109	–$9.639	–$7.351	–5.24%
Domestic slaughter cattle producer surplus	–$3.116	–$1.415	–$21.813	–$17.430	–7.82%
Imported slaughter cattle producer surplus	–$0.003	–$0.001[c]	–$0.020[d]	–$0.016[d]	–7.67%
Feeder cattle producer surplus	–$6.000	–$0.996	–$29.004	–$24.094	–15.96%
Total change in domestic producer surplus	$10.501	–$3.987	–$68.687	–$55.242	–6.64%
Total change in imported producer surplus	–$0.002	–$0.001[c]	–$0.020[c]	–$0.016[d]	–7.67%[d]
Total change in producer surplus	$10.503	–$3.988	–$68.707	–$55.258	–6.64%
Consumer surplus					
Retail beef consumer surplus	–$2.002	–$0.806	–$13.657	–$10.962	–4.56%

[a] This scenario corresponds to a 0.157% decrease in retail beef demand, a 4.68% decrease in the wholesale derived beef supply function, and a 0.70 percentage point reduction in beef packer potential oligopsony power.

[b] Producer and consumer surplus are calculated relative to 2000–2003 average quantities and prices.

[c] Not significantly different from zero.

[d] Significantly different from zero at the 10% level.

such a scenario. However, if the goal of a complete elimination of formula and packer ownership procurement is to eliminate potential oligopsony power, it is interesting to consider a hypothetical situation in which that actually occurs. Note that potential oligopsony power could still occur within cash markets. However, we ignore that possibility in this simulation.

This simulation follows that of Section 6.10.2, except that the potential market power parameter (ρ) is assumed to equal 1 after the elimination of formula and packer ownership procurement. That is, it is assumed that a price wedge would no longer exist between the demand and supply prices for domestic and imported slaughter cattle.

Table 6-18 reports mean changes in the endogenous price and quantity variables and associated 95% confidence intervals for this scenario. All short-run estimates are at least significantly different from zero at the 10% level, as are most of the long-run estimates.

Table 6-18. Percentage Changes in Prices and Quantities Given a 100% Reduction in Formula and Packer Ownership Beef Procurement and the Elimination of Potential Oligopsony Power[a]

Endogenous Variables	Short Run	Long Run (Year 10)
Retail beef price	2.48% (1.41, 4.15)	0.90% (0.48, 1.56)
Retail beef quantity	–2.28% (–3.50, –1.40)	–1.21% (–1.95, –0.71)
Wholesale beef price	3.73% (2.32, 5.97)	3.43% (2.21, 5.59)
Wholesale beef quantity	–4.36% (–6.38, –3.13)	–4.33% (–6.72, –2.92)
Domestic slaughter cattle demand price	–7.76% (–17.59, –3.84)	–4.52% (–8.95, –2.52)
Domestic slaughter cattle supply price	–6.38% (–15.81, –2.40)	–3.09% (–7.58, –1.06)
Domestic slaughter cattle quantity	–1.27% (–3.31, –0.37)	–1.79% (–4.47, –0.55)
Imported slaughter cattle demand price	–1.71% (–2.92, –1.24)	–1.37% (–2.23, –0.98)
Imported slaughter cattle supply price	–0.23%[b] (–1.46, 0.002)	0.11%[b] (–0.76, 0.50)
Imported slaughter cattle quantity	–2.35%[b] (–14.65, 2.36)	1.07%[b] (–7.61, 5.04)
Feeder cattle price	–0.49% (–1.44, –0.11)	–0.39% (–1.04, –0.10)
Feeder cattle quantity	–4.74% (–14.03, –1.16)	–1.64% (–4.35, –0.41)

[a] This scenario corresponds to a 0.157% decrease in retail beef demand and a 4.68% decrease in the wholesale derived beef supply function.

[b] Not significantly different from zero. All other values are significantly different from zero at the 5% level.

The results reported in Table 6-18 are very similar to those reported in Table 6-16. That is, even if the elimination of formula and packer ownership cattle procurement would completely eliminate potential oligopsony power, the net effects would be to reduce price and quantities in almost all sectors because of additional processing costs and reductions in beef quality.

Table 6-19 presents changes in producer surplus at each level of the marketing chain and changes in consumer surplus at the retail level in response to this hypothetical scenario. Again, the results are virtually identical to those reported in Table 6-17.

Table 6-19. Changes in Producer and Consumer Surplus Given a 100% Reduction in Formula and Packer Ownership Beef Procurement and the Elimination of Potential Oligopsony Power, Billion $[a,b]

Header	Short Run	Long Run (Year 10)	Cumulative	Cumulative Present Value	Percentage of Total Present Value Cumulative Surplus
Producer surplus					
Retail beef producer surplus	–$0.530	–$0.440	–$7.867	–$6.091	–1.92%
Wholesale beef producer surplus	–$0.807	–$1.036	–$9.150	–$6.988	–4.97%
Domestic slaughter cattle producer surplus	–$2.792	–$1.187	–$19.059	–$15.270	–6.79%
Imported slaughter cattle producer surplus	–$0.001	–$0.001[c]	–$0.004[c]	–$0.003[c]	–1.54%[c]
Feeder cattle producer surplus	–$5.366	–$0.832	–$25.427	–$21.171	–13.79%
Total change in domestic producer surplus	–$9.495	–$3.496	–$61.503	–$49.520	–5.92%
Total change in imported producer surplus	–$0.001	–$0.001[c]	–$0.004[c]	–$0.003[c]	–1.54%[c]
Total change in producer surplus	–$9.496	–$3.496	–$61.507	–$49.523	–5.91%
Consumer surplus					
Retail beef consumer surplus	–$1.937	–$0.760	–$13.083	–10.511	–4.37%

[a] This scenario corresponds to a 0.157% decrease in retail beef demand and a 4.68% decrease in the wholesale derived beef supply function.

[b] Producer and consumer surplus are calculated relative to 2000–2003 average quantities and prices.

[c] Not significantly different from zero.

6.10.4 Potential Market Power, Processing Costs, and AMAs

Section 6.10.3 illustrates a hypothetical case in which a 100% reduction in formula and packer ownership procurement would completely eliminate potential oligopsony market power. However, these results are dependent upon the assumption of the initial size of oligopsony markdown pricing behavior. That is, if such potential market power is large enough initially, then elimination of that potential market power could theoretically offset increased processing costs and reduced beef quality in terms of changes in producer surplus.

Therefore, the equilibrium displacement model was used in a static simulation to determine the minimum size of initial potential market power for which, upon its removal through the complete elimination of AMAs, slaughter cattle producers would be invariant to such an action. The model indicates that an initial oligopsony markdown pricing of fed cattle of 4.28% would have to exist in order for benefits and costs of reducing AMAs to be equivalent. Most empirical estimates of oligopsony markdowns in beef are generally less than 3.8%.

Finally, it is interesting to consider relative magnitudes of negative effects of changes in AMAs in processing costs and beef quality versus the positive effects of reductions in potential market power. A static simulation was conducted to further investigate these tradeoffs. The above simulation was repeated (i.e., a 100% reduction in AMAs and the complete elimination of potential market power), and the negative impacts on processing costs and beef quality were altered until the discounted net present value of domestic slaughter cattle producer surplus was unaffected by changes in AMAs.

The results indicate that domestic slaughter cattle producers would be indifferent to the elimination of AMAs if that action would cause no change in beef quality and only a 1.71% increase in processing costs. Note that Section 6.7.2 estimates that the complete elimination of AMAs would reduce retail demand because of a reduction in beef meat quality by 0.157%, and Section 6.8 indicates that this action would increase processing costs by 4.68%.

6.11 SUMMARY OF CHANGES IN PROCUREMENT METHODS ON PRICES, QUANTITIES, AND PRODUCER SURPLUS

We developed a stochastic, dynamic, equilibrium displacement model of the U.S. beef industry. The model includes supply and demand relations for the feeder cattle, domestic slaughter cattle, imported slaughter cattle, wholesale beef carcasses, and retail beef demand sectors. The model explicitly considers oligopsony markdown pricing behavior by beef packers and correlations among elasticity estimates. The model is parameterized by econometrically estimating a structural demand supply system of equations using publicly available annual data from 1970 to 2003.

The equilibrium displacement model also requires estimates of changes in costs that may occur if restrictions are placed on specific AMAs. We estimated a monthly, reduced-form model of boxed beef, slaughter cattle, and feeder cattle prices. A potential market power equation based on packer concentration ratios is included. The system is estimated using monthly MPR data. The monthly model is used to estimate the effects of changes in marginal costs at the packer level and changes in potential oligopsony market power in response to assumed restrictions on the use of AMAs. In addition, we incorporate potential changes in beef quality resulting from changes in AMAs.

Specifically, we simulate the results of a 25% reduction in the procurement of domestic and imported slaughter cattle by formula and packer ownership procurement. We also simulate changes caused by a 100% reduction in formula and packer ownership procurement of slaughter cattle. In both cases, it is assumed that these reductions caused increased procurement via other methods.

The equilibrium displacement model quantifies the effects of the above changes in AMAs on annual equilibrium prices, quantities, producer surplus, and consumer surplus over a 10-year period. In addition, Monte Carlo simulations (1,000) are used to construct empirical probability distributions so that the statistical significance of each endogenous variable can be evaluated. Empirical results are reported for short-term (1 year), long-term (10 years), and cumulative effects. All sectors lose producer (consumer) surplus in the short and long runs.

Furthermore, the feeder cattle production sector loses the most producer surplus relative to all other sectors in both absolute and percentage terms. Feeder cattle producers collectively lose the most producer surplus by restricting the use of AMAs because the derived demand and primary supply elasticity estimates at this level are more inelastic relative to other levels. That is, feeder cattle producers are less able to make short-run supply adjustments to price changes relative to other sectors. In addition, feeder cattle producers have the most to lose from decreases in the demand for beef because the own-price elasticity of the derived demand for feeder cattle is also more inelastic relative to other sectors. Therefore, to the extent that a reduction in AMAs reduces processing cost efficiencies and beef quality by more than the gains obtained from reductions in potential market power, the feeder cattle sector is harmed more than any other cattle/beef production sector.

For illustration purposes, a third simulation was conducted in which a 100% reduction in formula and packer ownership procurement was assumed to completely eliminate potential oligopsony market power. The results were not significantly different from those reported above. That is, even if the elimination of formula and packer ownership cattle procurement would completely eliminate potential oligopsony power, the net effects would be to reduce price, quantities, and producer and consumer surplus in almost all sectors because of additional processing costs and reductions in beef quality.

Finally, two additional simulations were conducted. The first evaluated the amount of oligopsony markdown pricing that must currently exist so that the complete elimination of that potential market power (by eliminating the use of AMAs) would result in no change in producer surplus at the slaughter cattle level. The analysis indicates that the current level of markdown pricing would have to be 4.28%, which is generally larger than empirical estimates for the beef industry. The second additional simulation evaluated the amount of increased processing costs that could be offset by reductions in potential market power so that producer surplus in the slaughter cattle sector would be unaffected. The simulation indicates that a 1.71% increase in processing costs (assuming no changes in beef quality) could be offset by reductions in potential market power. However, under the scenario in which a 100% reduction in AMAs occurs, we estimate that processing costs would increase by 4.68%.

7 Implications of Alternative Marketing Arrangements

In this section, we describe the implications of AMAs, based on the outcome of the combined set of research activities conducted for the study. First, we describe qualitative results from the interviews with beef producers and packers regarding the implications of restricting the use of marketing arrangements. Then, we assess the economic implications of and incentives for changes in the use of AMAs in the beef industry in the future.

7.1 EXPECTED EFFECTS OF CHANGES IN MARKETING ARRANGEMENTS BASED ON THE INDUSTRY INTERVIEWS

As part of this study, we interviewed cattle feeders and packers in person and asked a series of questions regarding their opinions on how restricting packer ownership would impact their business. We conducted the interviews in early 2005 at the producer's or packer's office.[1] The questions we asked included the following:

- What kind of immediate adjustments would your company have to make if packer ownership of livestock were restricted?

[1] A description of the process for conducting the interviews and the complete findings from the interviews is provided in the interim report for the study (Muth et al., 2005).

Prior to conducting the quantitative analyses for this study, we interviewed fed cattle producers and beef packers to obtain qualitative information about the short- and long-term effects of a ban on packer ownership of livestock.

- What effects would restrictions on packer ownership of livestock have on how your company operates in the long run?
- If this method affects costs, what would you guess is the percentage change in costs compared with using the spot market?
- If this method affects quality, what would you guess is the percentage change in value compared with using the spot market?

The feeder responses to the question of immediate adjustments were mixed. Some thought that they would go out of business and that the adjustments would have a dramatic effect on the structure and stability of the industry. Others thought that the adjustments would have no impact on their business or that effects would depend on how narrowly packer ownership was defined. Still others had no opinion.

One implication of restricting AMAs that was noted by several respondents was the affect on risk-bearing ability and capacity utilization.

One implication of restricting AMAs that was noted by several respondents was the impact on risk-bearing ability and capacity utilization. Full or partial packer ownership of a pen of cattle reduces the equity the feeder (or other cattle owners) must provide to feed cattle. Packer ownership also allows the feeders to secure better terms from lenders. Feeders may be able to own more of the cattle that are currently owned by packers, but they would face a capital constraint preventing them from owning all the cattle. The individual feedlots would have underutilized capacity or would have to find new investors to replace the capital packers once provided.

Packers indicated that in the short run they simply would adjust to a restriction on packer ownership and that the extent of adjustment would depend on how the restrictions were defined.

To attract capital that is not in cattle feeding would require a higher rate of return than cattle feeding currently offers; otherwise, that capital would already have been invested in cattle feeding. Given that the supply and demand of beef is relatively fixed in the short run, fed cattle prices are not expected to change substantially. Thus, higher rates of return would have to come from downward pressure on feeder cattle price. Likewise, if feeders have more debt and/or more risk, the higher cost of borrowing will result in lower bids for feeder cattle.

Packers indicated that in the short run they simply would adjust to a restriction on packer ownership and that the extent of adjustment would depend on how the restrictions were defined. Packers that own feedlots in addition to cattle would have to liquidate assets, which is more disruptive than not replacing cattle once they are sold.

In the short run, feeders and packers would adjust to restrictions on packer ownership. Packers face the same beef demand and cattle supply, but they would buy more cattle through other methods. Individual feeders that have packer-owned cattle would face increased risk and higher financing costs because they must own or find owners for the cattle that packers currently own. Packers expect that they would have to reduce capacity utilization if packer ownership were banned. In the short run, because cattle supplies are fixed, someone would own and feed the cattle, but there would be a higher rate of return or higher finance costs to replace the capital that is removed, thus leading to downward pressure on feeder cattle prices.

Feeders and packers expressed concern about the difficulty of meeting the needs for customized product in branded programs if packer ownership was restricted.

Feeders and packers identified two primary long-run effects of restricting packer ownership of cattle. The first effect, consistent with short-run impacts, would be increased risk and reduced feedlot capacity utilization due to removing capital from the feeding sector. The second effect would be reduced product quality by moving back to a commodity market. In particular, feeders and packers expressed concern about the difficulty of meeting the needs for customized product in branded programs if packer ownership was restricted. New strategies would have to be developed to meet this segment of the market; otherwise feeders and packers would miss out on these higher-value consumer markets.

Several respondents have an expectation that removing or restricting capital to the feeder sector ultimately will lead to reduced capacity, particularly during downturns in the market. Greater quality concerns, more risk, and less capital will lead to a smaller beef industry.

Feeders thought that their costs would increase if packer ownership were restricted. Cost savings associated with packer-owned cattle come in the form of operational efficiency and lower average overhead cost through improved throughput.

Operational efficiency from packer ownership results in more consistent operations. The number of cattle in the feedlot is more consistent from month to month. Labor is used more efficiently because of this predictability. For example, a labor efficiency of one person per 1,500 to 1,600 cattle may be achieved using packer ownership rather than an industry average of one per 1,000 cattle. Feeders with packers as a major customer have more consistent cattle and feeding programs and the consistency improves efficiency. For example, a feedlot might need fewer feed trucks and could have larger feed batch runs, because a high percentage of the cattle would be on the same program (instead of having many different types of cattle and diets). Some feeders reported a 20 percentage point increase in capacity utilization due to packer ownership, which spreads overhead costs over more cattle.

Cost savings were estimated in the 17% to 22% range across those interviewed. With $0.30 per day yardage cost and 150 days on feed, total feedlot cost per head is $45.00; thus, cost savings would be $7.65 to $9.90 per head. Labor cost savings estimates account for much of this gain and were reported to be in the $1.25 to $10.00 per head range. Quality premium loss estimates are over and above the efficiency gains and ranged from $15.00 to $17.00 per head.

Packers estimated that their change in costs from restricting packer ownership would be less than the change reported by feeders.

Packers estimated their change in costs from restricting packer ownership would be less than those reported by feeders. They noted some lost efficiencies and the need to add more cattle buyers to return to an all-cash procurement system (for example, an additional buyer cost of $0.40 per head). Packers' particular concerns were related to beef quality and potential loss of customers for higher quality products.

Feeders and packers expressed concern about the impact on quality if packer ownership were restricted. They expected to revert to a commodity market with few incentives for higher quality cattle. Feeders reported this loss to be worth $1.00/cwt or higher.

We compared the opinions of feeders and packers with the equilibrium displacement model (EDM) results discussed in Section 6. The interviews and models were in agreement that the changes in quality and prices are expected to be small because of restricting AMAs. They also agree that everyone from consumers to cow-calf producers would be worse off because of the restrictions; quality would be reduced in the long run, costs would increase for feeders and packers, and cattle supplies would decline.

The EDM predicted a larger decline in fed cattle prices than in feeder cattle prices as a result of restrictions on AMAs. However, the implications of the comments from feeders was that feeding margins would have to improve in order to justify the added risk or to attract new investment to replace packers' current investment in cattle. Improved feeding margins would require a larger decline in feeder cattle prices than in fed cattle prices—the opposite of what the EDM predicted, although for a slightly different scenario.

7.2 IMPLICATIONS OF AND INCENTIVES FOR CHANGES IN USE OF MARKETING ARRANGEMENTS OVER TIME

> Based on the evidence from this study, we expect the use of AMAs in the fed cattle and beef industry to remain at levels similar to their current levels.

Based on our assessment of the beef industry from the industry interviews, industry survey, and analyses of the transactions data, we expect the use of AMAs in the beef industry to remain at levels similar to their current use. Almost 50% of feeder cattle originate from herd sizes of less than 35 head. These producers are not likely to seek use of AMAs. Often, cattle are produced on land with a low opportunity cost. In addition, large genetic differences exist among beef cattle breeds, because certain breeds are more suited to particular climates in the United States and cattle are raised outside. Given these factors, there are few incentives for major changes in the production and marketing practices for beef cattle. However, if a country of origin labeling (COOL) requirement or a mandatory national animal identification system (NAIS) is implemented, the cost of cattle production will increase and could cause some small producers to exit. Furthermore, if the demand for quality increases dramatically, producers with poor genetic lines of cattle will likely exit the industry. In addition, increased requirements for food safety practices and certification could potentially increase incentives for using AMAs. If any of these scenarios occurs, the use of AMAs in the beef industry likely will change substantially.

In the subsections below, we assess the economic incentives for and implications of changes in the use of AMAs for fed cattle purchases and beef product sales.

7.2.1 Assessment of Economic Incentives for Increased or Decreased Use of AMAs

In this section, we summarize our findings related to the economic incentives for changes in the use of AMAs in the fed cattle and beef industry. This discussion is within the context of hypothetical restrictions on the use of AMAs.

Summary measure of the economic incentives associated with the use of AMAs. Buyers and sellers of livestock and meat may have a number of different economic incentives associated with using alternative or cash marketing arrangements or the cash market. Buyers of livestock and meat may choose to use specific marketing arrangements because they reduce the cost of procurement, improve the quality of animals and products purchased, aid in risk management, and generate efficiencies in procurement and marketing. Likewise, sellers of livestock and meat may choose to use specific marketing arrangements because they facilitate market access, reduce the cost of selling, increase the price received, and reduce risk.

The empirical analyses indicate that small but statistically significant effects result from restrictions on the use of AMAs.

The results also indicate that the positive effect of reduced potential oligopsony market power that might result from restricting AMAs is unable to offset the negative effects of increased processing costs and reduced quality associated with restricting AMAs.

As presented in Section 6, a measure of the economic incentives associated with use of AMAs is the consumer and producer surplus changes that would result if their use was restricted. The empirical analyses indicate small but statistically significant effects result from restrictions on the use of AMAs. Beef product quality decreases, consumer demand for beef decreases, slaughter and processing costs increase, and oligopsony markdowns decrease from an assumed initial level. For the scenario in which AMAs, as represented by formula (i.e., marketing agreement and forward contracts) and packer ownership arrangements, are reduced by 25%, producer surplus decreases by an estimated $1.9 billion and consumer surplus decreases by an estimated $0.4 billion in the short run. For the scenario in which these AMAs are reduced by 100%, producer surplus decreases by an estimated $10.5 billion and consumer surplus decreases by an estimated $2.0 billion in the short run. The results also indicate that the positive effect of reduced potential oligopsony market power that might result from restricting AMAs is unable to offset the negative effects of increased processing costs and reduced quality associated with restricting AMAs. In describing these results, it is important to note that the economic incentives associated with using individual types of AMAs by individual industry participants may differ from the results for the industry as a whole.

System-wide long-run effects of major types of marketing arrangements on the livestock and meat industries. To examine the system-wide long-run effects of AMAs, we calculated the consumer and producer surplus changes in Year 10 following a restriction on the use of AMAs. Based on a scenario of a 25% reduction in the use of AMAs, producer surplus declines by an estimated $0.7 billion and consumer surplus declines by an estimated $0.2 billion in Year 10 following the restriction. Furthermore, based on a scenario of a 100% reduction in the use of AMAs, producer surplus declines by an estimated $4.0 billion and consumer surplus declines by an estimated $0.8 billion in Year 10 following the restriction. Thus, the effects diminish somewhat over time. As with the short-run results described above, the economic incentives associated with using individual types of AMAs by individual industry participants may differ from the results for the industry as a whole.

In total, cash market methods of selling fed cattle predominate.

The most significant types of spot and alternative marketing arrangements based on the likelihood that the arrangement is or will be used extensively in the livestock and meat industries, including the types of marketing arrangements that are likely to grow in importance and usage and those that are likely to decrease in importance. Based on the transactions data for October 2002 through March 2005, the most significant types of marketing arrangements used in the sale of fed cattle to beef packers are direct trade (58% of head slaughtered) followed by marketing agreements (29% of head slaughtered). Auction barn sales are used much less often but, as indicated in the survey results, more so by smaller producers and smaller packers. Sales through dealers and brokers, forward contracts, and packer ownership are each estimated to be less than 5% of the total fed cattle transactions in the industry. Thus, in total, cash market methods of selling fed cattle predominate. As indicated in the results of the industry survey and interviews, the use of AMAs used in the sale of fed cattle is not expected to change greatly in the future.

For packer sales, the transactions data indicate that the most significant type of marketing arrangements used for the sale of beef products is the cash market. However, many packers did not indicate the sales method used for beef products because they do not track these data. Forward contracts, marketing agreements, and internal company transfers were used, but to a much lesser extent. As with fed cattle transactions, the types and volumes of AMAs used in the sale of beef products are not expected to change greatly in the future based on the results of the industry survey and interviews.

Summary effects of combinations of marketing arrangements across different stages of the supply chain (e.g., used by a combination of producers, packers, retailers, foodservice operators, exporters). At a strategic level, producers, packers, meat processors, and retailers make decisions to procure inputs that will satisfy the quality, volume, and price requirements of their buyers. For example, based on the industry interviews, some marketing arrangements are used upstream (e.g., between the producer and packer) to meet requirements for meat products downstream (e.g., between the packer and retailer). However, based on the data maintained by packers and processors, it is difficult to model specifically the relationship among marketing arrangements across multiples stages of production. Thus, it is unclear whether the use of AMAs for the purchase of fed cattle is associated with the use of AMAs for the sale of beef products.

Based on the results of the different analyses conducted, AMAs are typically associated with higher quality and appear to be used specifically to ensure quality, but the small percentage of cattle sold through auction barns is associated with higher quality in some cases.

Major summary effects of AMAs on consumer demand. Consumer demand for meat is affected by the use of AMAs if those arrangements allow for the production of higher quality products and/or sale of beef products at lower prices. Based on the analysis of the transactions data, we found that fed cattle purchased through marketing agreements had a higher percentage of Choice and Prime Quality Grade cattle without a higher percentage of Yield Grade 4 and 5 cattle. Other procurement methods appear to have a larger tradeoff between preferred quality grade and preferred yield grade. However, quality grades are the measure of quality relevant to the consumer. Using a composite quality index, marketing agreement cattle and packer-owned cattle were associated with relatively higher quality compared with direct trade cattle, but the small percentage of cattle sold through auction barns was associated with the highest quality and the highest variability in quality. The small percentage of cattle sold through forward contract cattle was associated with the lowest quality but also the lowest variability in quality. The percentage of cattle used for branded beef product was relatively similar across most types of AMAs, but substantially higher for packer-fed/owned cattle and substantially lower for cattle purchased through auction barns. Additional analyses conducted using MPR data showed that the use of AMAs for cattle procurement had a relatively small but statistically significant effect on beef quality. Thus, based on the results of the different analyses conducted, AMAs are typically associated with higher quality and appear to be used specifically to ensure quality, but the small percentage of cattle sold through auction barns is associated with higher quality in some cases.

7.2.2 Implications of Expected Changes in Use of AMAs over Time

In this subsection, we summarize our findings related to the implications of expected changes in the use of AMAs for fed cattle purchases and beef product sales.

Implications changes in use of marketing arrangements on price discovery. Price discovery refers to the process by which a buyer and a seller agree on a price for a specific transaction. Price discovery thus depends on the pricing method used for each type of marketing arrangement. The association between types of marketing arrangements and types of pricing methods in the fed cattle and beef industry is as follows:

- auction barns: auction pricing
- direct trade: individually negotiated pricing and sometimes formula pricing
- dealers or brokers: individually negotiated pricing and sometimes formula pricing
- marketing agreements: formula pricing
- forward contracts: formula pricing
- packer ownership: internal transfer pricing[2]

The price discovery process is most apparent for auction pricing, followed by individually negotiated pricing. In the case of formula pricing, the base price is most often based on a publicly available price such as USDA live quotes or dressed

[2] Some packers consider their internal transfer pricing mechanism to be formula pricing, because the internal transfer price is based on a publicly reported price.

Because prices are reported under MPR for different types of marketing arrangements, the effect of the use of AMAs on the price discovery process is minimal.

(carcass) quotes, but, in some cases, the base price is based on plant average prices, plant average costs, or a subscription service price. Internal transfer prices also are often based on a publicly reported price. If the base price used in formula pricing is not reflective of a true market price, then the price discovery process is impeded. However, because prices are reported under MPR for different types of marketing arrangements, the effect of the use of AMAs on the price discovery process is minimal.[3]

Implications of expected changes in use of marketing arrangements on thin markets. Markets are considered thin when the volume of transactions is so few that prices are highly volatile and transactions prices do not always reflect prices in other markets with the same quality of livestock or meat. Cattle procured through AMAs are not sold in auction barns and, thus, may cause thinness of auction markets. Prior to MPR, price, quantity, and quality information for cattle sold through AMAs were not publicly reported or were reported only on a voluntary basis. Without publicly reported data, changes in the use of AMAs can cause cash markets to become relatively thin. However, with the reauthorization of MPR, the effects of changes in the use of AMAs on thinness of markets are attenuated.

An analysis of the relationship between use of AMAs and cash market prices in the beef industry indicates that an increase in the use of AMAs is associated with decreases in the cash market price for fed cattle. However, these results are not necessarily indicative of manipulation of prices by packers but could instead be resulting from benign cattle delivery timing decisions made by price-taking market participants. Furthermore, as noted by Xia and Sexton (2004), removing a share of cattle from the cash market affects both supply and demand in that market. Thus, in a competitive market, the effect on price is ambiguous because it depends on the relative magnitudes of the shifts and on demand and supply elasticities.

Implications of expected changes in use of marketing arrangements on risk management. Participants in the

[3] The Livestock Mandatory Pricing Act was passed by congress in 1999, implemented in 2001, and expired in 2005. It was then reauthorized in 2006, and reimplementation is expected in 2007. In the meantime, many packers are continuing to report prices on a voluntary basis.

Changes in the use of AMAs will have effects on production and price risk for only certain types of AMAs, but changes in the use of any type of AMA will affect market access risk.

production and marketing of fed cattle and beef face production, price, and market access risk. Most AMAs provide little opportunity to shift production risk among market participants. The exceptions are custom feeding arrangements, in which the cattle owners (either a cow-calf producer or a packer) retain some portion of the production risk, or shared ownership arrangements, which shift some risk to the feedlot that is partnering in ownership of the cattle. Thus, changes in the use of these types of AMAs would affect management of production risk. As with production risk, most AMAs provide little opportunity to shift price risk, but each type of marketing arrangement has different levels of price volatility. The exceptions are custom feeding arrangements, in which all of the market price risk is borne by the owner of the cattle, and forward contracts, in which producers shift price risk to the packer. Based on results of analyses for this study, prices for fed cattle during the October 2002 through March 2005 period were least volatile for marketing agreements and most volatile for auction barn sales when controlling for month of sale and cattle quality. In contrast to production and price risk, all AMAs eliminate market access risk for both the buyer and the seller. Thus, changes in the use of AMAs will have affects on production and price risk for only certain types of AMAs, but changes in the use of any type of AMA will affect market access risk. Specifically, reduced use of AMAs would increase market access risk for both buyers and sellers.

Beef products are substitutes for other types of meat and poultry, and thus a decrease in the quality of beef due to reductions in the use of AMAs would decrease the competitiveness of beef relative to its substitutes.

Implications of expected changes in use of marketing arrangements on competitiveness among meats. Competitiveness among meats changes if prices or quality of products change. Based on the simulations conducted in this volume, restrictions on the use of AMAs would decrease the quality of beef products. Beef products are substitutes for other types of meat and poultry, and thus a decrease in the quality of beef due to reductions in the use of AMAs would decrease the competitiveness of beef relative to its substitutes.

If AMAs reduce the viability of public auctions, it may be more difficult for smaller producers to obtain market access.

Implications of expected changes in use of marketing arrangements on ease of entry into each stage of the livestock and meat industries. Ease of entry refers to whether individuals who would like to enter the beef production industry are able to do so. Ease of entry is affected by the availability of AMAs, because financing of production operations often depends on the assurance of market access and price risk management offered by AMAs. However, it may be more difficult for small producers to use AMAs than for large producers because it is more costly for packers to negotiate with many small producers compared with fewer large producers. Therefore, if AMAs reduce the viability of public auctions, it may be more difficult for smaller producers to obtain market access.

Because the beef packing industry exhibits significant economies of scale, there is an incentive for plants to increase in size, and larger plants tend to rely more on AMAs.

Implications of expected changes in use of marketing arrangements on concentration in livestock production and feeding and in meatpacking, structure of the livestock industry, and structure of the meatpacking industry. Based on the analyses conducted for this study, there appear to be no clear effects of the changes in the use of AMAs on concentration and structure of the beef industry. During the past decade, concentration, as measured by CR4, has been relatively flat, as have trends in the use of AMAs in the fed cattle and beef industry. Because the beef packing industry exhibits significant economies of scale, there is an incentive for plants to increase in size, and larger plants tend to rely more on AMAs. Thus, a reduction in the use of AMAs would increase costs of production and possibly reduce the incentive for plants to grow larger in size.

Even without changes in the use of AMAs, we expect to see changes in the structure of the fed beef cattle industry in the near future for two reasons. First, some beef packing plants are expected to close because of the period of losses experienced by many plants during the past few years. Second, beef cattle feedlots and cow-calf producers are faced with higher corn prices, which are expected to remain high for the foreseeable future, and this may reduce the viability of many enterprises. Thus, while the structure of the industry is expected to change, regardless of whether AMA use is restricted, the net effect on the companies that own packing plants is unclear, as is the effect on concentration in the industry.

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Appendix A: Supplementary Analysis of Price Differences across Marketing Arrangements

Table A-1. Coefficient Estimates for Quantile Regressions of Price Differences by Type of Marketing Arrangement, October 2002–March 2005

	Fed Dairy Cattle				Fed Beef Cattle				
Quantile	d_ auction	d_ foward	d_ packer	d_ marketing	d_ auction	d_ forward	d_ packer	d_ marketing	d_ beefcattle
5	–1.91	–8.79	–0.96	0.08	8.50	–1.59	1.50	1.28	4.34
10	–1.20	–7.73	–1.31	–0.27	10.03	–0.85	1.64	1.39	3.88
15	–0.19	–6.90	–1.51	–0.42	10.45	–0.42	1.78	1.43	3.44
20	0.39	–6.14	–1.71	–0.49	11.38	–0.42	1.92	1.43	3.10
25	0.83	–5.24	–1.85	–0.53	12.13	–0.72	2.00	1.43	2.90
30	1.33	–4.70	–1.92	–0.54	12.43	–0.77	2.03	1.41	2.76
35	1.73	–4.28	–1.87	–0.57	12.24	–0.66	1.95	1.40	2.62
40	1.84	–4.02	–1.80	–0.58	12.50	–0.43	1.86	1.37	2.46
45	1.90	–3.79	–1.77	–0.59	11.94	–0.20	1.76	1.35	2.35
50	2.00	–3.47	–1.71	–0.59	11.51	–0.15	1.63	1.30	2.23
55	2.08	–3.28	–1.72	–0.61	10.85	0.05	1.57	1.28	2.07
60	2.11	–2.97	–1.89	–0.58	9.55	0.13	1.68	1.20	1.95
65	2.27	–2.69	–1.82	–0.61	7.69	0.15	1.61	1.16	1.84
70	2.40	–2.46	–1.70	–0.62	5.52	0.13	1.43	1.10	1.79
75	2.81	–2.20	–1.59	–0.61	2.45	0.14	1.30	0.99	1.71
80	3.00	–2.01	–1.70	–0.66	0.28	0.34	1.40	0.95	1.58
85	3.39	–1.74	–1.62	–0.68	–2.01	0.57	1.28	0.86	1.41
90	3.60	–1.61	–1.98	–0.76	–3.18	1.04	1.60	0.82	1.21
95	4.79	–1.28	–2.25	–0.72	–5.03	2.11	1.72	0.62	1.10

Appendix B: Stochastic Equilibrium Displacement Models

Elasticity-based computable equilibria (equilibrium displacement models) or partial equilibria models are commonly used when assessing the effects and/or the costs of potential changes in economic policy or structure. Elasticity-based computable equilibria models are attractive in that they are obtained by simple manipulation or row operations of differential approximations to economic models and are accurate to the degree that the underlying system can be linearly approximated (Davis and Espinoza, 1998; Brester, Marsh, and Atwood, 2004).

In economic modeling, the system's actual parameters are usually unknown and must be estimated or assumed. Most studies use some combination of assumed, previously published, and/or statistically estimated shares and elasticities. In all cases, it should be recognized that uncertainty exists with respect to the model's actual parameters and, as a result, with respect to the policy effects derived using estimated parameters. Davis and Espinoza (1998) illustrate the importance of examining the sensitivity of changes in prices and quantities (as well as producer and consumer surplus) relative to variations in selected elasticity estimates. Also, as a practical matter, the amount of uncertainty with respect to model parameters may vary across parameters. For example, if a number of researchers and statistical methodologies have obtained similar estimates for a given elasticity, the degree of uncertainty with respect to the given elasticity will be less than for a parameter for which published estimates have varied widely across researchers and methodologies.

An additional complication in policy models is that subsets of the model's economic parameters are likely to be correlated, nonnormally distributed, and possibly intractable. For example, elasticities of supply in a vertically structured model might be positively correlated and restricted to be positive, while own-demand elasticities might be positively correlated and restricted to be negative (Davis and Espinoza, 1998). Brester, Marsh, and Atwood (2004) use Monte Carlo simulations of an equilibrium displacement model in which elasticities among vertical demand and supply sectors are correlated.

As indicated below, if independent marginal distributions of a model's parameters can be approximated, Monte Carlo simulation techniques can be used to introduce correlation between marginal pseudo-samples from possibly widely divergent statistical families of distributions. However, in such cases, the common methods for generating correlated multivariate normal random variates are inappropriate if applied directly to the marginal pseudo-samples themselves.

We use a variant of the Iman-Conover (1982) process for generating correlated random variables. The Iman-Conover process is attractive in that marginal distributions can be simulated independently from most continuous distributions. Each of the independently generated marginal samples is then merely reordered to obtain a rank correlation similar to the desired correlation structure. The Iman-Conover process is straightforward and easy to implement in most common spreadsheets and statistical packages. The following examples were developed in “R”—a free public source statistical modeling software package.

We first demonstrate why traditional procedures for generating correlated multivariate normal random variates are inappropriate for a general set of marginal distributions. We then demonstrate the use of Iman-Conover procedures for introducing correlation while preserving all marginal pseudo-samples.

B.1 GENERATING MULTIVARIATE NORMAL PSEUDO-SAMPLES

The most commonly used procedures for generating correlated multivariate normal samples exploit the fact that linear combinations of normal random variates are themselves normally distributed. Assume that an n by k multivariate normal “sample” Z_C with covariance matrix Σ is desired. A common procedure to generate such a sample matrix is to initially populate an n by k matrix Z_1 with randomly and independently generated normal (0,1) random variates. If the random variates in Z_1 are independently generated, the expected covariance matrix of Z_1 is a k by k identity matrix I_1. However, for finite samples the realized sample covariance matrix is computable as

$$\hat{\Sigma}_{Z_1} = Z_1' \left[\frac{1}{n-1} \left(I_n - \frac{1}{n} \underline{1}_n \underline{1}_n \right) \right] Z_1' \hat{C} Z_1 \qquad \text{(B.1)}$$

and may not equal I_k. In the above expression, $\underline{1}_n$ is an n by 1 vector with each element equal to 1, and $\hat{C}$ is the sample covariance operator. Procedures similar to those presented in Greene (2003) can be used to easily demonstrate that $Y'\hat{C}Y$ is the sample covariance matrix of any corresponding sample matrix Y.

Before proceeding, we apply an Iman-Conover "whitening" process by factoring $\hat{\Sigma}_{Z_1} = U'U$ using a Cholesky or similar factorization algorithm. If Z_1 was generated randomly, the matrix U will be nonsingular and a "whitened" sample matrix Z_W can be constructed as $Z_W = Z_1U^{-1}$. Because the columns of Z_W are linear combinations of the columns of Z_1, the n by k sample Z_W will be multivariate normal with sample covariance matrix:

$$\hat{\Sigma}_{Z,W} = Z_W'\hat{C}Z_W = \left(U^{-1}\right)' Z_1'\hat{C}Z_1U^{-1} = \left(U^{-1}\right)'\hat{\Sigma}_{Z_1}U^{-1} = \left(U'\right)^{-1}U'UU^{-1} = I_k. \quad \text{(B.2)}$$

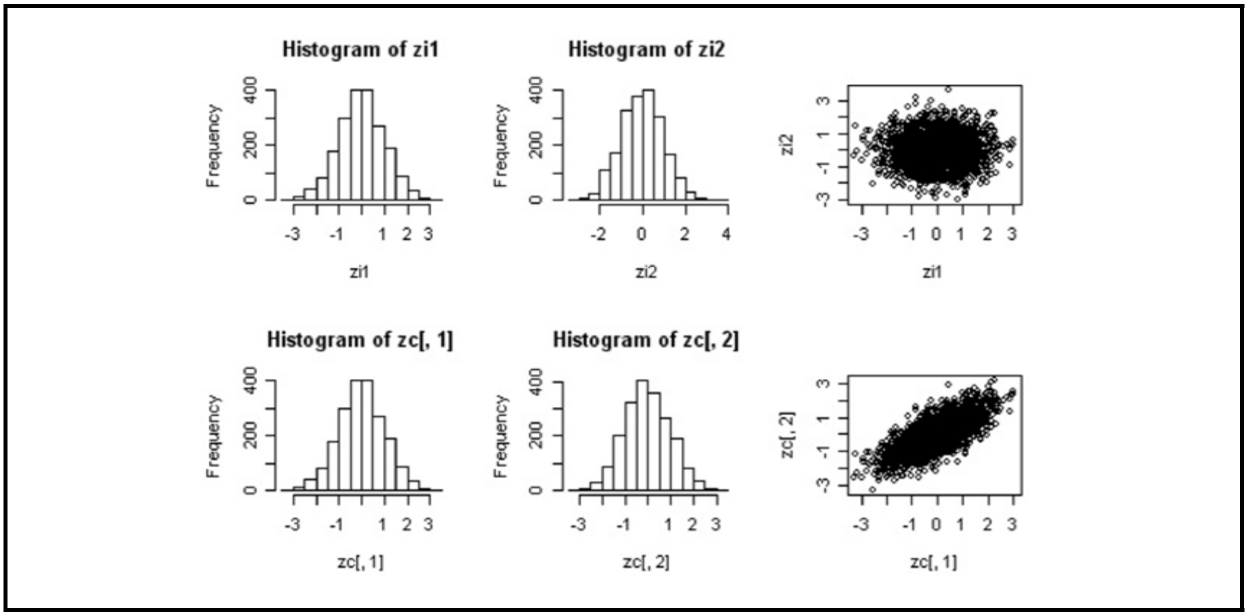
Obtaining a multivariate normal sample Z_C with sample covariance matrix Σ is accomplished by factoring $\Sigma = V'V$ and generating $Z_C = Z_WV$, which has sample covariance matrix:

$$\hat{\Sigma}_{Z_C} = Z_C'\hat{C}Z_C = V'Z_W'\hat{C}Z_WV = V'\hat{\Sigma}_{Z_W} = V'V = \Sigma. \quad \text{(B.3)}$$

Because each column of Z_C is generated as linear combinations of the columns of Z_W, the columns in Z_C are distributed multivariate normal while having a sample covariance equal to the desired covariance matrix Σ. The panels in Figure B-1 plot the results of applying the above process with 2,000 observations on two normal variates with a target correlation of 0.7. The top three panels are histograms of the two independently generated normal (0,1) variates and a joint scatter plot. The bottom three panels in Figure B-1 present histograms and a joint scatter plot of the two marginals after the above transformations were applied. The resulting correlation between the two marginals is 0.7.

In the following discussion we return to the multivariate normal matrix Z_C because it is integral to the variant of the Iman-Conover procedure that we use. In the next section, we demonstrate why the above process for generating correlated random variables (taking linear combinations of independently generated marginals) is not appropriate when working with nonadditively regenerative marginal distributions.

Figure B-1. Plots of Normally Random Variates Before and After Transformation

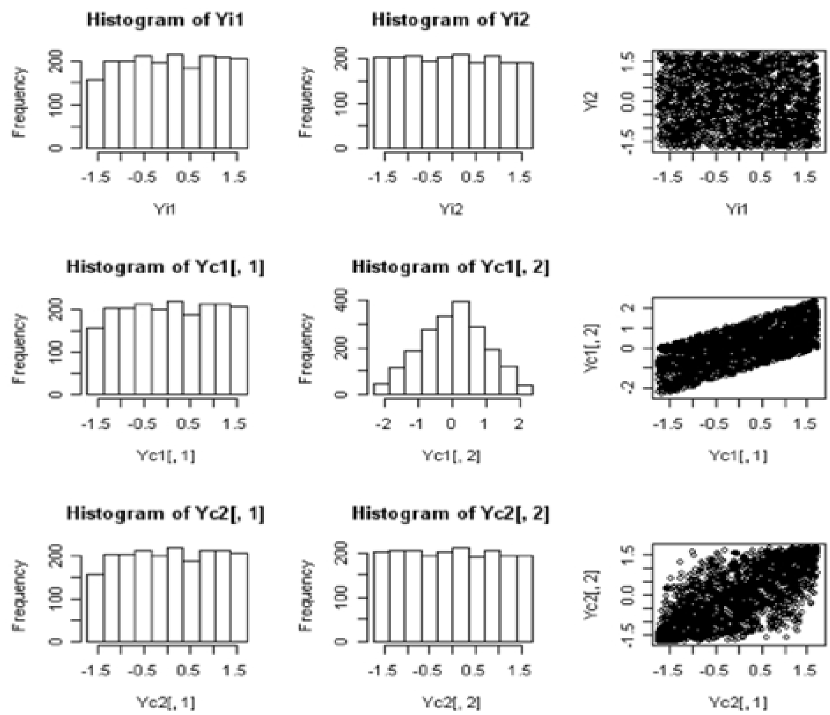


B.2 LINEAR COMBINATIONS OF NONREGENERATIVE DISTRIBUTIONS

The top three panels in Figure B-2 present histograms and a joint scatter plot from a 2,000 by 2 bivariate pseudo-sample Y_1 generated as two independent *uniform* $-\sqrt{3}, \sqrt{3}$ distributions with mean 0 and variance 1. The histograms and scatter plot of the marginal distributions indicate that the pseudo-samples appear to be uniformly and independently distributed over the $-\sqrt{3}, \sqrt{3}$ interval.

Assume that a correlated bivariate uniform distribution is desired with correlation 0.7. Because the uniform distribution is not additively regenerative, generating correlated variates using the Cholesky decomposition weighted-average procedure destroys the original marginal distributions. The middle three panels in Figure B-2 demonstrate this result. With a bivariate distribution, the Cholesky decomposition transformation leaves the first marginal unchanged. However, the second variate is reconstructed as a linear combination of both the original marginal samples. The second histogram in the middle set of panels clearly shows that the resulting variate is not uniformly distributed although the correlation between the two transformed random variates is 0.7. The scatter plot of the joint observations is presented in the third panel of Figure B-2.

Figure B-2. Results of Generating Correlated Uniform Random Variates



The results of applying the Iman-Conover process to the uniform marginal samples are presented in the third panel of plots in Figure B-2.[1]

---

[1] As we indicate above, the Iman-Conover process can easily be implemented in Excel or other programming environments. Following is R code that can be used to compute the reordered correlated pseudo-sample. The user calls the function with the Y_I and SIGMA matrices. The function returns the correlated Y_C sample matrix.

```
ImanConover=function(yi,sigma) {yc=yi
ydim=dim(yi)            # record the dimension of the YI matrix
zi=matrix(rnorm(ydim[1]*ydim[2]),ydim[1],ydim[2])   # populate the
   normal(0,1) ZI matrix

zc=(zi %*% (solve(chol(cov(zi)))) %*% (chol(sigma))  # create the
   correlated ZC matrix

for (j in 1:ncols) {
 ys=sort(yi[,j])
 yc[,j]=ys[rank(zc[,j])]              # create the correlated YC matrix
 }
yc
}
```

Because the Iman-Conover process merely involves reordering the original marginal pseudo-sample, the process has clearly not affected the histograms of the marginal distributions. The Pearson correlation of the transformed variates for this example is about 0.695. The third plot in panel three is a scatter plot of the joint distribution after the reordering process.

The Iman-Conover process can easily be used to generate correlated random variables over a wide range of possible functional forms for the marginal distributions in an economic policy simulation model.

B.3 GENERAL SIMULATION ISSUES

All simulations were conducted after selecting prior distributions for each of the elasticities used in the model. We apply nonstandard beta priors to the estimated demand and supply elasticities. The use of nonstandard beta distributions maintains original means and standard deviations for each elasticity. In addition, nonstandard beta distributions allow demand elasticities to be constrained to always be negative and supply elasticities to always be positive.

A sensitivity analysis of an equilibrium displacement model should consider both variations of elasticity estimates and correlations among these estimates (Davis and Espinoza, 1998). We assume that demand elasticities are uncorrelated with supply elasticities across the SUR block models. However, estimated correlations among the demand elasticities and among the supply elasticities are used in the simulation.

All of the Monte Carlo simulations conducted in Section 6 are the result of 1,000 iterations. Empirical distributions are generated for each endogenous variable and for all estimates of changes in consumer and producer surplus. We use these empirical distributions to develop reported means, confidence intervals, and P values for our results (Brester, Marsh, and Atwood, 2004).

January 2007

GIPSA Livestock and Meat Marketing Study

Contract No. 53-32KW-4-028

Volume 4: Hog and Pork Industries
Final Report

Prepared for

Grain Inspection, Packers and Stockyard Administration
U.S. Department of Agriculture
Washington, DC 20250

Prepared by

RTI International
Health, Social, and Economics Research
Research Triangle Park, NC 27709

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Abstract

Over time, the variety, complexity, and use of alternative marketing arrangements (AMAs) have increased in the livestock and meat industries. Marketing arrangements refer to the methods by which livestock and meat are transferred through successive stages of production and marketing. Increased use of AMAs raises a number of questions about their effects on economic efficiency and on the distribution of the benefits and costs of livestock and meat production and consumption between producers and consumers. This volume of the final report focuses on AMAs used in the hog and pork industry and addresses the following parts of the Grain Inspection, Packers and Stockyard Administration (GIPSA) Livestock and Meat Marketing Study:

- Part C. Determine extent of use, analyze price differences, and analyze short-run market price effects of AMAs.
- Part D. Measure and compare costs and benefits associated with spot marketing arrangements and AMAs.
- Part E. Analyze the implications of AMAs for the livestock and meat marketing system.

This final report follows the publication of an interim report for the study that used qualitative sources of information to identify and classify AMAs and describe their terms, availability, and reasons for use. The portion of the study contained in this volume of the final report is based on quantitative analyses, using industry survey data from producers, feeders, packers, processors, wholesalers, retailers, and food services, as well as transactions data and profit and loss (P&L) statements from packers and processors.

This volume of the final report presents the results of analyses of the effects of AMAs on the markets for hogs and pork products. Economic and statistical models were developed and estimated to examine the effects of AMAs on hog and pork prices, procurement costs, quality, price risk, and consumers

and producers. Results of analyses of the estimated effects of hypothetical restrictions on AMAs are also presented.

The principal contributors to this volume of the final report are the following:

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This report and the study on which it is based were completed under a contract with GIPSA, U.S. Department of Agriculture (USDA). Any opinions, findings, and conclusions or recommendations expressed in this report are those of the authors and do not necessarily reflect the views of GIPSA or USDA.

Contents

Figures

Tables

Executive Summary

As part of the congressionally mandated Livestock and Meat Marketing Study, this volume of the final report presents the results of analyses of the effects of alternative marketing arrangements (AMAs) in the hog and pork industries. This final report focuses on determining the extent of use of AMAs, analyzing price differences and price effects associated with AMAs, measuring the costs and benefits associated with using AMAs, and assessing the broad range of implications of AMAs. The analyses in this volume were conducted using the results of industry interviews; the industry surveys; and the analysis of individual packers' transactions data, individual packers' profit and loss (P&L) data, Mandatory Price Reporting (MPR) data, Agricultural Resource Management Survey (ARMS) data, and other publicly available data.

In this report, AMAs refer to all possible alternatives to the cash or spot market. AMAs include arrangements such as forward contracts, marketing agreements, procurement or marketing contracts, production contracts, packer owned, custom feeding, and custom slaughter. Cash or spot market transactions refer to transactions that occur immediately, or "on the spot." These include auction barn sales; video or electronic auction sales; sales through order buyers, dealers, and brokers; and direct trades.

The central focus of this report is the market segment between hog producers/farmers and pork packers. In the simulation analyses, the effects of hypothetical restrictions on the use of AMAs were evaluated for the entire vertically integrated chain, from producers to packers to consumers. The other analyses focus, in particular, on hog producers and pork packers. The analyses rely primarily on the data reported in the hog producers' survey, the pork packers' survey, the packer purchasing side of the individual transactions data, and the individual packers' P&L data. To supplement the analyses conducted using the survey and transactions data and to address some of the specific study questions, secondary and publicly available data were used also.

Primary conclusions for this final report, as they relate to the hog and pork industries, are as follows:

- **AMAs are an integral part of hog producers' selling practices and pork packers' procurement practices.** There are significant regional differences in the observed patterns of use of AMAs: a stronger reliance on cash/spot markets and marketing contracts is apparent in the Midwest and a stronger reliance on production contracts and packer ownership of hogs is apparent in the East. The pattern of future use of AMAs is not expected to change dramatically; hence, we do not expect that hog industry industrialization will emulate the industrialization of the poultry sector.
- **Based on individual transactions data, there are substantial differences in daily hog prices paid by packers on a carcass weight basis.** On average, the price dispersion is about 40% of the average value of the transaction prices each day. One part of such strong price dispersion can be explained by factors such as region, quality, or plant size. However, even after controlling for these factors, the remaining differences must be due to organizational issues related to supply chain management in the pork processing sector.
- **Results indicate that, on average, plants that use a combination of marketing arrangements pay lower prices for their hogs relative to plants that use the cash/spot market only.** In addition, comparing the magnitudes of the portfolio effects to the magnitudes of the individual marketing arrangement effects shows that individual marketing arrangements have minimal additional impact on the average price after accounting for the portfolio effect. That is, the portfolio system categorical variables capture almost the entire effect on lowering the average price.
- **Of particular interest for this study is the effect of both contract and packer-owned hog supplies on spot market prices; as anticipated, these effects are negative and indicate that an increase in either contract or packer-owned hog sales decreases the**

spot price for hogs. Specifically, the estimated elasticities of industry derived demand indicate

– a 1% increase in contract hog quantities causes the spot market price to decrease by 0.88%, and

– a 1% increase in packer-owned hog quantities causes the spot market price to decrease by 0.28%.

A higher quantity of either contract or packer-owned hogs available for sale lowers the prices of contract or packer-owned hogs and induces packers to purchase more of the now relatively less expensive hogs and purchase fewer hogs sold on the spot market.

- **Based on tests of market power for the pork industry, we found a statistically significant presence of market power in live hog procurement.** However, the results regarding the significance of AMA use for procurement of live hogs in explaining the sources of that market power are inconclusive. Whereas the model based on farm–wholesale price spread data shows that a higher proportion of AMA use leads to increased market power, the model estimated with company-level individual transactions data indicates that AMA use may not be a source of market power in pork packing.
- **Estimated total and average cost functions indicate that economies of scale diminish as the pork packing firm size increases.** The estimates indicate that the scale economies are exhausted well within the sample output range such that the biggest plants already exhibit negative returns to scale. That is, they operate on the upward-sloping portions of their average cost curves. The observed patterns of procurement portfolio choices by packers also indicate that certain combinations of marketing arrangements may reduce costs and/or increase economies of scale. In particular, relative to using spot market procurements alone, all other combinations of marketing arrangements improve the efficient scale of production.
- **Based on the observation that packers use marketing arrangements in clusters (portfolios), we hypothesized that marketing arrangements may be complementary to each other in the sense that implementing one procurement practice may increase the marginal return of the other practice; however, the analyses of the complementarity of marketing arrangements produced inconclusive results.** Simpler tests based on the correlation/association approach indicate that marketing

contracts are in fact complementary to production contracts and/or packer owned arrangements. Also, the portfolio coefficients in the performance equations based on either the earnings before insurance and taxes (EBIT) or the gross margin show that all marketing arrangement portfolios improve plant performance relative to simple spot market purchases. However, the coefficient associated with the portfolio of three marketing arrangements is smaller than the coefficient associated with portfolios of two marketing arrangements, thus violating the complementarity requirement. More conclusive formal tests were not feasible given data limitations.

- **To analyze quality differences in live market hogs across alternative procurement methods (AMAs), we tested whether various quality attributes used by the industry are significantly different across AMAs and found that different AMAs are associated with different levels of quality of hogs.** Even though the rankings are not unique, we found that marketing contracts (especially other purchase arrangements and other market formula purchases) are consistently associated with higher quality hogs than negotiated (spot market) purchases.
- **An examination of the relationship between the proportion of AMAs used to procure live hogs and the quality of resulting pork products indicates that a higher proportion of AMA use is associated with higher quality pork products.** We measured pork product quality using Hicks' composite commodity index and hypothesized that a higher percentage share of the AMAs (essentially marketing contracts and packer-owned hogs) should produce higher quality pork products. The correlation coefficient showed that these two series are positively correlated, thus confirming our hypothesis.
- **An analysis of risk associated with different marketing arrangements shows that different types of marketing arrangements exhibit different price volatilities as measured by the variance of prices.** Therefore, hog producers selling hogs using different types of marketing arrangements experience different levels of risk. From the hog producers' point of view, the ordering of marketing arrangements in decreasing order of risk is as follows: (1) spot/cash market sales; (2) marketing contracts in which the pricing formula is based on spot market prices; (3) marketing arrangements in which the pricing formula is

based on some futures or options price; (4) other purchase arrangements containing ledgers, windows, and other pricing mechanisms, which may serve as a cushion against price volatility; and (5) production contracts.

- **In analyzing the importance of hog producers' risk aversion for contract choice, we found that hog producers who use production contracts are more risk averse than producers who use cash/marketing arrangements.** The difference in risk exposure between contract producers and independent farmers is substantial because production contracts eliminate all but 6% of total income volatility. Therefore, the utility losses associated with forcing producers to market their hogs through channels different from their risk-aversion-preferred marketing arrangement choice are substantial.
- **In analyzing the economic effects of hypothetical restrictions on the use of AMAs in the hog and pork industries, we found that hog producers would lose because of the offsetting effects of hogs diverted from AMAs to the spot market, consumers would lose as wholesale and retail pork prices rise, and packers would gain in the short run but neither gain nor lose in the long run.** The results applied to three different simulations: (1) 25% reduction in both contract- and packer-owned hogs, (2) increase the spot/cash market share to 25%, and (3) complete ban of packer-owned hogs. The reason that producers and consumers lose in all three simulation scenarios is because of efficiency losses from reducing the proportion of hogs sold through contracts and/or packer owned channels. Although a reduction in AMAs leads to an improvement for hog producers through a reduction in the degree of market power, the loss in cost efficiencies offsets the gains from reduced market power. In all instances, the price spread between farm and wholesale prices would be expected to increase because of the net increase in the costs of processing. Moreover, wholesale, and hence retail, prices would increase, causing pork to become more expensive for consumers.

Decisions regarding methodologies, assumptions, and data sources used for the study had to be made in a short period of time. The analyses presented in this volume are based on the best available data, using methodologies developed to address the study requirements under the time constraints of the study.

However, we faced many challenges in resolving inconsistencies within each source and across sources of data under the tight schedule dictated by the study. For example, the plant-level comparison of procurement methods for market hogs between the individual transactions data and survey data reveals substantial differences in some cases. Also, the differences between carcass weight prices and liveweight prices indicate an unreasonably high implicit average yield ratio, which we were unable to resolve. Throughout the report, secondary data, as available, were used to supplement primary data to conduct the analyses.

1 Introduction and Background

AMAs include all possible alternatives to the use of cash or spot markets for conducting transactions.

As part of the congressionally mandated Livestock and Meat Marketing Study, this volume of the final report presents the results of analyses of the effects of AMAs in the hog and pork industries. The types of questions posed by the Livestock and Meat Marketing Study include the following: What types of marketing arrangements are used? What is the extent of their use? Why do firms enter into the various arrangements? What are the terms and characteristics of these arrangements? What are the effects and implications of the arrangements on participants and on the livestock and meat marketing system?

The overall study comprises five parts based on the performance work statement in the contract with GIPSA. An interim report released in August 2005 addressed the first two parts, Parts A and B, of the study (Muth et al., 2005). It described marketing arrangements used in the livestock and meat industries and defined key terminology.[1] Results presented in the interim report were preliminary because they were based on assessments of the livestock and meat industries using published data, review of the relevant literature, and industry interviews.

This final report describes the results of quantitative analyses addressing Parts C, D, and E of the study as follows:

- Part C. Determine extent of use, analyze price differences, and analyze short-run market price effects of AMAs.

[1] A glossary of terms used in the study is included as a separate document.

The interim report released in August 2005 addressed the first two parts of the study. This final report focuses on the final three parts of the study (Parts C, D, and E).

- Part D. Measure and compare costs and benefits associated with spot and AMAs.
- Part E. Analyze the implications of AMAs for the livestock and meat marketing system.

The analyses presented in this volume address these final three parts of the study using information from industry interviews,[2] data from the industry surveys (described in Volume 2), transactions data and profit and loss statements from packers and processors, and a variety of publicly available data. Analyses conducted for the Livestock and Meat Marketing Study are limited to economic factors associated with spot and AMAs and do not analyze policy options or make policy recommendations.

1.1 OVERVIEW OF THE HOG AND PORK INDUSTRIES

In this section, we describe the stages of hog production and location of operations as background information for analyses described in later sections of this volume.[3]

1.1.1 Stages of Pork Production

Traditionally, hogs were raised in farrow-to-finish operations on small diversified farms where hogs provided price risk protection for grain production. Starting in the 1950s, many farmers adopted new technologies that allowed them to grow and specialize in feed grain production. Some farmers discontinued hog production because the opportunity cost of time and land increased, and risk protection for feed grains was supplemented by income and price supports (Spinelli, 1991). Hogs are now commonly produced by specialized operations that separate production facilities for each phase of production and purchase or process their feed rations.

The production phases are categorized into three segments: farrow-to-wean, wean-to-feeder, and feeder-to-finish. The output from one production segment is generally the input into the next segment; however, the lines that separate each segment are less pronounced in actual production. Figure 1-1 illustrates a typical timeline for hog production.

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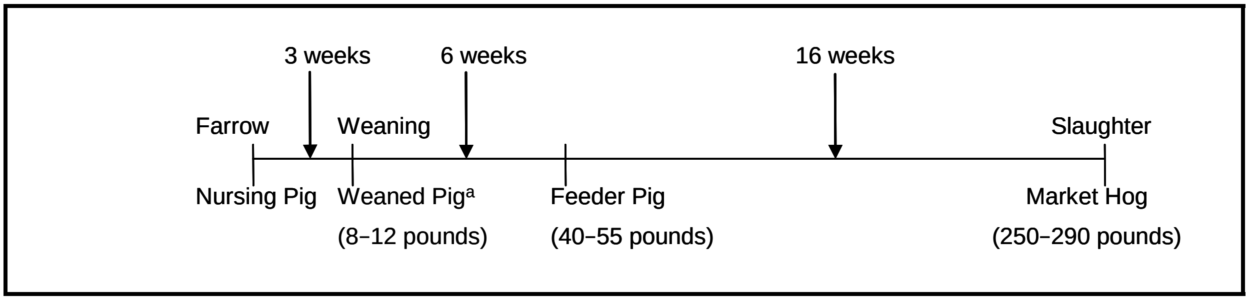
[2] A description of the process for conducting the interviews and the complete findings from the interviews is provided in the interim report (Muth et al., 2005).

[3] A more complete overview of the hog and pork industries is provided in the interim report (Muth et al., 2005).

Figure 1-1. Hog Production Timeline
Capital-intensive production has solidified hog production methods into relatively precise segments.



[a] Also known as nursery pig or isowean.

During the **farrow-to-wean** phase, hog producers house parent stock sows that are bred by natural or artificial insemination for the production of nursing pigs. These pigs are weaned from the sow at 2 to 3 weeks of age, at which time they weigh between 8 and 12 pounds each.

Following the farrow-to-wean stage, hogs enter the **wean-to-feeder** production stage. This transition occurs in several different ways: weaner pigs might remain at the same physical location as the sow, weaner pigs might be shipped to a separate location, or younger aged isoweans might be shipped to a separate (isolated) nursery facility. Whichever method is used, the pigs are fed for approximately 6 weeks until they weigh between 40 and 55 pounds. The hogs are then ready to enter the final feeder phase of production.

In the **feeder-to-finish** segment, feeder pigs are fed for approximately 16 weeks until they reach a market weight of 250 to 290 pounds. Operations that retain weaned hogs up to the feeder stage might continue to feed those animals to market weight (farrow-to-finish operations), or they might choose to sell the hogs rather than feed them (farrow-to-feeder operations). Hogs from nursery operations are transferred into a separate finishing operation. Some growers specialize in the final two production stages and purchase weaner pigs to raise them to slaughter weight (wean-to-finish). However, given the vastly different level of care weaner pigs need relative to finishing hogs, this type of production is not as common.

Some packers only slaughter hogs and sell the carcasses to a separate processor or breaker; however, the majority of packers have their own fabrication facilities.

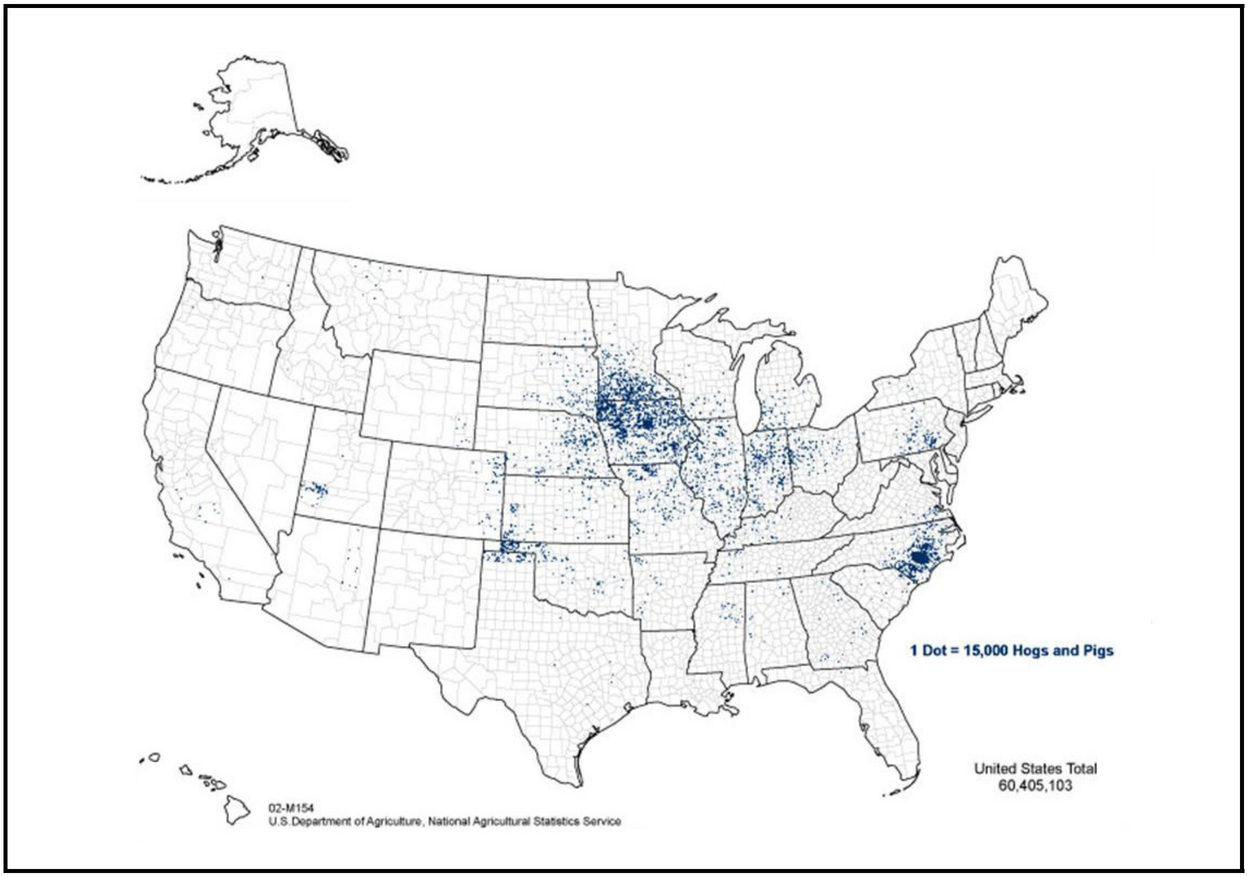
Regardless of the method used to raise the pigs, the finished market hogs are shipped to a slaughter facility (packer). As with all meat types, hog carcasses are inspected for wholesomeness by the U.S. Department of Agriculture (USDA)/Food Safety and Inspection Service (FSIS) or by a state government inspection system. However, unlike beef, pork is rarely quality graded by USDA/Agricultural Marketing Service (AMS). Instead, packers rely on other measures of quality, such as lean percentage, back fat, and loin eye depth. After the hogs have been slaughtered, the carcasses are chilled and then sent to the fabrication area of the plant where they are broken down into pork cuts. Some packers only slaughter hogs and sell the carcasses to a separate processor or breaker; however, the majority of packers have their own fabrication facilities. The largest cuts are primals consisting of groups of muscles from the same area of the carcass. These primals are further cut into subprimals and portion cuts. Fresh meat cuts are typically sold as boxed pork, which refers to similar cuts that are boxed together for shipping. Many of these meat cuts will still need to be further processed or repackaged by the buyer before they are ready for sale to consumers. Packers also package case-ready meats that are ready to be placed in the retail meat case.

1.1.2 Locations of Pork Operations

Hog production has been shifting over time from the Corn Belt States to other states such as North Carolina, Oklahoma, Utah, and Wyoming.

Hog production in the United States has historically been concentrated in the Corn Belt States. In 1990, Iowa, Illinois, Minnesota, Indiana, and Nebraska had the largest hog inventories in the country (USDA/NASS, 1994). As discussed above, hog production was traditionally part of diversified farming practices, and given that feed costs account for approximately 60% of the cost for producing market hogs (Lawrence, Kliebenstein, and Hayenga, 1998), hog producer operations were located close to feed supplies. However, by 1994, North Carolina had the second largest hog inventory in the country (USDA/NASS, 1998), thus indicating a shift in production locations. Between 1990 and 2003, the largest growth percentages in hog inventory were in Utah, Oklahoma, Wyoming, and North Carolina, respectively. Figure 1-2 maps the U.S. inventory of hogs in 2002. Many of the nontraditional hog-producing states now supply the Corn Belt States with feeder pigs. For example, in 2003 Iowa imported as many feeder hogs from Canada and other states as it produced locally

Figure 1-2. U.S. Inventory of Hogs and Pigs, 2002
Most of the hog production is conducted in the Corn Belt and the Southeast.



Source: U.S. Department of Agriculture, National Agricultural Statistics Service. 2004. "2002 Census of Agriculture." Washington, DC: USDA. <http://www.nass.usda.gov/research/atlas02/>.

(Haley, 2004), suggesting that producers in Iowa are becoming more specialized in feeding operations.

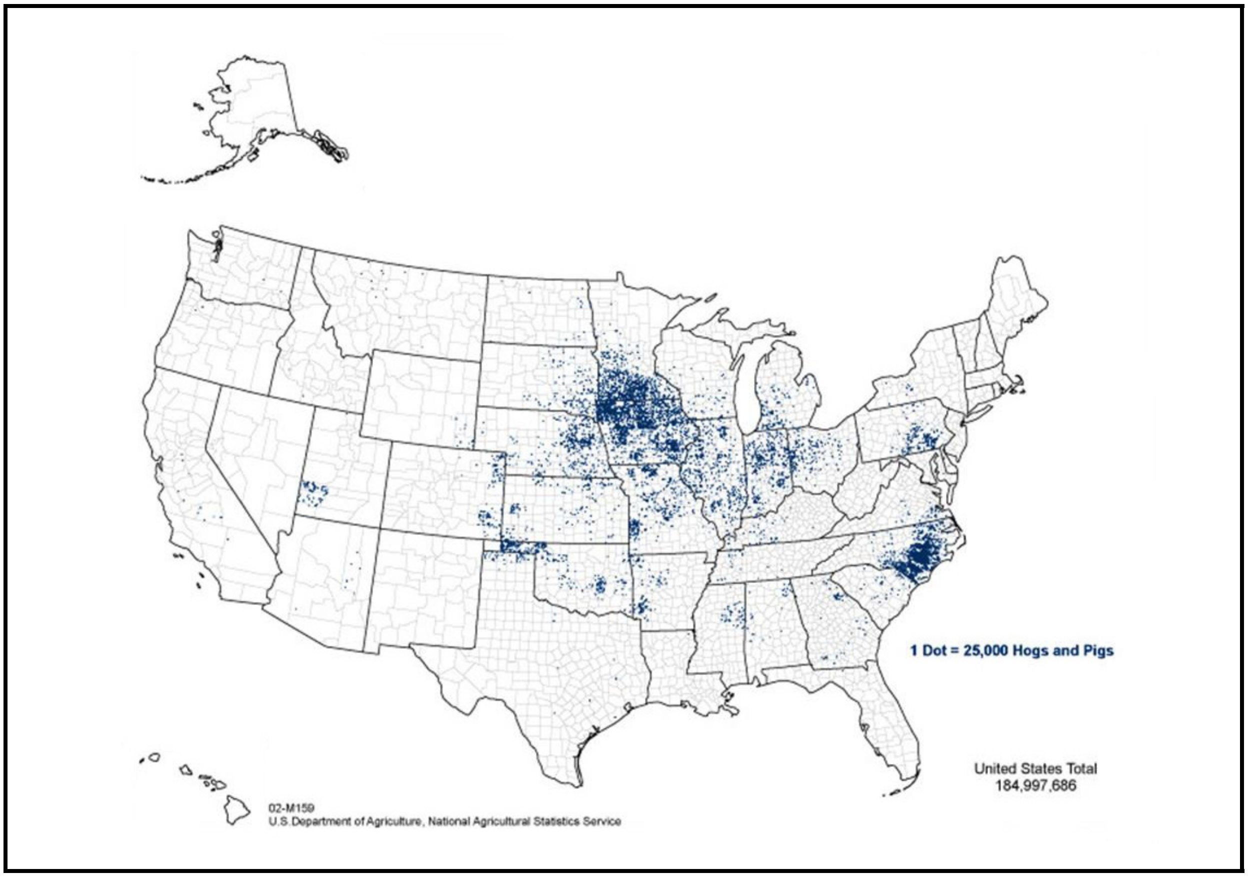
Transporting intermediate-stage hogs to different geographical areas is a relatively new practice. Hog production has always been unique compared with other livestock species, in that breeding and finishing occur in the same area. Figure 1-3 shows that in 2002 the regions of the Southeast and the Corn Belt that dominate production were also the regions where most hogs are sold.

> The largest hog packers are located close to hog production facilities.

As the location of hog inventories has changed, so has the location of slaughter facilities (Figure 1-4). In 1990, almost 60% of U.S. slaughter capacity was located in Iowa and surrounding states. By 2003, North Carolina had become the second largest state in slaughter capacity. Large increases in hog inventories for nontraditional hog-producing states (e.g.,

Figure 1-3. Number of Hogs and Pigs Sold, 2002

All phases of hog production are conducted in the same geographical locations.



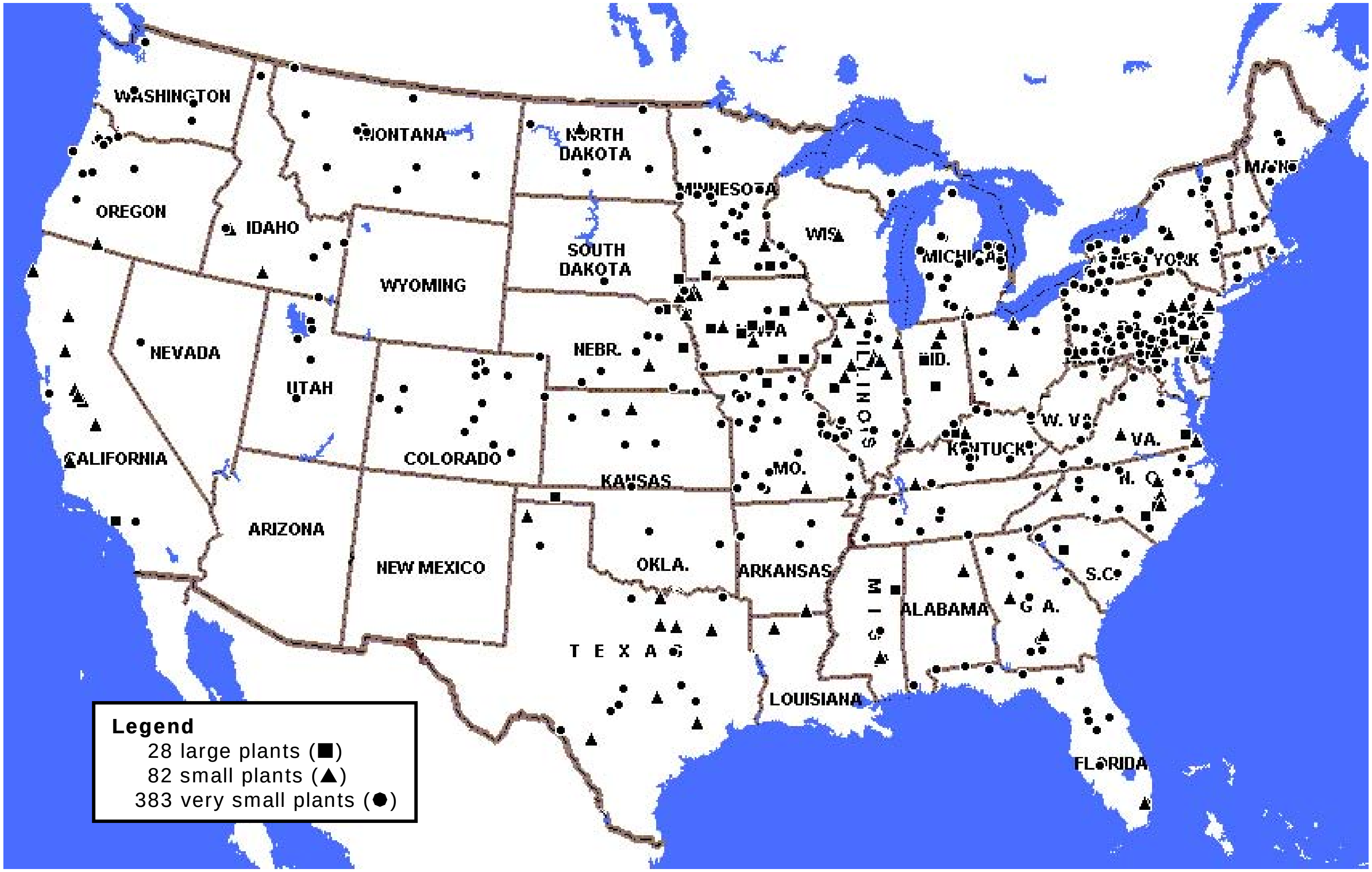
Source: U.S. Department of Agriculture, National Agricultural Statistics Service. 2004. "2002 Census of Agriculture." Washington, DC: USDA. <http://www.nass.usda.gov/research/atlas02/>.

Oklahoma and North Carolina) directly coincide with the opening of large slaughter facilities in those states. Comparing Figures 1-3 and 1-4 shows that the largest packers continue to be located close to production facilities.

1.1.3 Trends in Pork Operations

The total U.S. inventory of hogs and pigs (Figure 1-5) has remained relatively stable since 1990; however, there has been significant variation within the individual stages of production. The number of breeding hogs decreased 17% from 1991 to 2005. During the same period, the number of market hogs increased by more than 9%.

Figure 1-4. Location of Federally Inspected Plants that Slaughter Barrows and Gilts[a]

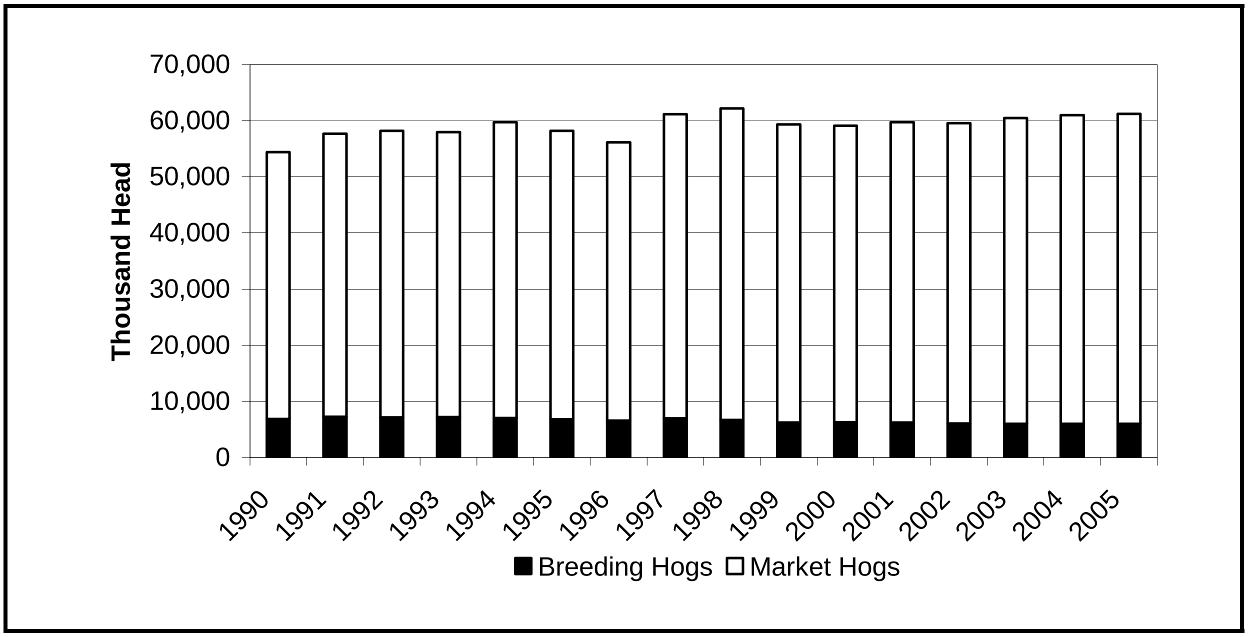


[a] Plants that slaughtered at least 50 head of barrows and gilts in FY2004 (October 1, 2003 through September 30, 2004) are included. Of 493 plants, 28 are classified by FSIS as large, with 500 or more employees; 82 are classified as small, with 10 to 499 employees; and 383 are classified as very small, with fewer than 10 employees or less than $2.5 million in annual sales. Plants in Alaska (2) and Hawaii (5) are not shown.

Source: RTI International. 2005. Enhanced Facilities Database. Prepared for the U.S. Department of Agriculture, Food Safety and Inspection Service. Research Triangle Park, NC: RTI.

Figure 1-5. U.S. Inventory of Hogs and Pigs, December 1, 1990–2005

Hog and pig inventory categories include breeding hogs (all hogs kept for breeding purposes) and market hogs (all hogs from those less than 60 pounds to those greater than 180 pounds that are intended for sale as market hogs).



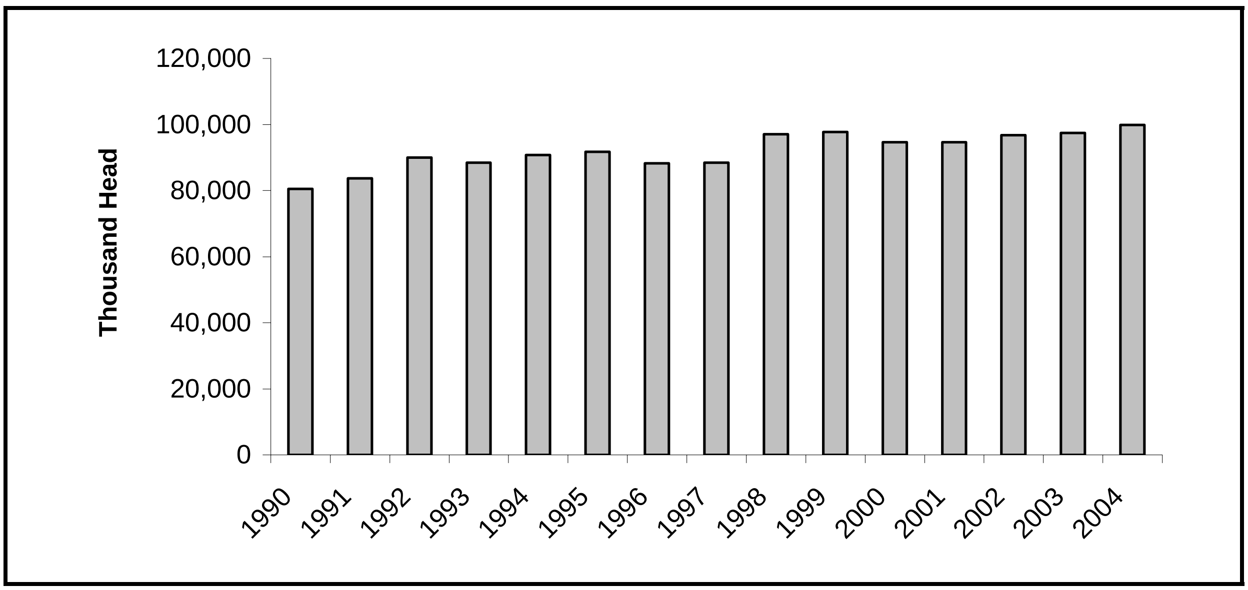
Source: U.S. Department of Agriculture, Economic Research Service, Market & Trade Economics Division. 2006. *Red Meat Yearbook*. Stock #94006. Washington, DC: USDA. <http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1354.>

The net effect of the changing domestic herd and Canadian imports is a steadily growing number of market hogs, barrows, and gilts slaughtered by U.S. packers.

To reconcile the difference between the decreasing size of the breeding herd and the increasing number of market hogs, a comparison can be made between the number of pigs born per litter and the number of pigs per breeding animal. The number of pigs per breeding animal per year grew by 57% between 1979 and 2001, with 29% of that increase attributed to the increase in the average litter size. The remaining 71% is attributed to the increase in the number of litters per sow per year (USDA/NASS, 2002). Collectively, this shows that the efficiency of the U.S. breeding herd is improving in terms of delivering more pigs from a smaller breeding herd. The difference between the decreasing breeding herd and the increasing number of market hogs is also partially offset by imported feeder hogs. Canada is the primary supplier of live hogs to the United States, providing 99.99% of the 7 million plus hogs imported in 2003 (Haley, 2004). More than 65% of those animals were imported as 10- to 40-pound feeder hogs that were fed to slaughter weight in the United States.

The net effect of the changing domestic herd and Canadian imports is a steadily growing number of market hogs (barrows and gilts) slaughtered by U.S. packers (Figure 1-6). Market hogs constitute over 96% of the hogs slaughtered in the country (USDA/GIPSA, 2002). The average annual growth in slaughter volume was approximately 2% between 1990 and 2004.

Figure 1-6. U.S. Commercial Barrow and Gilt Slaughter, 1990–2004
Commercial barrow and gilt slaughter includes animals slaughtered at federally inspected and nonfederally inspected plants but does not include animals slaughtered on the farm.

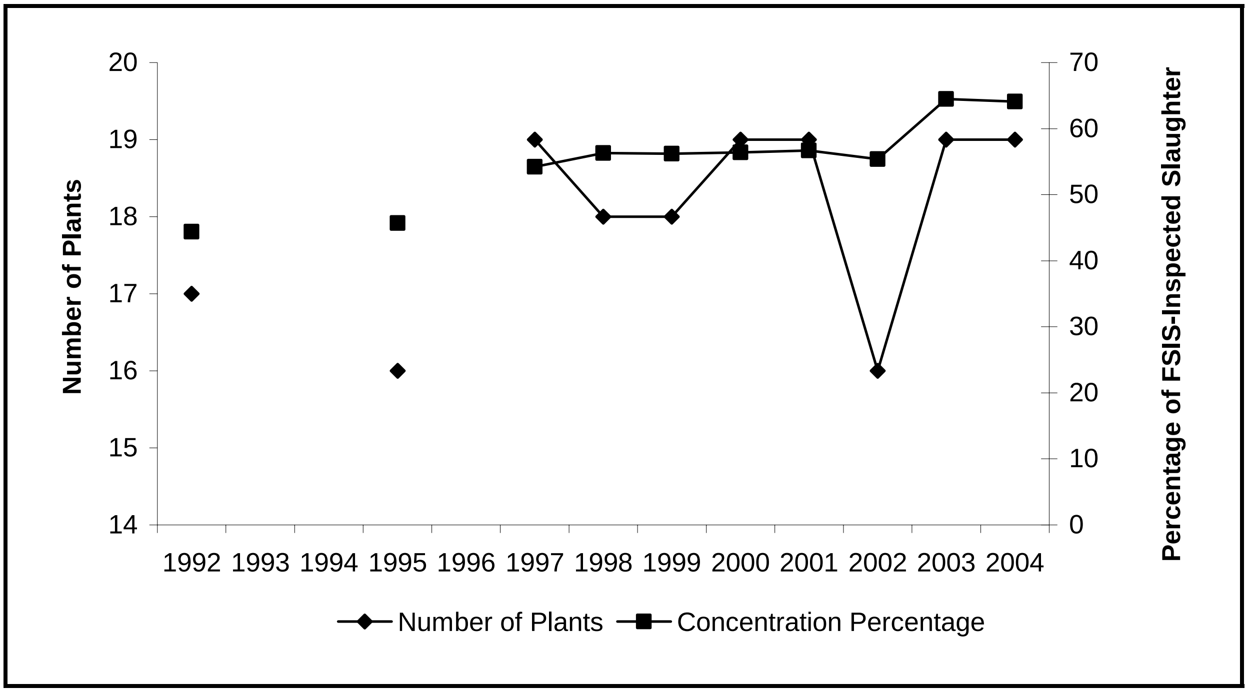


Source: U.S. Department of Agriculture, Economic Research Service, Market & Trade Economics Division. 2006. *Red Meat Yearbook*. Stock #94006. Washington, DC: USDA. <http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1354.>

Packers were able to produce more pork per pig slaughtered, as the average market hog's liveweight increased by 17 pounds and carcass weight increased 20 pounds during the same period. Availability of hogs and carcass weight are two of the factors that contribute to individual packer efficiency. Packers have increasingly built larger facilities that operate closer to capacity to decrease per-unit costs of production (Ward, 2003). This shift in operations was facilitated by the decrease in seasonal fluctuations of hog production. Previously, packers maintained excess capacity for most of the year to accommodate large slaughter levels during the last quarter of the year (Haley, 2004). Subsequently, fewer packing facilities are currently operating. In fiscal year 2002, 558 federally inspected plants slaughtered at least 50 market hogs. However, as indicated in the CR4, the four largest packers slaughtered over 50% of the hogs under federal inspection since 1997 (Figure 1-7). The total number of plants operated by these companies has varied since 1992.

Figure 1-7. U.S. Hog Packer Four-Firm Concentration Ratio (CR4), Selected Years, 1992–2004

The CR4s show the percentage of all hogs slaughtered at plants owned by the four largest firms during the respective year. The total number of plants operated by those firms is also included. Percentages are based on total federally inspected slaughter numbers.



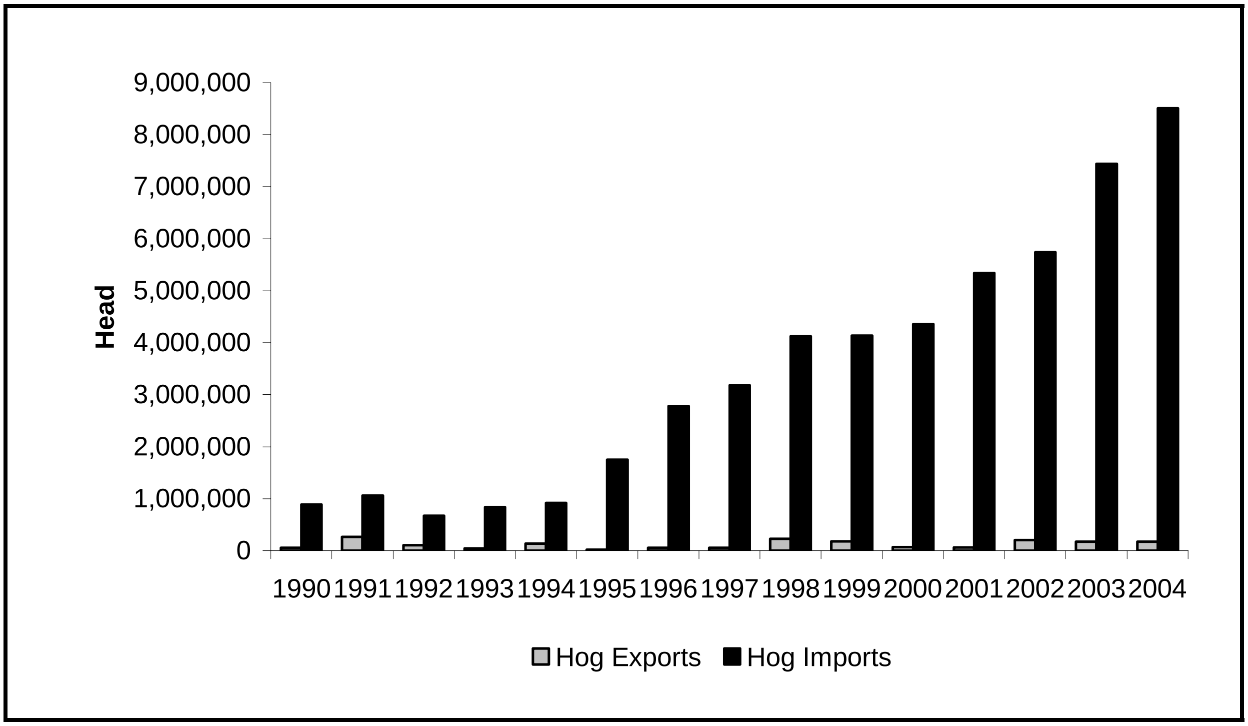
Source: U.S. Department of Agriculture, Grain Inspection, Packers and Stockyards Administration. 2004. *Packers and Stockyards Statistical Report*. SR-06-1. Washington, DC: GIPSA.

1.1.4 Imports and Exports of Hogs and Pork

The United States is a net importer of live hogs (Figure 1-8). As discussed earlier, virtually all the live hogs imported into the United States are from Canada. The total number of hogs imported increased dramatically since 1990, while the type of hogs imported changed concurrently. In 1990, 77% of the Canadian hogs were slaughter hogs and 23% were feeder pigs. By 2003, the numbers switched: 33% of imported hogs were slaughter hogs and 67% were feeder pigs. Approximately 95% of the feeder pigs are shipped to Midwest and Corn Belt States. Slaughter hog shipments are more dispersed, but the majority of shipments are destined for the Western States (Haley, 2004). Mexico consumes over 80% of U.S. live exports. From mid-1980 to the early 2000s, nearly two thirds of live exports

Figure 1-8. Total U.S. Hog Imports and Exports, 1990–2004

The United States is a net importer of live hogs. Live animal trade is typically restricted to North America.

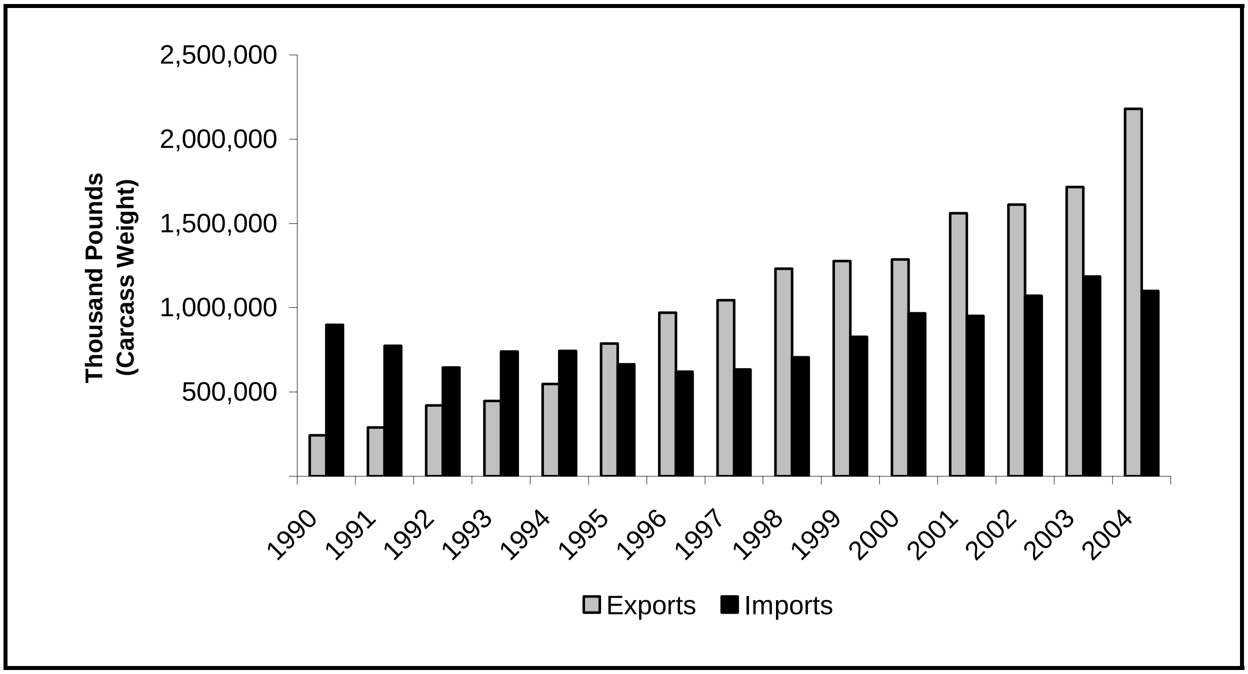


Source: U.S. Department of Agriculture, Economic Research Service, Market & Trade Economics Division. 2006. *Red Meat Yearbook*. Stock #94006. Washington, DC: USDA. <http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1354.>

were slaughter hogs, and approximately one third were breeding animals (USDA/ERS, 2004).

The United States has recently become a net exporter of pork products (Figure 1-9). In addition, the United States is the third largest pork importer in the world. In 2003, pork imports were approximately 6% of U.S. pork consumption, and exports were approximately 9% of U.S. pork production (USDA/ERS, 2004). Over three quarters of the U.S. pork exports are sent to Japan, Mexico, and Canada. Japan, the world's largest pork importer, consumes 46% of U.S. pork exports (USDA/ERS, 2004). Canada and Denmark continue to be the primary suppliers of imported pork to the United States. Expansion in the Canadian hog industry and lower costs relative to Denmark have allowed Canada to become the dominant foreign supplier since 1985 (USDA/ERS, 2004).

Figure 1-9. Total U.S. Pork Imports and Exports, 1990–2004
The United States has become a net exporter of pork products. Canada, Denmark, and the Netherlands are the primary sources of imported pork. Japan, Mexico, and Canada are the primary destinations for exported U.S. pork.



Source: U.S. Department of Agriculture, Economic Research Service, Market & Trade Economics Division. 2006. *Red Meat Yearbook*. Stock #94006. Washington, DC: USDA. <http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1354.>

1.2 OVERVIEW OF MARKETING ARRANGEMENTS IN THE HOG AND PORK INDUSTRIES

In this report, cash or spot market transactions refer to transactions that occur immediately or “on the spot.” These include auction barn sales; video or electronic auction sales; sales through order buyers, dealers, and brokers; and direct trades. The terms “cash market” and “spot market” are used interchangeably. “AMAs” refer to all possible alternatives to the cash or spot market. These include arrangements such as forward contracts, marketing agreements, procurement or marketing contracts, packer owned, production contracts, custom feeding, and custom slaughter. For AMAs at the producer level, livestock may be owned by the individual(s) that owns the farm or facility, or they may be owned by a different party.

In addition to the type of procurement or sales method, other key dimensions that define each marketing arrangement are ownership method of the animal or product, pricing method, and valuation method for livestock. Pricing method is further defined by formula base, if formula pricing is used, and internal transfer pricing method, if the product is internally transferred within a single company.

Figure 1-10 illustrates the types of marketing arrangements used for sales of live pigs and hogs. The key dimensions of marketing arrangements at each stage include the **ownership method** for the animal or product while it is at an establishment (e.g., hogs owned by the producer or owner of the farm, hogs not owned by the producer, and packer-owned farms) and the **pricing method** used. If formula pricing is used, a **formula base price** must be specified. The **valuation method** for carcasses might be on a per-head basis, liveweight basis, carcass weight basis, or primal cuts basis. Carcass weight valuation might be based on a grid that offers premiums or discounts based on weight and carcass quality grade. If animals or products are shipped from one establishment to another owned by the same company, an **internal transfer pricing method** must be specified.

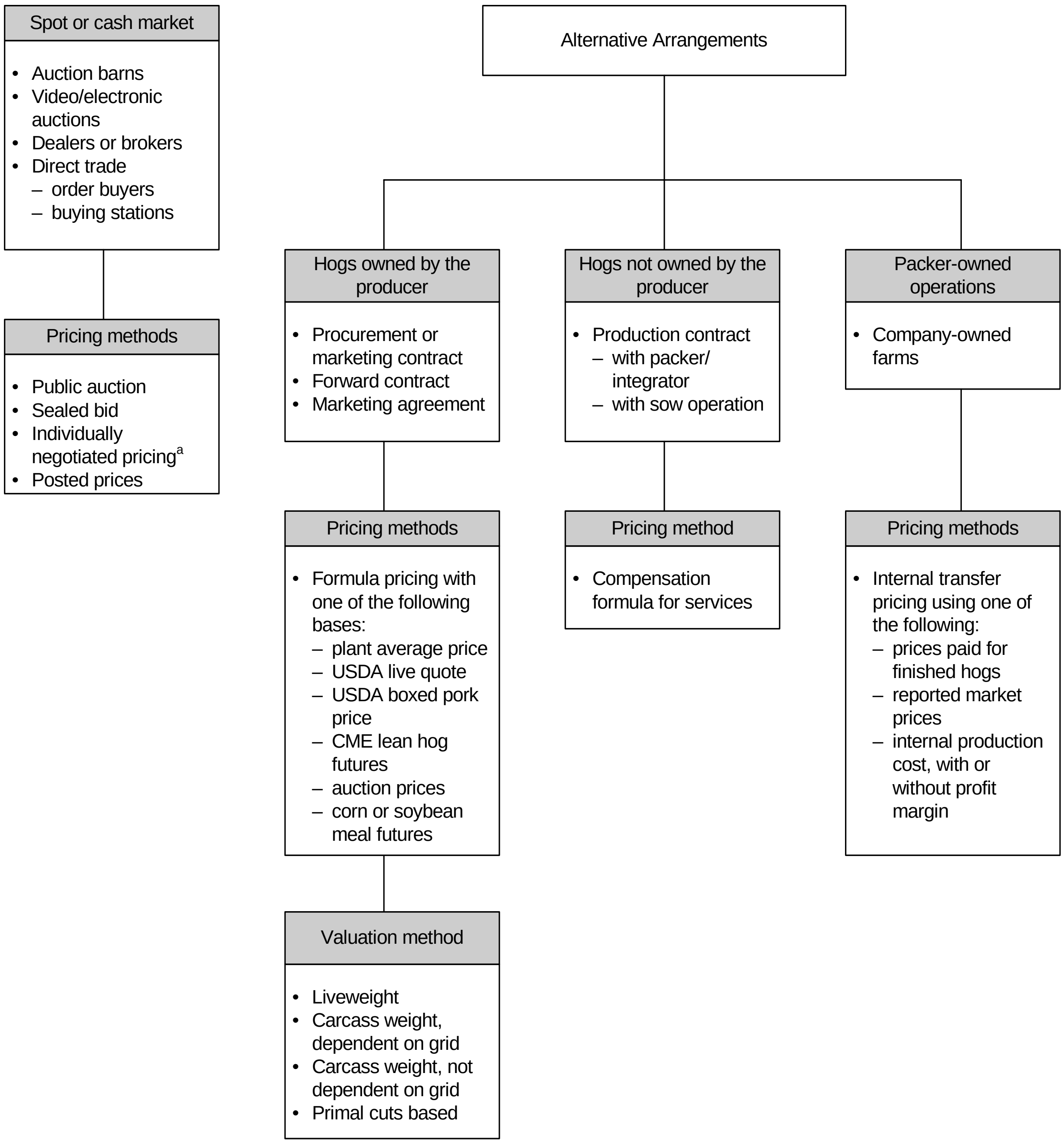
Production contracts and marketing contracts as used in the pork industry are unique types of marketing arrangements and warrant further description. **Production contracts** specify the division of production inputs supplied by the two parties, the quality and quantity of a particular output, and the type of the remuneration mechanism for the grower. The hogs are owned by the contractor (packer or integrator) who also assumes most of the price risk and some of the production risk. Because contractors control the volume of production and production practices, they tend to dictate the terms of contracts.

Marketing contracts refer to an agreement that establishes a price or pricing mechanism and an outlet for the product prior to harvest. Most management decisions remain with the growers because ownership is retained until harvest. Producers also assume all production risk but share price risk with a contractor. Forward contracting and price setting after delivery based on a predetermined formula that reflects quality grades and yields are examples of marketing contracts.

The types of buying and selling mechanisms vary by stage of the pork production system. Figure 1-11 illustrates the types of marketing arrangements used for sales or transfers of all types of meat products (including pork) by packers. Under AMAs, meat products might be sold by the packer or transferred to

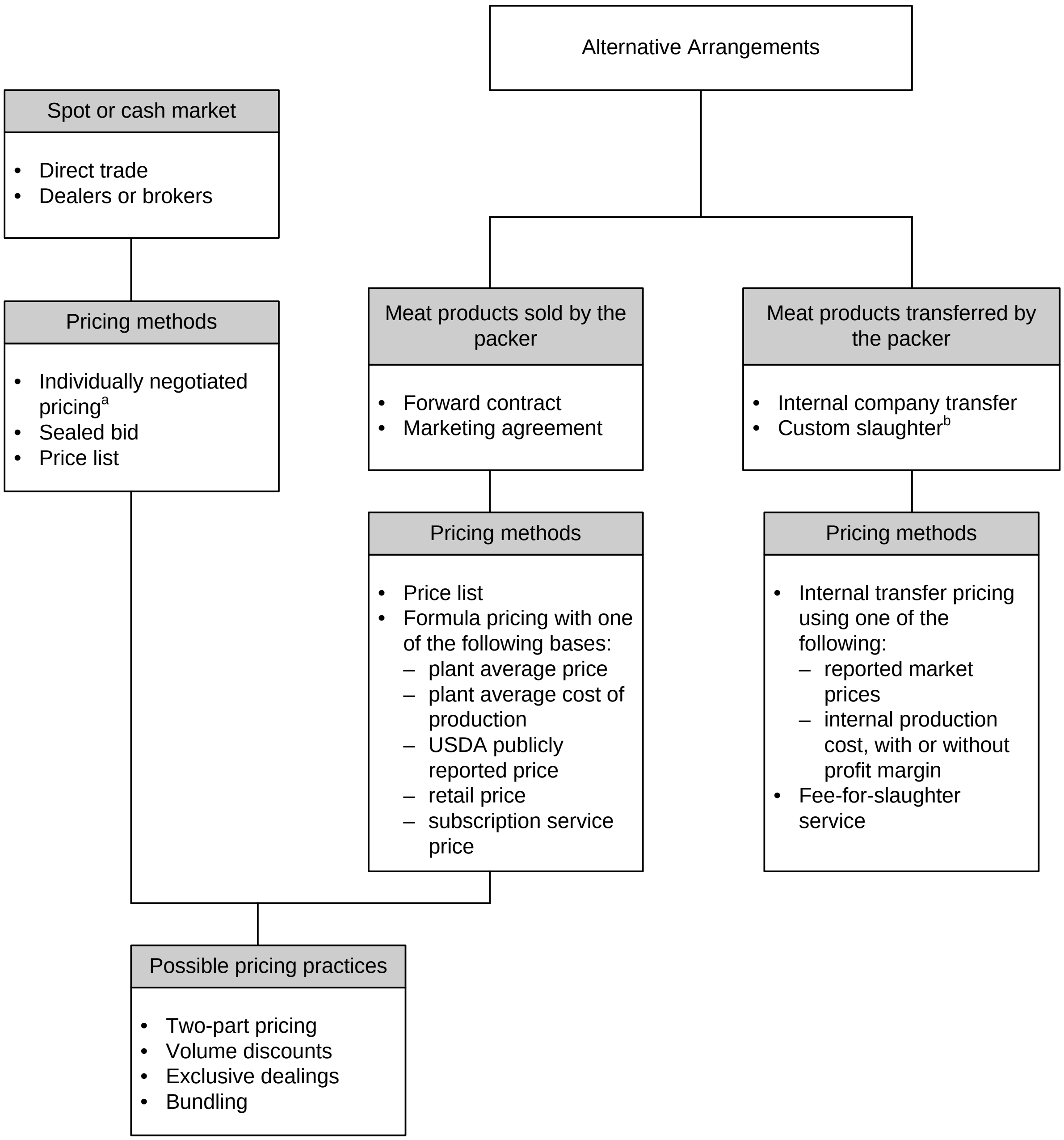
Figure 1-10. Marketing Arrangements for Sale or Transfer of Weaner, Feeder, and Finished Hogs by Pork Producers

Different types of pricing methods are associated with each type of marketing arrangement used in the industry.



[a] Individually negotiated pricing is often benchmarked against reported prices.

Figure 1-11. Marketing Arrangements for Sale or Transfer of Meat Products from Packers
Meat products are sold or transferred to processors, wholesalers, exporters, food service operators, or grocery retailers.



[a] Individually negotiated pricing is often benchmarked against reported prices.

[b] Custom slaughter may be coordinated by a cooperative for its producer-members.

another establishment owned by the same company or to the owner of the livestock if custom slaughtered. Spot or cash market sales of meat are primarily conducted via individual negotiations. Transactions may be for very large or very small volumes and may be for carcasses, single cuts, or a variety of cuts. Other pricing practices used for meat products might include two-part pricing, volume discounts, exclusive dealings, and bundling.

1.3 ORGANIZATION OF THE HOG AND PORK STUDY VOLUME

In the remaining sections of this volume, we present results of the study for the hog and pork industries. Section 2 provides results on volume differences, price differences, and market price effects associated with AMAs. Section 3 provides results on economies of scale, cost, and efficiency differences associated with AMAs. Section 4 provides results on quality differences and Section 5 provides results on risk shifting associated with AMAs. Section 6 provides results on the measurement of welfare affects associated with restricting AMAs by simulating hypothetical scenarios. Finally, Section 7 describes the implications of AMAs including the incentives associated with changing the use of AMAs and the expected effects of possible changes in use of AMAs over time.

Note that each section of this volume addresses the requirements of the study as defined in the performance work statement for the contract. Section 2 addresses Part C; Sections 3, 4, and 5 address Part D; and Sections 6 and 7 address Part E.

In addition to these sections, Appendix A provides summary data on hog prices from the transactions data, Appendix B provides technical details on a model of the hog and pork industries from the packer perspective used for conducting simulations of restrictions on AMAs, Appendix C describes the Agricultural Resource Management Survey (ARMS) data used in parts of the analyses, and Appendix D provides estimation details for factor demand equations used in the modeling efforts.

2 Volume Differences, Price Differences, and Short-Run Spot Market Price Effects Associated with Alternative Marketing Arrangements

In this section, we present results on volume differences associated with AMAs, price differences across AMAs, and effects of AMAs on cash market prices.

2.1 DATA SOURCES FOR THE ANALYSES

The analyses described in this section are based on data from three different sources: surveys of pork producers and packers, pork packers' individual transactions (purchase) data, and Mandatory Price Reports (MPR) data. We describe these data below.

2.1.1 Surveys of Pork Producers and Packers

The surveys of pork producers and packers contain data on quantities, but not prices. The responses reflect the producers' or packers' activities in a self-chosen 12-month period between January 2004 and December 2005. The number of respondents to the surveys is 229 pork producers and 88 pork packers. In this section, we focus only on the transactions in the producer–packer relationship; that is, we deal only with those producers in the survey who sell market hogs. Market hogs are procured by packers as the production input into their packing plants.[1] Among the survey respondents, 25 pork producers (Question 6.1.c) and 3 pork packers (Question 1.4) did not provide the total number of market hogs they sold or procured during the last year. As a result, the usable number of observations in the pork producers data set is 204 and 85 in the pork packer data set. When using the survey results, we report both the raw survey numbers and the weighted responses. The survey weights are constructed so that the total national quantities of market hogs in the survey match the National Pork Board checkoff system numbers for 2004.[2]

2.1.2 Packers' Individual Transactions (Purchase) Data

The packers' individual purchase transactions contain data on prices and quantities. The data set consists of 2,103,322 individual transactions (lots) of hogs and pigs from 30 different pork packing plants during the time period October 2002 through March 2005.[3] Packers were asked to report the total number of hogs per lot and the number of barrows and gilts, sows, and boars and stags. However, only the total number of hogs was available for some plants. Therefore, we prescreened the data excluding observations outside reasonable bounds for either liveweight or carcass weight. When the total liveweight of a transaction was available, we calculated the average liveweight per head and excluded observations below 220 pounds or greater than 320 pounds. In cases where only carcass weights were available, we calculated the average carcass weight per head and eliminated observations below 150 pounds or greater than 220 pounds. In addition, we also excluded all transactions with five or fewer market hogs. After applying these data preparation steps, the number of transactions was 1,757,286.

Each transaction in the data included the base price (average base price paid for the lot), price adjustment (average merit-based adjustments, such as premiums and discounts), and pricing units. For transactions in which adjustments were reported, the net prices were calculated by summing the base

[1] Summaries of other survey results are presented in Volume 2, Section 6: Survey Results: Livestock Producers and Feeders and Volume 2, Section 7: Survey Results: Meat Packers.

[2] For details on constructing the survey weights, see Volume 2 of this report.

[3] For the exact instructions/protocol for data collection for pork packers, see Volume 2, Appendix D.

price and adjustment. The pricing units variable indicates whether prices were reported on the basis of liveweight or carcass weight. Some plants use both pricing units and some only use one type. For analysis purposes, we converted all liveweight prices to a carcass weight basis using the carcass weight to liveweight ratio (percentage yield) for that transaction. When liveweights or carcass weights were missing, we were unable to calculate yield; therefore, that transaction was dropped.[4] Similar to prescreening for nonmarket hogs, we screened transactions based on price. Observations with a price per hundred weight less than $20 or greater than $100 were dropped. This rule approximately corresponds to eliminating observations outside the upper and lower 1 percentile of the price distribution.[5] After this additional data preparation, we had 1,677,227 transactions from 29 processing plants owned by 15 different companies.

The implemented data preparation procedures caused a considerably smaller loss of information in terms of the actual number of market hogs transacted then appears to be the case based on the eliminated number of transactions (lots). The data preparation procedures eliminated 20.3% of all transactions (lots) but only 6.7% of the transacted market hogs. However, even the prepared data set still suffers from considerable deficiencies, whose origins are very difficult to determine. A couple of problems are worth mentioning. First, comparing the individual transactions data with survey data for a plant-level comparison of procurement methods for market hogs reveals nontrivial differences. For example, the percentage of reported cash/spot market purchases that a plant reported in the survey is sometimes more than 50 percentage points different than that indicated in the same plant's transactions data. Second, the differences between carcass weight prices and liveweight prices indicate an unreasonably high implicit average yield ratio, for which we do not have a very good explanation. Both of these problems are carefully discussed and elaborated in the subsequent sections.

[4] For this reason, we were not able to use observations for one entire plant (they reported only liveweights). This plant was the smallest one in terms of the total number of market hogs purchased during the sample period.

[5] The distribution of carcass prices shows that the first percentile is $28.64 and the 99th percentile is $104.95 per hundred pounds.

2.1.3 Mandatory Price Reports (MPR) Data

The USDA/AMS Mandatory Price Reports[6] data records the transactions of National Daily Direct Hog Prior Day—Slaughtered Swine through the following categories of marketing arrangements (MAs):

§ Negotiated Purchases (MA1): Cash or spot market purchase of hogs by a packer from a producer when there is an agreement on base price and a delivery day not more than 14 days after the date on which the livestock are committed to the packer.

§ Other Market Formula Purchases (MA2): Purchase of hogs by a packer in which the pricing mechanism is a formula price based on any market other than the market for hogs, pork, or pork product. This includes formula purchases where the price formula is based on one or more futures and options contracts.

§ Swine or Pork Market Formula Purchases (MA3): Purchase of hogs by a packer in which the pricing mechanism is a formula price based on a market for hogs, pork, or a pork product, other than any formula purchase with floor, window, or ceiling price, or a futures options contract for hogs, pork, or pork product.

§ Other Purchase Arrangements (MA4): Purchase of hogs by a packer that is not a negotiated purchase, hogs or pork market formula purchase, or other market formula purchase and does not involve packer-owned swine. This would include long-term contract agreements; fixed price contracts; cost of production formulas; and formula purchases with a •oor, window, or ceiling price.

§ Packer Owned (MA5): Hogs that a packer, including a subsidiary or affiliate of the packer, owns for at least 14 days immediately before slaughter.

§ Packer Sold (MA6): Hogs that are owned by a packer, including a subsidiary or affiliate of the packer, for more than 14 days immediately before sale for slaughter and sold for slaughter to another packer.

In this section, we use the MPR data primarily as a reference point. To the extent that the individual transactions data correspond closely to the MPR data, they can be used with reasonable confidence. In other sections of this report, the MPR

[6] MPR is available at http://mpr.datamart.ams.usda.gov.

data have been used as the primary data source for various analyses.

2.1.4 Market Hog Volume Data

Before conducting analyses, we compared our data with other publicly available sources at the national and regional levels. We divided the national hog market into three regional markets: Eastern market, Midwestern market, and Other. Each region is defined as follows:

- East: North Carolina, South Carolina, Georgia, Virginia, Pennsylvania, Maryland
- Midwest: Illinois, Indiana, Iowa, Kansas, Kentucky, Minnesota, Missouri, Nebraska, Oklahoma, South Dakota, Wisconsin, Tennessee, Ohio
- Other: all other states

Tables 2-1a through 2-1e compare the number of market hogs produced or purchased in different regions across different data sources. Tables 2-1a and 2-1b present summaries of data from the pork producer and packer surveys. We report both the raw numbers and weighted sums. Table 2-1c summarizes market hog purchases from the pork packers' individual transactions data. The numbers reflect transactions from October 2002 through March 2005. For comparison purposes, we also extracted the data for calendar year 2004. Transactions data were only requested from large packers. The regional distribution of these plants reflects the geographical dispersion of the hog industry, with 7 plants in the Eastern region, 19 plants in the Midwest region, and 3 plants in other states. As Table 2-1c shows, the final data set consists of close to 1.7 million individual transactions (records); 655,000 of these occurred in 2004.

Data in Tables 2-1a through c are compared with the data available from two public sources. Table 2-1d summarizes market hog sales in 2004 from the National Pork Board Checkoff System, and Table 2-1e provides the number of hogs slaughtered commercially in 2004 reported in Agricultural Statistics (USDA, 2005). Because the survey weights are constructed to match the National Pork Board checkoff numbers, both producers' and packers' total quantities of market hogs match the checkoff numbers exactly, and are very close to the USDA numbers. The regional distributions are also

Table 2-1a. Market Hogs by Region: Pork Producers' Survey Data (Based on Q6.1.c[a])

		Raw Number		Weighted Sum	
Region	Number of Producers	Number of Market Hogs	Percentage	Number of Market Hogs	Percentage
East	16	489,222	13.9%	18,719,156	18.6%
Midwest	175	2,791,146	79.5%	77,595,023	77.0%
Other	13	231,283	6.6%	4,477,447	4.4%
Total	204[b]	3,511,651	100.0%	100,791,626	100.0%

[a] Q6.1.c: How many market hogs did your operation sell or ship during the past year?
[b] Of the 229 pork producers in the survey data set, 25 did not reply to Q6.1.c.

Table 2-1b. Market Hogs by Region: Pork Packers' Survey Data (Based on Q1.4[a])

		Raw Number		Weighted Sum	
Region	Number of Producers	Number of Market Hogs	Percentage	Number of Market Hogs	Percentage
East	26	14,819,608	19.5%	18,719,156	18.6%
Midwest	30	58,297,443	76.8%	74,387,321	73.8%
Other	29	2,804,179	3.7%	7,685,149	7.6%
Total	85[b]	75,921,230	100.0%	100,791,626	100.0%

[a] Q1.4: How many market hogs (barrows and gilts) were procured by your plant during the past year?
[b] Of the 88 pork packers in the survey data set, 3 packers did not reply to Q1.4.

Table 2-1c. Market Hogs by Region: Pork Packers' Transactions (Purchase) Data: October 2002–March 2005 and 2004 Only

	October 2002–March 2005			2004 Only		
Region	Number of Records	Number of Market Hogs	Percentage	Number of Records	Number of Market Hogs	Percentage
East	D	D		D	D	
Midwest	1,414,754	145,469,746	76.8%	544,231	57,653,358	75.7%
Other	D	D		D	D	
Total	1,677,227	189,481,919	100.0%	655,153	76,115,709	100.0%

D = Results suppressed.

Table 2-1d. Market Hogs by Region: National Pork Board Checkoff System, 2004

Region	Number of States	Number of Hogs	Percentage
East	6	18,719,156	18.6%
Midwest	13	75,090,931	74.5%
Other	31	6,981,539	6.9%
Total	50	100,791,626	100.0%

Source: http://www.pork.org.

Table 2-1e. Market Hogs by Region: Number Slaughtered Commercially, 2004

Region	Number of States	Number of Hogs Slaughtered	Percentage
East	5	17,751,900	17.61%
Midwest	13	79,121,000	78.49%
Other	26	3,932,200	3.90%
Total	44	100,805,100	100.00%

Source: USDA Agricultural Statistics, 2005.

reasonably close. Comparing the transactions data for 2004 (76.1 million hogs) with publicly available sources indicates that the individual transactions data account for about 76% of the total industry as reported by the checkoff system (101 million hogs).

To get a more detailed picture of the regional distribution of market hogs, Table 2-2 reports the numbers for the 16 largest production states. The data from all three sources (transactions, checkoff, and USDA) exhibit similar regional patterns, although the absolute numbers are different. According to all three sources, the top two producing states are Iowa (with approximately 31% share) and North Carolina (with between 11% and 16.5% share depending on the source). According to the transactions data and the checkoff data, the third state is Minnesota, and according to the USDA data, the third state is Illinois and Minnesota is fourth.

Table 2-2. Market Hogs by States from Various Sources, 2004

State	Transactions Data	Pork Checkoff Program	USDA[a]
Iowa	24,206,285	28,284,405	29,891,000
North Carolina	D	14,941,334	10,811,300
Minnesota	D	12,530,432	9,089,700
Indiana	D	5,399,740	7,153,100
Oklahoma	D	3,259,726	4,928,800
South Dakota	D	2,221,727	4,690,900
Illinois	D	6,863,046	9,237,100
Virginia	D	1,177,253	3,925,100
Nebraska	D	5,271,858	6,953,300
Pennsylvania	D	1,942,645	2,846,400
Kentucky	D	530,137	2,488,300
California	D	205,578	2,519,700
Mississippi	D	474,921	N/A
Missouri	D	3,963,032	2,042,500
Ohio	D	2,802,273	1,204,900
South Carolina	D	254,501	N/A
Total	76,115,709	90,122,608	97,782,100

[a] Number slaughtered commercially, USDA, NASS (2005).

D = Results suppressed.

2.1.5 Market Hog Price Data

For analysis purposes, the transactions data prices were aggregated. Table A-1 in Appendix A of this volume reports weekly average prices and their standard deviations. Out of 29 plants, 16 reported using liveweight and carcass weight pricing, 9 used only liveweight prices, and the remaining 4 used only carcass weight pricing. The definitions of the variables in Table A-1 are as follows:

(1) avg_hogp_3: average total price (base price + adjustment) when pricing unit is $/cwt liveweight

(2) avg_basep_3: average base price when pricing unit is $/cwt liveweight

(3) avg_hogp_4: average total price (base price + adjustment) when pricing unit is $/cwt carcass weight.

(4) avg_basep_4: average base price when pricing unit is $/cwt carcass weight.

The price data exhibit some interesting features. First, the differences between the minimum and maximum values of weekly average prices are much larger than expected. We expect to see different plants paying different prices for hogs, depending on their location and the type of procurement arrangement used. However, the maximum values are up to three times larger than the minimum values during some weeks.

Second, the regression of average total liveweight price (base price plus adjustment) on average total carcass weight price indicates that the estimated slope coefficient in this regression is 0.8778. Comparatively, the ratio of carcass weight to liveweight ranges from 0.73 to 0.76. The regression of average base liveweight price on the average base carcass weight price shows a very similar estimated slope coefficient of 0.8827. To ensure that the obtained results are not a consequence of an aggregation approach, we reran the above regressions with individual plants' weekly data. Of 16 plants that reported using both pricing units (liveweight and carcass weight), no plant's slope coefficients were comparable with their reported physical yields. Using total prices (base plus adjustments), we found the coefficients ranging from 0.46 to greater than 1.0, with most of them above 0.8. The coefficient larger than unity means a higher price per pound liveweight than per pound carcass weight. Using base prices, we found that the results are quite similar to the results using the total prices.

To further investigate this puzzle, we analyzed the timing of the purchases within each week. The idea is that because most hogs (67%) are purchased on a carcass basis, liveweight pricing, especially when used by large plants, is frequently used to smooth out packing plant scheduling problems.[7] These hogs may be overpriced because they are purchased at the last moment, primarily to fill next week's kill, thus explaining the anomaly we observe. The problem with conducting this analysis arises because, for the majority of observations, the purchase date and the kill date are the same, with some of the recorded dates actually indicating a Sunday. Because both of those data

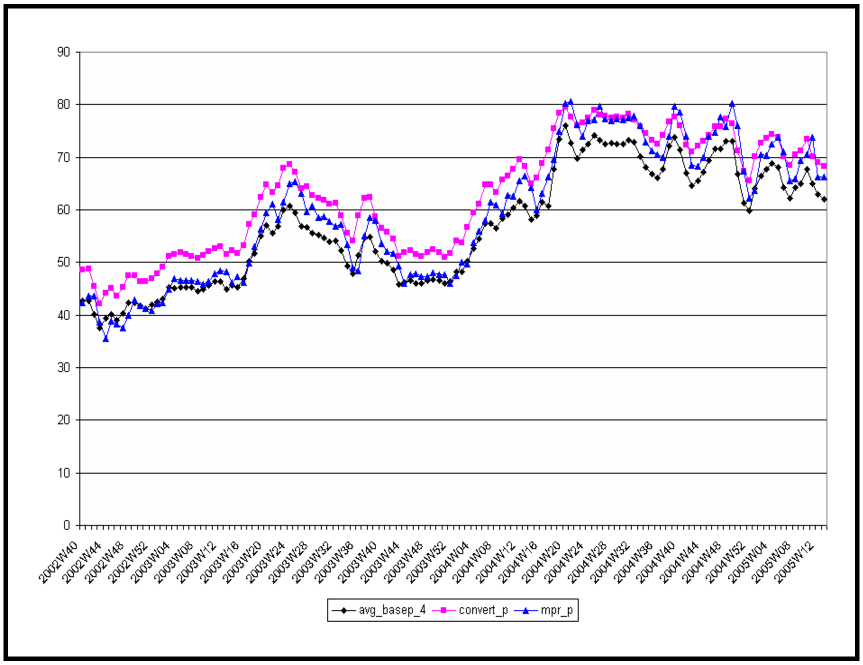
[7] This idea was actually suggested by one of the anonymous peer reviewers.

observations are doubtful, a careful timing analysis would not have been useful. However, regressing the implicit yield (the ratio of live price to carcass price) on a set of daily binary variables indicates that Monday through Thursday implicit yields are significantly smaller than Friday through Sunday yields. This corroborates the hypothesis that near the end of the week, live prices relative to carcass prices tend to be higher than earlier in the week. However, the Monday through Thursday implicit yields are still higher than the actual physical yields, so the timing of the purchases does not explain the anomaly of the unreasonably high live price to carcass price ratios.

Given the discrepancy between liveweight and carcass weight pricing, we worked with the constructed carcass weight prices as discussed above. The last two columns of Table A-1 report the converted carcass price series and, for comparison purposes, the national weighted average base price series from MPR data.[8] We compared the constructed carcass weight prices (convert_p) with the average base price series when the pricing unit was carcass weight (i.e., the originally reported carcass weight price series) (avg_basep_4) and with the national weighted average base price from MPR data (mpr_p). First, we tested the hypotheses of equal means for each pair of prices. As Table A-2 shows, avg_basep_4 and mpr_p have statistically indistinguishable means. The other two pairs have statistically different means. The mean of the constructed carcass weight price series ($62.90/cwt) is larger than the mean of the MPR price series ($59.56), which is understandable because the MPR series includes only the base price, while our constructed series includes the base price plus adjustments. Next, we calculated the Pearson correlation coefficients for each pair of prices; the results are provided in Table A-3. The correlation coefficients are almost all unity, and all P values for the null of zero correlation are less than .0001. This indicates that all three prices are almost perfectly correlated, as seen in Figure 2-1.

[8] This series is from various issues (2002, 2003, and 2004) of USDA's "Annual Meat Trade Review: Meat, Livestock and Slaughter."

Figure 2-1. Comparison of Carcass Weight Hog Price Series From Different Sources, October 2002–September 2005



2.2 VOLUME OF MARKET HOGS TRANSFERRED BY TYPE OF MARKETING ARRANGEMENT

In this section, we determine the volume of market hogs transferred through the types of spot and alternative arrangements by type, size, and location of market participants.

2.2.1 The Importance of Various Marketing Arrangements in Total Purchases and Sales of Hogs

Table 2-3 presents the summary of market hog purchase methods by region from the packers' transactions (purchase) data. In this table, the procurement methods are classified into the following categories:

- auction barns
- video/electronic auctions
- dealers or brokers
- direct trade (cash or spot market transaction between an individual buyer and seller of livestock within 2 weeks of kill date)
- procurement or marketing contract (formal agreement specifying terms for transfer of market hogs using prespecified price or payment formula)

Table 2-3. Summary of Market Hog Purchase Methods by Plant Region: Pork Packers' Transactions (Purchase) Data, October 2002–March 2005

Region	Auction Barns	Video/ Electronic Auctions	Dealers or Brokers	Direct Trade	Procurement or Marketing Contract	Forward Contract	Marketing Agreement	Packer Owned	Other	Missing	Total
East											
Observations	D	0	D	D	D	D	70,307	D	0	D	D
Percentage		0.00%					28.83%		0.00%		
Number of market hogs	D	0	D	D	D	D	10,557,294	D	0	D	D
Percentage of market hogs		0.00%				0.00%	27.64%		0.00%		100.00%
Midwest											
Observations	D	0	41,354	207,319	498,752	170,179	175,646	95,808	D	25,491	1,414,754
Percentage		0.00%	2.92%	14.65%	35.25%	12.03%	12.42%	6.77%		1.80%	100.00%
Number of market hogs	D	0	2,387,863	14,484,372	47,189,061	22,924,220	21,038,919	14,896,056	D	1,380,624	145,469,746
Percentage of market hogs		0.00%	1.64%	9.96%	32.44%	15.76%	14.46%	10.24%		0.95%	100.00%
Other											
Observations	D	D	D	D	D	D	0	D	0	D	D
Percentage							0.00%		0.00%		100.00%
Number of market hogs	D	D	D	D	D	D	0	D	0	D	D
Percentage of market hogs							0.00%		0.00%		100.00%
Total											
Observations	7,852	D	45,026	224,135	530,341	170,196	245,953	231,766	D	25,954	1,677,227
Percentage	0.47%		2.68%	13.36%	31.62%	10.15%	14.66%	13.82%		1.55%	100.00%
Number of market hogs	998,886	D	3,015,746	16,860,654	54,892,478	22,925,829	31,596,213	37,157,144	D	1,449,891	189,481,919
Percentage of market hogs	0.53%		1.59%	8.90%	28.97%	12.10%	16.68%	19.61%		0.77%	100.00%

D = Results suppressed.

- forward contract (oral or written agreement for the future purchase of a specified quantity of livestock; contract is entered into at any time between placement of livestock on feed and 2 weeks prior to kill date)
- marketing agreement (long-term oral or written arrangement where a packer agrees to purchase livestock under specific terms)
- packer owned
- other
- missing

This classification does not specifically address production contracts.[9] Overall, the most important procurement method is marketing contracts, accounting for almost 29% of all market hogs purchased by packers in the data set. The second most important category is packer-owned hogs, accounting for almost 20% of all market hogs procured, and the third category is marketing agreements. The regional picture is quite different from the national averages. In the East region, the most important procurement method is packer-owned hogs, accounting for over 58% of market hogs, followed by marketing agreements and marketing contracts. In the Midwestern region, the picture more closely resembles the national averages.

To compare the volume of hogs by marketing arrangement from the transactions data, the producer survey, and the packer survey, we combined the procurement methods into broader categories. These results are presented in Tables 2-4a, 2-4b, and 2-4c. The “cash/spot” category includes auction barns, video/electronic auctions, dealers or brokers, and direct trade; “marketing contracts” include procurement or marketing contracts, forward contracts, and marketing agreements; “internal\production” includes internal transfers, packer-owned hogs, and production contracts (in the surveys); and “other” combines the remaining categories (other, sold through

[9] Production contract settlement data were requested separately from transactions data because of the distinctly different type of data. However, all data were collected at the plant level, not the company level. Therefore, individual plants that did not maintain their own production contracts were unable to provide settlement data. In these situations, production contract hogs were included in the transactions data, but they are typically included in the “other” category.

Table 2-4a. Summary of Market Hog Volume by Marketing Arrangement and Region: Pork Producers' Survey

Marketing Arrangement	East			Midwest			Other			All[a]		
	Number of Producers	Number of Market Hogs	Percent-age	Number of Producers	Number of Market Hogs	Percent-age	Number of Producers	Number of Market Hogs	Percent-age	Number of Producers	Number of Market Hogs	Percent-age
Pork Producers' Survey Data (Based on Q6.2[b] Without Using Survey Weights)												
Cash/spot	D	D		117	459,871	16.6%	D	D		133	510,741	14.6%
Marketing contract	3	260,000	53.1%	57	2,234,620	80.5%	4	204,226	88.3%	64	2,698,847	77.2%
Internal/production	D	D		9	68,894	2.5%	D	D		16	274,303	7.8%
Other	0	0	0.0%	4	14,021	0.5%	0	0	0.0%	4	14,021	0.4%
Total	15	489,222	100.0%	187	2,777,406	100.0%	15	231,283	100.0%	217[c]	3,497,911	100.0%
Pork Producers' Survey Data (Based on Q6.2[b] Using the Modified Survey Weights)												
Cash/spot	D	5,005,966	26.7%	117	18,277,978	23.9%	D	821,879	18.4%	133	24,105,823	24.2%
Marketing contract	3	5,439,792	29.1%	57	51,609,434	67.6%	4	3,512,857	78.5%	64	60,562,083	60.8%
Internal/production	D	8,273,398	44.2%	9	5,416,695	7.1%	D	142,711	3.2%	16	13,832,804	13.9%
Other	0	0	0.0%	4	1,042,822	1.4%	0	0	0.0%	4	1,042,822	1.0%
Total	15	18,719,156	100.0%	187	76,346,930	100.0%	15	4,477,447	100.0%	217[c]	99,543,533	100.0%

[a] Because of nonresponse in Q6.2, the total number of market hogs here is less than the totals in Table 2-1a.

[b] Q6.2: What methods for selling or shipping pigs and hogs[d] are used by your operation? Enter the percentage of total head.

[c] Because producers can be counted multiple times, this total is not the same as the total in Table 2-1a.

[d] Because Q6.2 is about general pigs and hogs, it does not perfectly reflect the methods for selling or shipping market hogs.

D = Results suppressed.

Table 2-4b. Summary of Market Hog Volume by Marketing Arrangement and Region: Pork Packers' Survey

Marketing Arrangement	East			Midwest			Other			All[a]		
	Number of Producers	Number of Market Hogs	Percent-age	Number of Producers	Number of Market Hogs	Percent-age	Number of Producers	Number of Market Hogs	Percent-age	Number of Producers	Number of Market Hogs	Percent-age
Pork Packers' Survey Data (Based on Q2.2[b] Without Using Survey Weights)												
Cash/spot	21	1,281,970	8.7%	28	15,986,481	27.4%	24	259,702	9.3%	73	17,528,153	23.1%
Marketing contract	8	10,911,282	73.6%	19	36,297,283	62.3%	9	2,119,903	75.6%	36	49,328,467	65.0%
Internal/production	3	2,626,006	17.7%	6	6,013,680	10.3%	5	424,574	15.1%	14	9,064,259	11.9%
Other	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Total	32	14,819,258	100.0%	53	58,297,443	100.0%	38	2,804,179	100.0%	123[c]	75,920,880	100.0%
Pork Packers' Survey Data (Based on Q2.2[b] Using the Modified Survey Weights)												
Cash/spot	21	1,716,684	9.2%	28	21,079,519	28.3%	24	1,191,798	15.5%	73	23,988,000	23.8%
Marketing contract	8	13,705,067	73.2%	19	46,305,187	62.2%	9	5,427,105	70.6%	36	65,437,359	64.9%
Internal/production	3	3,296,471	17.6%	6	7,002,615	9.4%	5	1,066,246	13.9%	14	11,365,332	11.3%
Other	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Total	32	18,718,221	100.0%	53	74,387,321	100.0%	38	7,685,149	100.0%	123	100,790,691	100.0%

[a] Q2.2: What methods are used by your plant for procuring market hogs?

[b] Since packers can be counted multiple times, this total is not same as the total in Table 2-1b.

[c] Because of nonresponse in Q2.2, total number of market hogs here are less than the totals in Table 2-1b.

Table 2-4c. Summary of Market Hog Volume by Marketing Arrangement and Region: Pork Packer Transactions Data, October 2002–March 2005

Marketing Arrangement	East			Midwest			Other			All		
	No. of Observa-tions	Number of Market Hogs	Percent-age	No. of Observa-tions	Number of Market Hogs	Percent-age	No. of Observa-tions	Number of Market Hogs	Percent-age	No. of Observa-tions	Number of Market Hogs	Percent-age
Pork Packers Transaction (Purchase) Data, October 2002–March 2005												
Cash/spot	D	D		253,536	17,574,147	12.1%	D	D		277,675	20,993,645	11.1%
Marketing contract	D	D		844,577	91,152,200	62.7%	D	D		946,490	109,414,520	57.7%
Internal/production	D	D		95,808	14,896,056	10.2%	D	D		231,766	37,157,144	19.6%
Other	D	D		220,833	21,847,343	15.0%	D	D		221,296	21,916,610	11.6%
Total	D	D	100.0%	1,414,754	145,469,746	100.0%	D	D	100.0%	1,677,227	189,481,919	100.0%

D = Results suppressed.

co-op,[10] and missing). According to all three data sources, the marketing contract is the most widely used purchase method in the hog industry. Using the raw data, the producers' survey indicates that marketing contracts' share is 77%, the packers' survey shows this share is 65%, and this share is 58% in the packers' transactions data. When we consider the modified survey weights, the marketing contract share is 61% in the producers' survey and 65% in the packers' survey. The second most important procurement method in both surveys is the cash/spot method with a 15% share reported by producers and 23% share reported by packers using raw data. The modified survey weights show the shares are 24% for both producer and packer surveys. The second most important method according to the transactions data is internal\production with a 20% share, whereas the cash/spot method is third with 11%.

Discrepancies between the survey data and the individual transactions data exist; however, it is important to note that the survey results contain a stratified sample of all packers, whereas the transactions data are from large packers only. Therefore, differences in the data sets may result from large packers' procurement methods not being representative of the entire industry. If this is true, then it appears that cash/spot marketing arrangements seem to be more important for small packers than for large packers, which seems to support the intuition and anecdotal evidence. We analyze variations in marketing arrangements by size of the operation in more detail in Section 2.2.

Tables 2-4a through 2-4c also provide a breakdown of volumes by region. Both surveys indicate that marketing contracts are the most frequently used procurement method in all regions, using raw data. For the East region, the packer survey summary indicates that marketing contracts account for 73% of all purchases, internal/production represents 18%, and the remaining 9% are from cash/spot purchases. However, the transactions data summary indicates that internal/production accounts for the majority of purchases, marketing contracts represent a moderate percentage, and a very small percentage is cash/spot purchases. The weighted producer survey responses confirm the ranking of marketing arrangements in the transactions data.

[10] This category is available only in the pork producers' survey data set.

In the Midwest region, weighted packer and producer surveys indicate that marketing contracts account for 62% to 68% of purchases, cash/spot purchases represent 24% to 28% of purchases, and 7% to 9% of purchases are through internal/production arrangements. Transactions data from the Midwest show that 63% of purchases are from marketing contracts, 12% are cash/spot, 10% are internal/production, and 15% are from other arrangements.

Finally, in other states all three data sources show marketing contracts and cash/spot are the most frequently used marketing arrangements. However, the percentage of market share varied significantly depending on the data source.

2.2.2 Variations in Marketing Arrangements due to Size and Type of the Operation

Because of the differences between the packers' survey results and the packers' individual transactions data, we split the survey results into size categories for more direct comparisons. Pork producers that had an annual revenue of $2.5 million or more were classified as large; otherwise, they were considered small. Pork packers that had a weekly slaughter capacity of 6,000 head or more were classified as large; otherwise they were classified as small. The 6,000-head cutoff point was derived from the installed capacity reported by packers in the individual transactions data set. This new definition of large packers should match the packers' survey results more precisely with the individual transactions data results. For ease of exposition, we continue to use the aggregated procurement methods defined in Section 2.2.1.

Table 2-5a summarizes producer sales methods by size and the marketing arrangements they use from the pork producers' survey. We present the results with raw survey data and the results using modified survey weights. Using modified survey weights, we see that, among the large producers, 81% of market hogs were sold through marketing contracts and 9% were sold through cash/spot market sales. Small producers tend to use more cash/spot sales than large producers; 50% of market hogs were sold through marketing contracts and 33% through cash/spot market sales. The results based on the raw survey numbers are similar.

Table 2-5b summarizes the packers' survey results for market hog purchase methods by size of the pork packer. According to

Table 2-5a. Market Hog Sales Methods by Size: Pork Producers' Survey

Sales Method	Large[a]			Small			All		
	Number of Producers	Number of Market Hogs	Percentage	Number of Producers	Number of Market Hogs	Percentage	Number of Producers	Number of Market Hogs	Percentage
Pork Producers' Survey Data (Based on Q6.1.c) Without Using Survey Weights									
Cash/spot	9	271,162	9.9%	124	239,579	31.5%	133	510,741	14.6%
Marketing contract	10	2,294,101	83.8%	54	404,746	53.2%	64	2,698,847	77.2%
Internal/production	3	172,489	6.3%	13	101,814	13.4%	16	274,303	7.8%
Other	0	0	0.0%	186	14,021	1.8%	186	14,021	0.4%
Total	22	2,737,752	100.0%	377	760,159	100.0%	399	3,497,911	100.0%
Pork Producers' Survey Data (Based on Q6.1.c) Using the Modified Survey Weights									
Cash/spot	9	2,991,838	8.7%	124	21,113,985	32.5%	133	24,105,823	24.2%
Marketing contract	10	27,946,515	81.0%	54	32,615,568	50.1%	64	60,562,083	60.8%
Internal/production	3	3,542,351	10.3%	13	10,290,453	15.8%	16	13,832,804	13.9%
Other	0	0	0.0%	186	1,042,822	1.6%	186	1,042,822	1.0%
Total	22	34,480,704	100.0%	377	65,062,828	100.0%	399	99,543,532	100.0%

[a] Large pork producers have annual revenues of $2.5 million or more.

Table 2-5b. Market Hog Purchase Methods by Size: Pork Packers' Survey

Purchase Method	Large[a]			Small			All		
	Number of Producers	Number of Market Hogs	Percentage	Number of Producers	Number of Market Hogs	Percentage	Number of Producers	Number of Market Hogs	Percentage
Pork Packers' Survey Data (Based on Q1.4) Without Using Survey Weights									
Cash/spot	28	17,116,966	22.7%	45	411,188	89.1%	73	17,528,154	23.1%
Marketing contract	29	49,279,522	65.3%	7	48,945	10.6%	36	49,328,467	65.0%
Internal/production	10	9,062,677	12.0%	4	1,582	0.3%	14	9,064,259	11.9%
Other	0	0	0.0%	0	0	0.0%	0	0	0.0%
Total	33	75,459,165	100.0%	52	461,715	100.0%	52	75,920,880	100.0%
Pork Packers' Survey Data (Based on Q1.4) Using the Modified Survey Weights									
Cash/spot	28	22,404,550	22.6%	45	1,583,451	86.2%	73	23,988,000	23.8%
Marketing contract	29	65,191,657	65.9%	7	245,702	13.4%	36	65,437,359	64.9%
Internal/production	10	11,356,909	11.5%	4	8,423	0.5%	14	11,365,332	11.3%
Other	0	0	0.0%	0	0	0.0%	0	0	0.0%
Total	33	98,953,116	100.0%	52	1,837,575	100.0%	52	100,790,691	100.0%

[a] Large pork packers have weekly slaughter capacity (for market hogs) of 6,000 head or more.

the survey data for large packers, marketing contracts are the most widely used procurement method with 66%, followed by cash/spot market sales with 23%, and packer owned and production contracts with 12%. The difference between these shares and the individual transactions data shares (Table 2-4c) mainly comes from the fact that a large percentage of packers' transactions were listed in the category "other or missing" (close to 12%); as a result, the shares of marketing contracts—58%—and cash/spot markets—11%—are lower, but the share of internal/production—20%—is larger than in the survey. Small packers essentially use only two procurement channels. Cash/spot market purchases is the most frequently used method—86%, followed by marketing contracts—13%.

Table 2-6 shows the breakdown of market hog sales methods by pork producers' type of operation from the producers' survey. Pork producers classified as independent growers produced almost 50% of market hogs, contract growers produced 12% of market hogs, hog integrators produced 27% of market hogs, and multitype producers produced about 9%.[11] The most popular avenue for selling hogs among independent growers was marketing contracts, followed by cash/spot market sales. As expected, contract growers sold most of their hogs through production contract settlements (83% of contract grower hogs). A small percentage of contract grower hogs were sold through cash/spot markets or marketing contracts. Hog integrators sold 83% of their hogs through marketing contracts and the rest through cash/spot markets and production contracts. Finally, multitype producers divide their sales between the cash/spot market category and marketing contracts.

2.3 PRICING OF MARKET HOGS BY TYPE OF MARKETING ARRANGEMENT

The analyses in this section are based on pork packers' individual transactions data for the full sample period—October 2002 to March 2005. Because the survey instruments did not contain pricing questions, the survey data could not be used for the analyses. In this section, we analyze pricing methods used by packers; report average price levels and differences in price

[11] Multitype producers are those who chose multiple answers in Question 1.2 in the survey, and the producers who did not respond to Question 1.2 are classified as not specified.

Table 2-6. Market Hog Sales Methods by Type of Pork Producer (Based on Q1.2[a])

Type of Pork Producer	Cash/Spot	Marketing Contract	Internal/ Production	Other	Total
Raw Numbers Without Using Survey Weights					
Independent grower					
Number of producers	117	D	D	156	319
Number of market hogs	329,300	D	D	14,021	1,119,340
Percentage	9.4%			0.4%	32.0%
Contract grower					
Number of producers	D	D	10	0	16
Number of market hogs	D	D	125,920	0	151,220
Percentage			3.6%	0.0%	4.3%
Hog integrator					
Number of producers	D	9	D	0	16
Number of market hogs	D	1,845,666	D	0	2,100,461
Percentage		52.8%		0.0%	60.0%
Multitype					
Number of producers	5	5	0	0	10
Number of market hogs	39,130	66,100	0	0	105,230
Percentage	1.1%	1.9%	0.0%	0.0%	3.0%
Not specified					
Number of producers	D	D	0	0	8
Number of market hogs	D	D	0	0	21,660
Percentage			0.0%	0.0%	0.6%
All					
Number of producers	133	64	16	156	369
Number of market hogs	510,741	2,698,847	274,303	14,021	3,497,911
Percentage	14.6%	77.2%	7.8%	0.4%	100.0%
Weighted Sums Using the Modified Survey Weights					
Independent grower					
Number of producers	117	D	D	156	319
Number of market hogs	15,601,104	32,369,633	506,759	1,042,822	49,520,318
Percentage	15.7%	32.5%	0.5%	1.0%	49.7%
Contract grower					
Number of producers	D	D	10	0	16
Number of market hogs	758,632	1,351,905	10,146,010	0	12,256,547
Percentage	0.8%	1.4%	10.2%	0.0%	12.3%

(continued)

Table 2-6. Market Hog Sales Methods by the Type of Pork Producers (Based on Q1.2[a]) (continued)

Type of Pork Producer	Cash/Spot	Marketing Contract	Internal/ Production	Other	Total
Hog integrator					
Number of producers	D	9	D	0	16
Number of market hogs	1,417,368	22,705,650	3,180,036	0	27,303,054
Percentage	1.4%	22.8%	3.2%	0.0%	27.4%
Multitype					
Number of producers	5	5	0	0	10
Number of market hogs	4,916,151	3,928,502	0	0	8,844,653
Percentage	4.9%	3.9%	0.0%	0.0%	8.9%
Not specified					
Number of producers	D	D	0	0	8
Number of market hogs	1,412,568	206,393	0	0	1,618,960
Percentage	1.4%	0.2%	0.0%	0.0%	1.6%
All					
Number of producers	133	64	16	156	369
Number of market hogs	24,105,823	60,562,083	13,832,804	1,042,822	99,543,533
Percentage	24.2%	60.8%	13.9%	1.0%	100.0%

[a] Q1.2: Which of the following describe your operation during the past year?

D = Results suppressed.

levels associated with various marketing arrangements, adjusting for relevant factors that can affect prices; and provide economic interpretation for the phenomena that we observe. We also examine whether price differences vary with market conditions, such as changes in consumer demand and feed costs.

2.3.1 Pricing Methods

Table 2-7 reports market hog purchases by pricing methods and plant region. The pricing methods are categorized as follows: individually negotiated pricing (negotiations between a buyer and seller, excluding negotiated formula pricing)—8% of total market hogs; public auction—0.4%; formula pricing (using another price as the base for the purchase of livestock)—57%; internal transfer (transfer of packer-owned livestock from a finisher to the slaughter plant)—19%, and other (pricing method not captured in other categories)—14%. There are stark differences in pricing methods between the East and Midwest regions, which clearly reflects the difference in the

Table 2-7. Summary of Market Hog Pricing Methods by Region: Pork Packers' Transactions (Purchase) Data, October 2002–March 2005

Region	Individually Negotiated Pricing	Public Auction	Formula Pricing	Internal Transfer	Other	Missing	Total
East							
Observations	2,607	D	104,846	D	0	D	D
Percentage	1.07%		42.99%		0.00%		100.00%
Number of market hogs	412,037	D	15,459,198	D	0	D	D
Percentage of market hogs	1.08%		40.47%		0.00%		100.00%
Midwest							
Observations	212,729	D	843,134	D	262,526	D	1,414,754
Percentage	15.04%		59.60%		18.56%		100.00%
Number of market hogs	14,933,500	D	88,948,186	D	26,464,282	D	145,469,746
Percentage of market hogs	10.27%		61.15%		18.19%		100.00%
Other							
Observations	0	0	D	0	0	D	D
Percentage	0.00%	0.00%		0.00%	0.00%		100.00%
Number of market hogs	0	0	D	0	0	D	D
Percentage of market hogs	0.00%	0.00%		0.00%	0.00%		100.00%
Total							
Observations	215,336	4,892	951,642	226,437	262,526	16,394	1,677,227
Percentage	12.84%	0.29%	56.74%	13.50%	15.65%	0.98%	100.00%
Number of market hogs	15,345,537	703,662	107,862,399	36,619,116	26,464,282	2,486,923	189,481,919
Percentage of market hogs	8.10%	0.37%	56.92%	19.33%	13.97%	1.31%	100.00%

D = Results suppressed.

industry structure. In the East, the majority of their market hogs were priced using internal transfer, 40% were priced using formula pricing, and 1% were priced using individually negotiated pricing. In the Midwest, 61% of their market hogs are priced using formula pricing, 10% were priced using individually negotiated pricing, and a small percentage were priced using internal company transfers. In other areas, formula pricing was the dominant pricing method. The remaining hogs purchased in this area did not have a pricing method reported.

Table 2-8 summarizes the details of the formula pricing method (formula base), in cases where formula pricing was used. The results indicate that most formula pricing was based on USDA dressed or carcass quotes (57%). Other frequently used formula base prices include the CME futures prices and USDA live quotes (a majority of formula purchases in other states). The total number of market hogs in each region in Table 2-8 does not match the number of market hogs under formula pricing in Table 2-7. Packers provided information on the formula base even though the pricing method used was not formula pricing.[12]

2.3.2 Price Differences across Marketing Arrangements

Table 2-9 shows the average price of market hogs (in dollars per hundred pounds carcass weight) by region. During the full sample period and for the calendar year 2004, the Midwest region had the highest hog price ($73.24 in 2004), the Other region had the second highest, and the East region had the lowest price ($60.85 in 2004). Table 2-10 presents the average hog price by procurement method and plant region. Ignoring the “other” and “not specified,” categories the largest average price during the period was associated with procurement or marketing contracts ($64.31/cwt) and the lowest price was associated with packer-owned hogs. The table is also useful for figuring out the relative importance of various purchase methods in total packers’ procurements. The procurement or marketing contract that exhibits the highest price is also associated with the highest number of individual transactions (lots), with 32% of the total number of purchases (individual transactions) recorded through this channel. This percentage must not be confused with the total number of hogs purchased through procurement or[13] marketing contracts, because not all lots contain the same number of hogs.

[12] For example, internal transfer pricing may use an external price source; therefore, the pricing method would be internal transfer, but a formula base would still be applicable.

[13] Table 2-3 shows that procurement or marketing contracts accounted for 32% of all observations, but only 29% of all hogs.

Table 2-8. Summary of Market Hog Formula Bases by Region: Pork Packers' Transactions (Purchase) Data, October 2002–March 2005 and 2004

Region	Individual or Multiple Plant Average Price	USDA Live Quote	USDA Dressed or Carcass Quote	USDA Boxed Pork Price	Chicago Mercantile Exchange Lean Hog Futures	Other Market Price	Other	Missing	Total
East									
Observations	0	D	219,597	0	D	0	4,995	D	D
Percentage	0.00%		90.05%	0.00%		0.00%	2.05%		100.00%
Number of market Hogs	0	D	34,194,974	0	D	0	876,571	D	D
Percentage of market hogs	0.00%		89.52%	0.00%		0.00%	2.29%		100.00%
Midwest									
Observations	D	D	739,158	D	D	D	96,806	405,312	1,414,754
Percentage			52.25%				6.84%	28.65%	100.00%
Number of market Hogs	D	D	73,330,824	D	D	D	9,888,890	40,569,951	145,469,746
Percentage of market hogs			50.41%				6.80%	27.89%	100.00%
Other									
Observations	0	D	0	0	0	0	0	D	D
Percentage	0.00%		0.00%	0.00%	0.00%	0.00%	0.00%		100.00%
Number of market Hogs	0	D	0	0	0	0	0	D	D
Percentage of market hogs	0.00%		0.00%	0.00%	0.00%	0.00%	0.00%		100.00%
Total									
Observations	D	21,891	958,755	D	154,755	D	101,801	421,850	1,677,227
Percentage		1.31%	57.16%		9.23%		6.07%	25.15%	100.00%
Number of market Hogs	D	4,471,370	107,525,798	D	21,144,541	D	10,765,461	43,153,826	189,481,919
Percentage of market hogs		2.36%	56.75%		11.16%		5.68%	22.77%	100.00%

D = Results suppressed.

Table 2-9. Hog Price of Market Hogs by Plant Region: Pork Packers' Transactions (Purchase) Data, October 2002–March 2005 and 2004

	October 2002–March 2005			2004		
Region	Number of Records	Hog Price (mean)[a]	Standard Deviation	Number of Records	Hog Price (mean)[a]	Standard Deviation
East	D	53.04	14.36	D	60.85	12.45
Midwest	1,414,754	64.10	13.78	544,231	73.24	12.94
Other	D	D	D	D	D	D
All	1,677,227	62.46	14.36	655,153	71.21	12.07

[a] Hog price is measured by dollars per hundred weight (cwt), carcass weight.

D = Results suppressed.

There are some differences in the average prices paid by packers across regions. The highest price in the East region was paid for market hogs coming from forward contracts, and the lowest price was paid for packer-owned hogs. In the Midwest, the highest price was paid for hogs coming through procurement or marketing contracts ($64.14), and the lowest price was for hogs acquired through auction barns. If we aggregate auction barns, video/electronic auctions, dealers and brokers, and direct trades into a joint spot/cash market transactions category, the average national cash/spot market price for the entire period was $59.40/cwt (std. dev.=13.41), with rather small differences across regions. The mean cash price was $58.53/cwt (std. dev.=15.89) in the East region and $59.36/cwt (std. dev.=13.26) in the Midwest region.

The primary cause for the regional difference in prices between the East and the rest of the country is the composition of AMAs used by packers to procure their hogs. The mean price of packer-owned hogs in the East is lower than the national average price of $54.66. Packer-owned hogs account for a majority of all hog purchases in this region. The recorded packer owned price represents an internal transfer price and, as such, may not represent an arms-length transaction. Therefore, the regional differences in prices may not necessarily mean that these regions constitute separate markets. In fact, based on the cash/spot market, the dealer or broker price in the East is actually higher than the national average, whereas the direct trade price is still lower than the national average, but the difference is only about $3/cwt carcass weight.

Table 2-10. Average Hog Price by Procurement Method and Plant Region, October 2002–March 2005

Region	Auction Barns	Video/ Electronic Auctions	Dealers or Brokers	Direct Trade	Procurement or Marketing Contract	Forward Contract	Marketing Agreement	Packer Owned	Other	Not Specified	All
East											
Observations	D	0	D	D	D	D	70,307	D	0	D	D
Percentage		0.00%					28.83%		0.00%		100.00%
Hog price (mean)	D	$0.00	D	$56.99	$67.21	D	$56.32	D	$0.00	D	$53.04
Standard deviation	D	0.00	D	16.09	9.10	D	15.21	D	0.00	D	14.36
Midwest											
Observations	D	0	41,354	207,319	498,752	170,179	175,646	95,808	D	25,491	1,414,754
Percentage		0.00%	2.92%	14.65%	35.25%	12.03%	12.42%	6.77%		1.80%	100.00%
Hog price (mean)	D	$0.00	$57.89	$59.69	$64.14	$61.02	$62.53	$64.11	D	$57.89	$64.10
Standard deviation	D	0.00	13.03	13.29	13.37	11.30	11.45	12.90	D	12.18	13.78
Other											
Observations	D	D	D	D	D	D	0	D	0	D	D
Percentage							0.00%		0.00%		100.00%
Hog price (mean)	D	D	D	D	D	D	$0.00	D	$0.00	D	D
Standard deviation	D	D	D	D	D	D	0.00	D	0.00	D	D
All											
Observations	7,852	D	45,026	224,135	530,341	170,196	245,953	231,766	D	25,954	1,677,227
Percentage	0.47%		2.68%	13.36%	31.62%	10.15%	14.66%	13.82%		1.55%	100.00%
Hog price (mean)	$59.52	D	$58.04	$59.66	$64.31	$61.02	$60.76	$54.66	D	$58.07	$62.46
Standard deviation	12.48	D	12.87	13.22	13.20	11.30	12.95	14.64	D	12.24	14.36

D = Results suppressed.

Table 2-11 shows the average hog price by ownership method. As indicated by the percentage of observations in various categories, the vast majority of the total number of lots (and market hogs) were purchased under sole ownership in all regions. Sole ownership tends to have a lower average hog price than other ownership methods, but because the number of observations in all other methods is very small, this result should not be given too much credence.

Table 2-11. Summary of Hog Prices by Ownership Method and Region: Pork Packers' Transactions (Purchase) Data, October 2002–March 2005

Region	Sole Ownership	Joint Venture	Shared Ownership	Other	Missing	All
East						
Observations	236,476	D	0	D	D	D
Percentage	96.97%		0.00%			100.00%
Hog price (mean)	$52.77	D	$0.00	D	D	$53.04
Standard deviation	14.33	D	0.00	D	D	14.36
Midwest						
Observations	1,367,266	0	D	D	D	1,414,754
Percentage	96.64%	0.00%				100.00%
Hog price (mean)	$64.44	$0.00	D	D	D	$64.10
Standard deviation	13.81	0.00	D	D	D	13.78
Other						
Observations	D	0	0	0	D	D
Percentage		0.00%	0.00%	0.00%		100.00%
Hog price (mean)	D	$0	$0	$0	D	D
Standard deviation	D	0.00	0.00	0.00	D	D
All						
Observations	1,622,357	D	D	D	43,812	1,677,227
Percentage	96.73%				2.61%	100.00%
Hog price (mean)	$62.71	D	D	D	$53.39	$62.46
Standard deviation	14.45	D	D	D	6.86	14.36

D = Results suppressed.

2.3.3 Explaining the Observed Differences in Prices

To see what other factors may explain the observed differences in prices, we looked at the differences in prices across lot sizes, quality characteristics, and sizes of plants and companies. The results are summarized in Tables 2-12 through 2-15. The results indicate that prices are inversely related to the lot size. Packers seem to pay significantly lower prices for large lots. The highest mean price ($63.13/cwt) was paid for hogs in lots

Table 2-12. Price of Market Hogs by Lot Size: Pork Packers' Transactions (Purchase) Data, October 2002–March 2005

Lot Size (Number of Market Hogs)	Number of Records	Hog Price (mean)[a]	Standard Deviation
Fewer than 50	535,078	62.85	14.34
Between 50 and 100	257,603	63.13	14.08
Between 101 and 200	855,998	62.04	14.45
Greater than 200	28,548	61.77	14.31
All	1,677,227	62.46	14.36

[a] Hog price is reported in dollars per hundred pounds (cwt), carcass weight.

Table 2-13. Price of Market Hogs by Quality Attribute (Loin-Eye Depth): Pork Packers' Transactions (Purchase) Data, October 2002–March 2005

Quality (Loin-Eye Depth [mm])[a]	Number of Records	Hog Price (mean)[b]	Standard Deviation
Less than 55.3	368,109	61.27	15.03
Between 55.3 and 66.3	776,617	62.43	15.26
Greater than 66.3	392,056	62.70	12.92
Missing	140,445	—	—
All	1,677,227	62.46	14.36

[a] These classifications are based on the interquartile ranges of loin-eye depth.
[b] Hog price is reported in dollars per hundred pounds (cwt), carcass weight.

Table 2-14. Price of Market Hogs by Weekly Slaughter Capacity: Pork Packers' Transactions (Purchase) Data, October 2002–March 2005

Capacity (Weekly Maximum Slaughter Capacity)[a]	Number of Records	Hog Price (mean)[b]	Standard Deviation
Fewer than 41,000	104,366	63.36	13.06
Between 41,000 and 95,000	704,346	61.73	13.77
Greater than 95,000	868,515	62.95	14.94
All	1,677,227	62.46	14.36

[a] These classifications are based on the interquartile ranges of weekly slaughter capacity.
[b] Hog price is reported in dollars per hundred pounds (cwt), carcass weight.

Table 2-15. Price of Market Hogs by Company Size: Pork Packers' Transactions (Purchase) Data, October 2002–March 2005

Company Size[a]	Number of Records	Hog Price (Mean)[b]	Standard Deviation
5 or more plants	D	D	D
2 to 4 plants	556,886	68.13	14.18
Single plant	D	62.55	12.29
All	1,677,227	62.46	14.36

[a] Company size is the number of plants owned by the company.

[b] Hog price is measured by dollars per hundred weight (cwt), carcass weight.

D = Results suppressed.

of 50 to 100 head. Prices also seem to respond to quality differences. The only quality attribute available for a sufficiently large number of observations was loin-eye depth.[14] Loin-eye depth is measured in millimeters and the greater value implies the higher quality of market hogs. Higher prices are clearly associated with higher loin-eye depth. Looking at the weekly slaughter capacities of plants, we see the lowest prices for market hogs were paid by plants in the middle of the capacity range (41,000 to 95,000 hogs slaughtered weekly). Finally, we looked at the relationship between the company size and the prices paid for live market hogs, as perhaps some preliminary indication of market power. We divided the sample of 29 plants into three groups: the first group contains companies with five or more plants, the second group contains companies with two to four plants, and the last group contains single-plant companies. Although the specific value is suppressed for confidentiality, the group containing five or more plants per company paid the lowest price on average.

To explore the determinants of the price differences in a more systematic way, we estimate a model similar in spirit to the performance approach used to test for complementarity of marketing arrangements in Section 3 of this report. The approach involves regressing a firm-level performance measure on portfolios of marketing arrangements and a vector of exogenous control variables X. In this context, the performance measure is the price that plants pay to procure their hogs, with the idea being that certain favorable combinations of marketing

[14] In Section 4 of this report, we talk extensively about the quality differences associated with various AMAs.

arrangements may actually result in a lower average price paid to procure hogs.

Once the procurement strategy (i.e., portfolio of marketing arrangements) is in place, plants do not change it very often.[15] Therefore the portfolio indicators in our model do not change during the sample period. However, different hogs are purchased through different channels, so each lot is associated with a particular marketing arrangement through which it was procured. Overall, the price of a lot of hogs is determined by the portfolio of marketing arrangements that a firm has in place, as well as by the individual marketing arrangement through which the particular lot was purchased. To capture both effects, we estimated the following linear regression model:

$$P\_carcass = f(D\_MA, D\_portfolio, X), \tag{2.1}$$

where P_carcass is the weekly average of the carcass prices (in $/cwt) paid by the packers in the data set. D_MA = (d_ma1, d_ma2, ..., d_ma4) is a vector of binary variables for marketing arrangement categories defined as follows:

- d_ma1 = 1 if procurement method is cash/spot sales (MA1); 0, otherwise
- d_ma2 = 1 if procurement method is marketing contract (MA2); 0, otherwise
- d_ma3 = 1 if procurement method is packer owned (MA3); 0, otherwise
- d_ma4 = 1 if procurement method is other (MA4); 0, otherwise

D_portfolio is the set of binary variables for each of the observed portfolios of marketing arrangements used by the plant during the data period. There are 15 possible combinations of marketing arrangements, but only 5 combinations are actually observed; hence, the portfolio binary variables are defined as follows:

- pfbin1 = 1 if only cash/spot is used; 0, otherwise

[15] Moreover, the data reveals an interesting fact that all plants owned by the same company use the same portfolio of AMAs to procure their hogs. This is a clear indication that the procurement strategy is decided at the company level and not at the plant level.

§ pfbin2 = 1 if only marketing contracts is used; 0, otherwise

§ pfbin3 = 1 if only cash/spot and marketing contracts are used; 0, otherwise

§ pfbin4 = 1 if only cash/spot, marketing contracts, and packer owned are used; 0, otherwise

§ pfbin5 = 1 if only marketing contracts, packer owned, and other marketing arrangements are used; 0, otherwise

The exogenous variables included in the regression are regional binary variables, two animal characteristics variables—the loin-eye depth (Loineye) and the liveweight (in pounds) of the market hogs per head (Livew), and time and time squared variables. Quadratic time trend is included in the regression to pick up all possible macro-economic influences (e.g., inflation) that may be affecting the hog price.

Table 2-16 summarizes the ordinary least squares (OLS) regression results. Because of the additional elimination of outliers and missing values of some explanatory variables, an additional 154,469 observations were excluded, so the final sample size used in this regression is 1,522,758. We omitted the binary variable for cash/spot sales (d_ma1) and the binary variable for the cash/spot-only portfolio (pfbin1).

All the estimates for individual coefficients are significant at the 1% significance level, which is not surprising given the sample size. The signs of the coefficients on the procurement method variables are consistent with the previous findings. On average, the price of marketing contract purchases (MA2) is higher than cash/spot purchases (MA1) by $0.75/cwt, while the packer owned price (MA3) is about $0.88/cwt lower than the cash/spot price. The actual means of the data are $59.40/cwt for cash/spot, $62.79/cwt for marketing contracts, and $54.66/cwt for packer owned. The sign of the regional variable R1 shows that the East region has a lower average price than the rest of the country by $10.50/cwt. The sign of the loin-eye depth variable is positive and significant. Thicker loin-eye depth indicates higher quality hogs, and higher quality hogs are sold at higher prices. The sign of Livew (liveweight per head) is negative and statistically significant. The magnitudes of both coefficients are small and thus have little influence on the average hog price.

Table 2-16. OLS Regression Analysis of Hog Prices: Pork Packers' Transactions (Purchase) Data, October 2002–March 2005

Variable	Parameter Estimate	Standard Error	t value	P value
Intercept	53.518	0.1223	437.35	<.0001
D_ma2	0.746	0.0227	32.81	<.0001
D_ma3	–0.875	0.0296	–29.54	<.0001
D_ma4	1.561	0.0460	33.96	<.0001
R1[a]	–10.486	0.0262	–399.83	<.0001
pfbin2	4.341	0.1512	28.72	.8260
pfbin3	0.734	0.0585	12.55	<.0001
Pfbin4	–1.750	0.0553	–31.65	<.0001
Pfbin5	13.899	0.0663	209.66	<.0001
Loin-eye depth (mm)	0.013	0.0016	8.41	<.0001
Liveweight per head (lb)	–0.047	0.0005	–103.55	<.0001
Time	0.055	0.0001	528.25	<.0001
Time squared	–2.123	0.0111	–191.63	<.0001
Adjusted R^2	0.670			

[a] Regional binary variable R1 = 1 if region is East; R1 = 0, otherwise.

In estimating the effect of various factors to explain the behavior of hog price, it is necessary to avoid any possible selection bias coming from nonrandom selection of marketing arrangement portfolios. The decision about the optimal portfolio of marketing arrangements is a company's strategic decision, and it is possible that companies with more capable management would organize their procurement service by selecting more appropriate marketing arrangement portfolios. Because the adoption of different procurement portfolios is likely to be nonrandom, the endogeneity problem needs to be addressed. Thus, we use the instrumental variable estimator (two-stage least squares [2SLS]).[16] Because we have four endogenous variables (portfolios 2, 3, 4, and 5) we need at least four instruments. We use the size of the company, as measured by the number of plants that it operates, the plant capacity, and its location. Capacity is the plant's maximum slaughter capacity per week for market hogs, not the actual

[16] For a detailed discussion about various approaches to address the endogeneity problem in a similar context, see the discussion in Section 3.3.

slaughter volume.[17] Location was introduced via the binary variable for the Midwest region. To capture possible nonlinearities, we also use the size squared, the capacity squared, and the interaction of size and capacity. The results are presented in Table 2-17.

Table 2-17. Instrumental Variable (2SLS) Estimation of the Hog Price Equation

Variable	Parameter Estimate	Standard Error	t value	P value
Intercept	58.030	0.1440	402.92	<.0001
D_ma2	1.928	0.0539	35.79	<.0001
D_ma3	–0.167	0.0330	–5.06	<.0001
D_ma4	3.925	0.2377	16.51	<.0001
R1[a]	–10.710	0.0361	–296.50	<.0001
pfbin2	–29.705	0.3824	–77.69	<.0001
pfbin3	–5.939	0.1976	–30.06	<.0001
pfbin4	–7.888	0.1271	–62.07	<.0001
pfbin5	5.933	0.3383	17.54	<.0001
Loin-eye depth (mm)	0.000	0.0027	0.01	<.9955
Liveweight per head (lb)	–0.039	0.0006	–67.42	<.0001
Time	0.055	0.0001	492.39	<.0001
Time squared	–2.140	0.0121	–177.23	<.0001
Adjusted R^2	0.651			

[a] Regional binary variable R1=1 if region is East; R1=0, otherwise.

Accounting for the endogeneity of marketing arrangement portfolio choices produced a couple of interesting results. First, two coefficient estimates on the portfolio binary variables changed signs, such that now three out of four portfolio binary variables are negative. The signs on pfbin2 (marketing contracts), pfbin3 (cash/spot and marketing contracts), and pfbin4 (cash/spot, marketing contracts, and packer owned) are negative, meaning that all AMAs reduce the average price for live hogs relative to cash/spot procurement only. The only qualitatively different result is pfbin5 (marketing contracts, packer owned, and other), which is positive. This result is

[17] Plants provided the capacity measures in the transactions data collection or the pork packers' survey.

difficult to interpret because this portfolio includes “other,” the content of which is unknown. The portfolio’s other feature is that it does not include cash/spot market purchases. However, this may not be a decisive factor because pfbin2 does not include cash/spot purchases either, yet it is still associated with a lower average price relative to cash market purchases. The results show that packers that use of a combination of marketing arrangements, on average, pay lower prices for their hogs relative to plants that use the cash/spot market only.

The second interesting result comes from comparing the magnitudes of the portfolio effects with the magnitudes of the individual marketing arrangement effects. Take, for example, pfbin3 (cash/spot and marketing contracts) and compare it with d_ma2 (marketing contracts). The magnitude of the negative price effect of the portfolio ($58.03 – $5.94 = $52.09/cwt) is larger (i.e., the price is lower) than the sum of the individual marketing arrangement effects ($58.03 + $1.93 = $59.96/cwt). Furthermore, comparing the magnitude of the pfbin4 (cash/spot, marketing contracts, and packer owned) with the sum of d_ma2 (marketing contracts) and d_ma3 (packer owned), the effect of the portfolio ($58.03 – $7.89 = $50.14/cwt) is larger (price is lower) then the sum of individual effects ($58.03 + $1.93 – $0.17 = $59.79/cwt). The results appear to indicate that individual marketing arrangements have minimal additional effect on the average price (i.e., the portfolio system binary variables capture almost the entire effect on lowering the average price). As will be seen in Section 3, these results are supportive of the claim that the various marketing arrangements may be complementary to each other.

2.4 SHORT-RUN PRICE EFFECTS OF AMAs

MPR data from August 10, 2001, through September 30, 2005 (the period in which MPR was in effect) were used to estimate the impact of AMAs on spot or negotiated market prices.[18] The six types of marketing instruments are (1) negotiated purchases, (2) other market formula purchases (based on formula price other than the market for hogs, pork, or a pork product; formula may be based on one or more futures or options contracts), (3) hog or pork market formula purchases

[18] Aggregate quantity data were obtained by multiplying proportions of head in each category by average pork production per week.

(formula price based on market for hogs, pork, or a pork product), (4) other purchase arrangements (includes long-term contract agreements, fixed-price contracts, cost of production formulas), (5) packer sold (sold for slaughter to another packer), and (6) packer owned (hogs owned by a packer for at least 14 days before slaughter). Price data were available only for categories 1 through 5 because packer-owned hogs were not traded. Hogs owned by packers (5) was viewed as intermediate inputs and therefore not included in the empirical model. However, the price of packer-sold hogs was taken to be the imputed price of packer-owned hogs because this price is a measure of the opportunity cost of hogs owned by packers.

For the econometric analysis, all marketing arrangements (categories 2 through 4) were aggregated together. The quantity index was the Fisher Ideal index multiplied by the sample mean average of quantities for this category. We obtained the price index by dividing the total value of hogs slaughtered by the quantity index. Summary statistics of the three marketing arrangements used in the econometric analysis (i.e., negotiated, contracted, and packer owned) are shown in Table 2-18.

Table 2-18. Summary Statistics of MPR Weekly Swine Prices and Quantities, August 10, 2001–September 30, 2005

Variable	N	Mean	Standard Deviation
Negotiated price	217	59.4053610	12.1348986
Contract price	217	60.3493519	9.7093267
Packer owned price	217	63.1364716	11.8053015
Negotiated pounds	217	50.4345681	8.6589549
Contract pounds	217	257.7430445	21.3350240
Packer owned pounds	217	72.8061901	8.6881661

Note: prices are in $/cwt, and quantities are in 1,000 lbs. carcass weight.

The different data were initially analyzed to determine their time-series properties. Dickey-Fuller tests indicated unit roots in all six data series. Thus, cointegration between the variables in the models estimated had to be established to ensure the error terms were stationary so that the statistical results could be viewed as valid.

The relationship between the cash/spot or negotiated price and AMAs was postulated to result from the effects of packer decisions regarding the purchase of hogs for slaughtering and processing. Packers were expected to select a portfolio of hogs purchased from different marketing arrangements (cash/spot market, contracts, and packer owned) to maximize net revenue from slaughtering and processing. Given anticipated demand for pork, packers would then choose the mix of hogs to minimize costs. From week to week, quantities of hogs available for slaughtering are predetermined (i.e., the quantities available are determined by decisions made in previous weeks) (Bullock, 2003). This means that the market within the week determines the cash/spot price for hogs, given the quantities of hogs offered for sale on the cash/spot market, hogs available from contracting, and hogs available from packer-owned operations. Therefore, causality is seen as running from the quantities of hogs sold from the various sources (cash/spot, contract, and packer owned) to cash/spot price for hogs within the week. Because anticipated demand for pork changes from week to week, expected quantity of pork to be processed is also a determinant of the inverse demand function for negotiated hogs.

To estimate the effect of AMAs on the cash/spot price, we added quantities of primal pork cuts sold in each week to the data set. We constructed an index of quantities to enable measurement of the effect of demand for pork on demand for hogs by packers within the week. The data were obtained from USDA/AMS, National Carlot Meat Trade Review: Meat, Livestock, and Slaughter Data, 2001–2005. The proportions of each cut (loin, butt, ham, picnic, belly, rib) were multiplied by average weekly U.S. pork production to obtain thousands of pounds marketed. Table 2-19 provides a summary of these data. We constructed a Fisher Ideal index of the quantities, multiplying the index by the average sample quantity of pork produced.

Appendix B of Volume 4 specifies how the model was formulated for econometric analysis. In essence, we used dynamic seemingly unrelated regression (DSUR) to estimate the three inverse demand functions for marketing instruments (cash/spot, contract, and packer owned). In addition to the current weekly quantities of hogs from cash/spot, contract, and company sales, as well as the current weekly quantity of pork

Table 2-19. Summary Statistics of MPR Pork Primal Cut Slaughter Values and Quantities, August 10, 2001–September 30, 2005

Variable	N	Mean	Std Dev
Loin price	217	79.9664516	10.1727399
Butt price	217	59.2835945	12.5855802
Ham price	217	50.3645161	12.2033613
Rib price	217	122.0556682	17.1121195
Belly price	217	83.9891705	14.4318368
Picnic price	217	40.8767281	11.1189015
Loin pounds	217	110.3752063	30.6538388
Butt pounds	217	58.3497952	18.3915121
Ham pounds	217	94.3521645	26.9974187
Rib pounds	217	12.5418756	6.9529211
Belly pounds	217	21.7612271	14.2663447
Picnic pounds	217	29.5053996	10.0565297

Note: Values are in $/cwt, and quantities are in 1,000 lbs carcass weight.

sold, the model also includes first differences in lags and leads for 3 weeks for all four variables. In addition, 11 monthly binary variables and an intercept were included in the equations to account for any seasonal effects that may be present in demand. Finally, a linear time-trend variable was included to account for omitted variables like wage rate in meat slaughtering. Such data were unavailable on a weekly basis and could not be included in the analysis.

The estimation procedure was conducted in two stages. In the first stage, the three prices (cash/spot, contract, and packer owned), the quantities of the three hog types, and the index of pork quantity were regressed on the first differences in lags and leads of quantities of hogs, the index of pork quantity, the time trend, the intercept, and the 11 binary variables. The residuals from the first-stage estimates were then used to form a system of equations to estimate the model using the iterated seemingly unrelated regression method. In the second stage, the residuals were corrected for first-order autocorrelation. Two different sets of estimates were obtained: one set for which symmetry was imposed on the cross-quantity variables of hogs and one set for which both symmetry and the restriction of negative semidefiniteness of the matrix of hog quantities was imposed. Theory suggests that both restrictions should hold. The latter restriction was imposed to ensure that the cost function had the right curvature conditions for the economic analysis. The advantage of the DSUR approach is that both endogeneity and dynamics are accounted for in a rather general way.[19] The results also allow us to evaluate the relationship between the steady-state values of the variables of interest. In addition, the relationships estimated were found to be cointegrated with stationary error terms so that valid inferences can be made from the estimation results.

Given these econometric considerations, the estimated relationship between the cash/spot price, quantities of hogs sold, and index of quantity of pork processed is as follows:[20]

$$\hat{pneg}_t = \underset{(0.051)}{-0.285}\, qneg_t \; \underset{(0.036)}{-0.172}\, qcon_t \; \underset{(0.050)}{-0.198}\, qown_t \; \underset{(0.040)}{+0.097}\, qpork_t \,. \qquad (2.2)$$

where neg refers to cash/spot sales, con refers to contract sales, and own refers to packer owned sales. All the quantity variables are highly statistically significant, as indicated by the asymptotic t-values constructed by forming the ratio of each coefficient estimate to its standard error (value in parenthesis). As indicated by the signs of the quantity variables, increases in quantities of cash/spot, contract, and packer-owned hogs all depress the cash/spot price of hogs. Greater anticipated demand for hogs, as indicated by the positive sign on the $qpork_t$ variable, leads to an increase in demand for hogs sold on the cash/spot market, and therefore the cash/spot price of hogs, everything else equal.

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[19] For example, one might expect that inventory holding is important from week to week, so the response of hog prices should be a distributed lag to current and past hog quantities and to current and past pork quantities. By including first differences in three lags of these variables, we are in essence including four lagged variables on each right-hand side variable and should therefore account for any dynamics that might be present. Including first differences in leads and lags also accounts for nonstrict exogeneity and endogeneities in the regressors that might be present in the model.

[20] These estimates are from Table B-6 in Appendix B of Volume 4. The estimates are for symmetry and negative-semidefiniteness imposed. The results are very similar to the case where negative-semidefiniteness is not imposed. Therefore, only these results are reported.

Of particular interest in Eq. (2.2) is the effect of both contract and packer-owned hog supplies on the cash/spot price. As anticipated, these effects are negative—an increase in either contracted hogs or packer-owned hog sales decreases the cash/spot price of hogs. At the sample means, a 1% increase in contract hogs sold causes the spot price to decline by 0.75%. A 1% increase in packer-owned hogs sold causes the cash/spot price to decline by 0.24%.

The negative relationship between the two AMAs and cash/spot price occurs, at least in part, because the three types of hogs are substitutes for one another in pork production. A higher quantity of either contract or packer-owned hogs available for sale lowers the prices of contract or packer-owned hogs and induces the packer to purchase more of the now relatively less expensive hogs and purchase fewer hogs sold on the cash/spot market.

Eq. (2.2), also as anticipated, shows that the demand curve for hogs is negatively sloped. A 1% increase in quantity of hogs sold on the cash/spot market decreases the cash/spot price by 0.24%, everything else held constant.

The estimated Eq. (2.2) does not allow for adjustment of pork quantities to changes in hogs slaughtered. Clearly, full equilibrium adjustment to changes in quantities of contract supplies and packer owned supplies would require the quantities of pork and prices of pork to change as both processors and consumers respond to the market changes. The packer model of input demand functions was combined with the packer model of price equations for the six primal pork cuts, as well as demand for the six primal pork cuts to calculate, the full impact of changes in spot market supplies, contract supplies, and packer owned supplies.[21] These total elasticities were calculated as follows: (1) a 1% increase in cash/spot market quantities causes the cash/spot market price to decrease by 0.27%, (2) a 1% increase in contract hog quantities causes the cash/spot market price to decline by 0.88%, and (3) a 1% increase in packer-owned hog quantities causes the cash/spot market price to decline by 0.28%. These estimates are quite

[21] In the economic literature, these estimated effects are for “industry-derived demand,” while the effects of changes in input quantities on input price indicated by Eq. (2.2) are for “output-constant input demand.”

close to the estimates derived from Eq. (2.2) of 0.24, 0.75, and 0.24, respectively, suggesting the downstream effects from changes in hog supplies are very small compared with the substitution effects among different sources of hogs for slaughter.

In addition to the above analyses, another model was estimated to evaluate how the spread between the cash/spot price and AMA supplies (referring to all marketing arrangements other than cash or spot markets) prices changes as the proportion of AMA supplies increases. We examine this relationship to see if in fact an increase in market power creates more of a gap between prices on the different market outlets. The same data set was used for estimation but with contract and packer-owned hog quantities aggregated into an index. We used the same procedure shown in Eq. (2.2). That is, the dependent variable, cash/spot price, and each of the right-hand side variables were first regressed on an intercept, 11 monthly binary variables, a time trend, three first differences in leads and lags of the current weekly price of AMA supplies (pama), and the ratio of AMA supplies to negotiated (cash/spot) market supplies (qama/qneg). In the second stage, the residuals on the dependent variable were regressed on the residuals of pama and (qama/qneg) to obtain the dynamic ordinary least squares (DOLS) estimates. To account for serial correlation in the residuals, DOLS estimates were obtained with correction for first-order autocorrelation in the residuals. The results were as follows:

$$\underset{}{\mathrm{pn\hat{e}g}_t} = \underset{(0.68)}{-13.61} + \underset{(0.01)}{1.23}\ \mathrm{pama}_t - \underset{(0.05)}{0.27}\ (\mathrm{qama}/\mathrm{qneg})_t \tag{2.3}$$

$$\bar{R}^2 = 0.99 \quad \hat{\rho} = \underset{(0.05)}{0.70}$$

where, as before, values in parentheses are standard errors of the parameters, $\hat{\rho}$ is the estimated first-order autocorrelation coefficient, and $\bar{R}^2$ is the adjusted R-squared value. The results show that both variables are highly statistically significant. Also, the results confirm the hypothesis that increases in AMA supplies relative to negotiated supplies decreases the cash/spot price, given the current level of the price of AMA supplies. Therefore, the gap between the cash/spot market price and the

AMA supplies price widens as the proportion of supplies through AMAs increases.

While the results in this section establish a negative relationship between AMA supplies and the cash/spot market price for hogs, this relationship does not necessarily imply that hog producers selling on the cash/spot market would be better off restricting or reducing AMA supplies. If reductions in supplies of hogs sold for contract or owned by packers are reduced through regulation, at least a portion of that reduction in supplies would be diverted to the cash/spot market, causing an offsetting decline in the cash/spot market price. A complete analysis of the effects of restricting use of AMAs on hog prices and hog producers is given in Section 6 of Volume 4.

2.5 PRICE DISPERSION IN THE SPOT MARKET FOR LIVE HOGS

In this section, we examine the phenomenon of price dispersion in the cash/spot market for live hogs. The empirical puzzle of price dispersion of homogenous goods has been noticed in the various markets. This literature that originates with the seminal paper by Stigler (1961) has been thoroughly surveyed by Baye, Morgan and Scholten (2005). Almost all previous studies focused on the consumer goods market, so this is a first attempt to examine this phenomenon in an intermediate good market. We present the empirical evidence and discuss and test several possible explanations for what we observe based on industrial organization theory.

2.5.1 Empirical Evidence

The data preparation procedure was similar to the procedure described in Section 2.1.2 with a few minor differences. First, we only focused on hogs transacted through direct trade between a farmer and a packer. According to Table 2-3, this type of transaction accounted for about 8.9% of the total transactions during the sample period. Second, we did not exclude transactions with five or fewer market hogs because we wanted to examine the entire price dispersion in this market. Third, we excluded all transactions for which the total number of hogs was greater than the number of barrows and gilts. These are the transactions for which nonmarket hogs like sows and boars are also included in the lot. Fourth, prices are expressed in dollars per 100 pounds of live hog weight instead of carcass weight. We also eliminated prices that are outside the $20 to $100 range. After conducting these four screening procedures and the procedures explained in Section 2.1.2, we ended up with 270,785 lots with a total of 17,609,568 hogs. The data originate from 23 plants owned by 12 companies. These numbers are slightly larger than those reported in the column of direct trade in Table 2-3, reflecting the fact that we included transactions with five or fewer hogs.

To conduct the regression analyses below, we needed to further prepare the data. We dropped all the observations that were missing information on quality measures (lean percentage, back fat, and loin-eye depth) and the location (three-digit zip code) of the seller. Furthermore, we dropped all observations that have values less than 10 millimeters on the loin-eye depth. Finally, the working data set has 183,665 transacted lots with a total of 12,236,418 hogs for 18 plants owned by eight companies.

Table 2-20 provides the summary statistics of the working data set. On average, each lot contains about 67 hogs, with the range from 1 hog to 394 hogs. The average transaction price for the sample period is about $58 per cwt of liveweight. The average lean percentage is about 53%. The average back fat is around 20 mm, and the average loin-eye depth is around 57 mm. Notice that the standard deviations for the three quality measures are pretty small compared with their means, indicating there is not much variation in quality among the transacted hogs. The average of the carcass weight of the lots is around 193 pounds. Finally, the variable ratio is the number of low-quality hogs as a percentage of the whole lot. The number of low-quality hogs is defined as the sum of the number of off-quality hogs, the number of assessed sort loss hogs, and the number of condemned hogs in the lot. On average, each lot contains about 1.78% off-quality hogs.

The first impression about the magnitude of the price dispersion can be obtained from the daily means, ranges, and standard deviations of transaction prices. Transactions occurred on 644 days in the data set. Table 2-21 reports the summary statistics. On average, each day, the price range (defined as the maximum price minus the minimum price) is around $24. This accounts for about 40% of the mean of the transaction prices. The maximum range in 1 day’s transaction price can be as high as $61. The statistics on the standard deviation gives roughly the same information, indicating strong price dispersion.

Table 2-20. Summary Statistics of the Working Data Set

Variable	Definition	Mean	St. Dev.	Min	Max
Q	Number of heads in the lot	66.6236	63.1421	1.0000	394.0000
P	Transaction price of the lot	57.7008	12.4348	20.5681	98.4584
Lp	Average lean percentage of the lot	52.8985	2.2953	1.0000	66.0000
Bf	Average back fat of the lot	19.7682	3.8291	2.0000	57.9120
Led	Average loin-eye depth of the lot	57.2453	6.0892	11.0000	100.8380
W	Average carcass weight of the lot	192.9760	13.2470	150.0000	220.0000
Ratio	The ratio of low-quality hogs in the lot	0.0178	0.0771	0.0000	1.0000

Table 2-21. Measures of Price Dispersion[a]

Variable	Mean	St. Dev.	Min	Max
Mean	59.4034	11.9641	36.9508	83.7075
Range	23.8500	8.6323	0.5515	61.1752
Standard deviation	3.7487	1.0979	0.3106	7.7339

[a] The number of observations here is 644.

To make these statistics independent of the absolute price level, we calculated two other price dispersion measures: the range/mean ratio and the standard deviation/mean ratio (coefficient variation) of the transaction prices for each day. This calculation allows us to compare the price dispersion across different trading days. In Figure 2-2, we plot the range/mean ratio. The graph indicates that the dispersion has a few spikes; however, most of the time, the measure is around 0.4, signaling a consistent rather than sporadic presence of dispersion in the live hog price data. Figure 2-3, where we plot the coefficient of variation, shows a similar pattern of price dispersion in this market.

Figure 2-2. Time-Series Plots of the Range/Mean Series

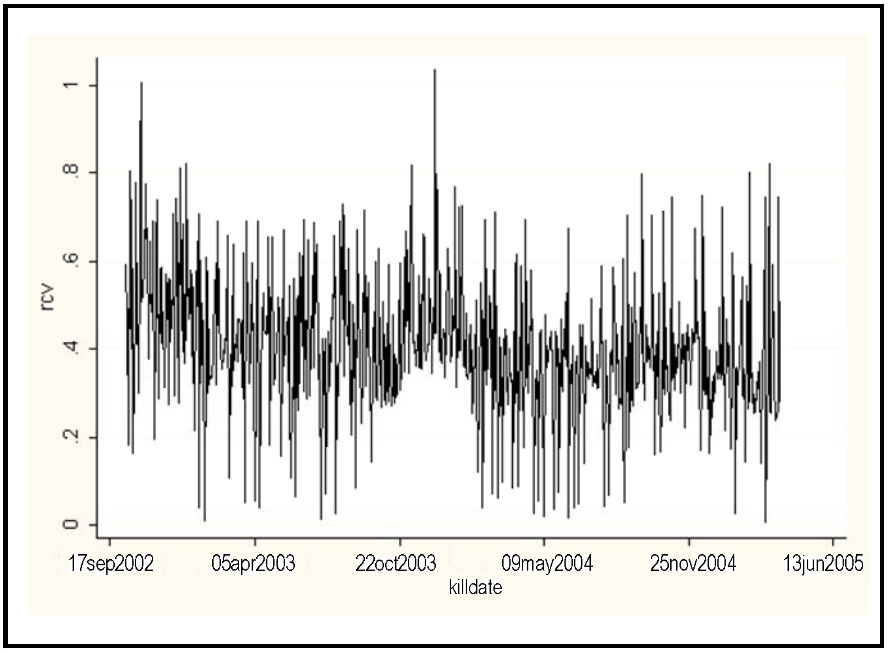
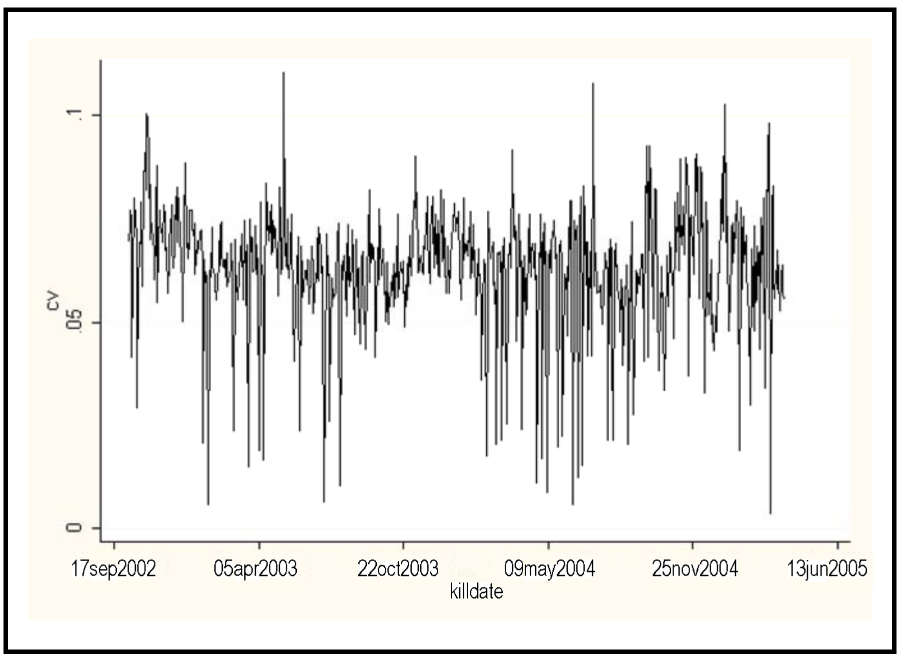


Figure 2-3. Time-Series Plots of the Coefficient Variation Series



2.5.2 Possible Explanations

What causes the price dispersion in the live hogs market? Several competing hypotheses may explain what we observe. Because of the computational intensity of some of the employed techniques, we focused on transactions that involve only sellers in the state of Iowa.[22]

As a base reference, we first regressed the ratio between the individual lot transaction price and the mean of transaction prices for that day on the constant, the plant binary variables, and the transaction day binary variables. Table 2-22 reports the regression results. Statistics for the binary variables were omitted; we focused only on the adjusted R^2 of 0.1004. This tells use that the plant and transaction day binary variables can only account for about 10% of the variation in price.

Table 2-22. OLS Regression Results with Binary Variables

Variable	Estimate	t-stat
Constant	0.9382	180.29
Adjusted R^2	0.1004	

Some of the explanations for the observed price dispersion are as investigated below.

Quality Differences

An obvious first explanation for price dispersion is the quality variation. We examined the importance of quality differences in determining the price dispersion by expanding the list of independent variables used in the previous regression. Independent variables now include the constant, the three quality measures, the weight variable, the ratio of bad hogs, and the plant and transaction day binary variables. Table 2-23 reports the regression results. Statistics for the binary variables were omitted. All coefficients have expected signs. Average lean percentage, average loin-eye depth, and average weight have significant positive effects on the transaction price. The average back fat and the ratio of bad hogs have significant negative effects on the transaction price. The adjusted R^2 increased to 0.2022.

[22] The number of observations is 50,115.

Table 2-23. OLS Regression Results with Quality Measures

Variable	Estimate	t-stat
Constant	0.7276	57.54
Lean percentage	0.0033	15.86
Back fat	–0.0030	–26.86
Average loin-eye depth	0.0009	10.74
Average weight	0.0001	5.87
Ratio	–0.1725	–30.21
Adjusted R^2	0.2022	

Transportation Costs

The second possible explanation for the price dispersion is the transportation costs. If a packer needs to pay more to transport the hogs from the farmer to the packing plant, it will pay a lower price to farmers who are located further away from the processing plant. To examine the explanatory power of this hypothesis, we calculated the distance measure for each transaction. For each transaction, we observed the three-digit zip code of the seller and the city of the buying plant. Using a zip code atlas, we located the center town of each three-digit zip code area and then obtained the shortest driving distance between the center of town of the seller's zip code and the city of the buying plant using Mapquest. Because hogs are always transported by trucks, the driving distance is the most appropriate distance measure. The mean of the driving distance for these transactions is 113.29 miles. The standard deviation is 96.11 miles.

We included the distance measure in our regression in Table 2-24. As expected, the distance measure has a significant negative effect on the transaction price. However, the magnitude of this effect is very small. Including the distance measure leaves other coefficients almost unchanged and only boosts is the adjusted R^2 by 0.0002. The conclusion is that transportation costs do not contribute to the price dispersion we observe in this market.

Table 2-24. OLS Regression Results with Distance Measure

Variable	Estimate	t-stat
Constant	0.7293	57.64
Lean percentage	0.0033	15.77
Back fat	–0.0030	–26.87
Average loin-eye depth	0.0009	10.86
Average weight	0.0001	5.80
Ratio	–0.1714	–29.97
Distance	–0.0000	–3.07
Adjusted R^2	0.2024	

Search Costs

The basic idea of the search costs theory adapted to the cash/spot market for live hogs is the following. Farmers need to incur a positive search cost to search for the best price to sell their hogs. Naturally, farmers with high search costs (or low search benefits) are less likely to search, and farmers with low search costs (or high search benefits) are more likely to search. A farmer who searches more is more likely to obtain a high price because the expected highest price increases with the number of searches. In equilibrium, different packers will offer different prices and some farmers get high prices and some farmers get low prices.

An implication of the search models is that for lots having more hogs farmers should have a higher incentive to search because the potential benefits of searching are higher than for lots with a small number of hogs. As they search more, farmers with bigger lots should receive, on average, higher prices.[23] To test for this hypothesis, we include the lot size variable into our regression. The average lot for Iowa sellers has 61.75 hogs, with the standard deviation of 59.56 hogs. As Table 2-25 shows, the estimated coefficient for the lot size is positive and significant, and the adjusted R^2 increases to 0.2532. This result lends support to the search costs explanation. Roughly 5% of the variation in the transaction prices can be attributed to farmers' search behavior.

[23] Sorensen (2000) tests another implication of the same theory using data on prescription drugs, that is, prices are less dispersed for those drugs where consumers' potential benefits of search are high.

Table 2-25. OLS Regression Results with Lot Size

Variable	Estimate	t-stat
Constant	0.7293	57.64
Lean percentage	0.0026	12.67
Back fat	–0.0025	–23.35
Average loin-eye depth	0.0010	12.62
Average weight	–0.0001	–2.21
Ratio	–0.1860	–33.58
Distance	–0.0000	–12.38
Lot size	0.0002	58.01
Adjusted R^2	0.2532	

The obtained results have two caveats. First, it is possible that bigger lots are more difficult to sell; hence, packers may offer a lower price to farmers with bigger lots. If this is the case, then the estimated effect of searching is underestimated because the lot size affects the transaction price in the opposite direction. Second, the lot size is a quantity measure, and the dependent variable of our regression analyses is the price. It is possible that the quantity measure in the regression is endogenous and the results are then biased. Both of those caveats need further investigation.

Competition Intensity

Yet another explanation for the observed price dispersion is the competition intensity that differs in different areas. In some areas, many farmers compete against each other to sell their hogs, and packers may be able to take advantage of it and depress the prices. To control for this effect and to test this proposition, we include in the regression analysis the binary variable for each seller's zip code. As shown by the results in Table 2-26, including these additional binary variables further boosts the adjusted R^2 by 1.37%, indicating that the explanatory power of this variable is also limited. Also notice that the weight variable and the distance variable change signs, but their t-stats, although significant, are rather small, given the sample size.

Table 2-26. OLS Regression with Competition Intensity

Variable	Estimate	t-stat
Constant	0.7731	62.70
Lean percentage	0.0026	12.76
Back fat	–0.0023	–22.01
Average loin-eye depth	0.0009	11.68
Average weight	–0.0001	–2.30
Ratio	–0.1818	–32.64
Distance	0.0000	6.97
Lot size	0.0002	54.88
Adjusted R^2	0.2669	

The list of possible explanation for why we observe significant price dispersion on the spot market for live hogs is not exhausted. Several other competing hypotheses can be added, such as price discrimination (first degree or third degree) and the role of committed procurement (the latter is investigated elsewhere in this report). Although we were able to cast some light onto possible drivers of price dispersion, the significant portion of the unexplained variability in spot prices still remains an unsolved puzzle.

2.6 SUMMARY

In this section, we examined the behavior of market hogs' prices and quantities. We focused on the finished hog market segment between producers/farmers and packers. The data come from three sources: surveys of hog producers and packers and transaction data from large packers. The data reported in the producers' survey reflect their selling practices and the data from the packers' survey and individual transactions data both reflect packers' buying practices. Due to inconsistencies in and across these data sources; secondary, publicly available, data sources were also utilized to conduct the analyses presented in the next sections.

The main conclusion of this section is that AMAs are becoming an integral part of producers' selling practices and packers' procurement practices. There are also significant regional differences in the observed patterns of use of marketing arrangements with a stronger reliance on cash/spot markets in the Midwest than in the East. The detected differences in carcass prices that packers pay for their hogs are significant, some of which can be explained by factors such as region, quality, or plant size. However, even after controlling for those factors, the remaining differences need to be explained by based on organizational issues related to supply chain management in the livestock processing sector. Results seem to indicate that plants that use a combination of marketing arrangements on average pay lower prices for their hogs relative to plants that use the cash/spot market only. The second interesting result comes from comparing the magnitudes of the portfolio effects with the magnitudes of the individual marketing arrangement effects. The results appear to indicate that individual marketing arrangements have minimal additional effect on the average price (i.e., the portfolio system binary variables capture almost the entire effect on lowering the average price).

Of particular interest for this study is the effect of both contract and packer-owned hog supplies on the cash/spot price. As anticipated, these effects are negative. That is, an increase in either contracted hogs or packer-owned hog sales decreases the cash/spot price of hogs. The elasticities of industry derived demand are quite close to the estimates derived from output-constant input demands, suggesting that downstream effects from changes in hog supplies are very small compared with the substitution effects among different sources of hogs for slaughter. A higher quantity of either contract or packer-owned hogs available for sale lowers the prices of contract or packer-owned hogs and induces the packer to purchase more of the now relatively less expensive hogs and purchase fewer hogs sold on the cash/spot market.

Finally, we conducted an analysis to enhance our understanding about mechanisms that may explain significant price dispersion in the cash/spot market for live hogs. On average, the live hog price range (defined as the maximum price minus the minimum price) is approximately $24/cwt each day. This accounts for about 40% of the average transaction price. Based on our analysis, we are able to partially explain this phenomenon using quality, transportation costs, search costs, and competition intensity differences, but a large proportion of the total variation in price still remains unexplained and requires further research.

3 Economies of Scale, Cost Differences, and Efficiency Differences Associated with Alternative Marketing Arrangements

In this section we estimate the cost differences and the economies of scale in pork packing and analyze the degree to which those differences can be explained by the differences in AMAs that different plants use to procure their hogs. We also look at the efficiency differences across plants by analyzing whether the observed profitability differences can be explained by the packers' AMA portfolio choices. In addition, we test for the presence of statistically significant complementarities across AMAs as an explanation for the differences in observed profitability across plants.

3.1 IDENTIFYING AND MEASURING COST AND EFFICIENCY DIFFERENCES

The first difficulty presented in identifying cost and efficiency differences is separating any market power effects from purely cost changes associated with changes in marketing arrangements. This requires development of an econometric model where an attempt is made to identify and estimate the separate effects of market power and marketing arrangements on prices and price-cost margins.[1] One approach taken in this study is to use the monthly farm–wholesale price spread data published by USDA, ERS to estimate a monthly model showing the relationship between the price spread and various variables believed to be important in causing changes over time in the price spread. The second approach relies on the individual transactions data from large packers to estimate a structural model to test whether market power exists and whether the source of that market power could be related to marketing arrangements in procuring market hogs.

3.1.1 Industry-Level Data Approach

The particular model estimated, which is described in more detail in Appendix B Attachment 2, has the following form:

$$\left(\frac{P}{W_1}\right)_t = b_0 + b_1 amashare_t + (c_0 + c_1 amashare_t)\left(\frac{W_{FIt}}{W_{1t}}\right)^2 + (d_0 + d_1 amashare_t)\left(\frac{W_{FIt}}{W_{1t}}\right)Y_t + u_t \ , \tag{3.1}$$

where the dependent variable is the wholesale price (P) to farm price (W_1) ratio. (Both prices are expressed in units of the wholesale product, price per pound wholesale weight.) The variable a*mashare* is the share of supplies of hogs through AMAs in total hog production (which refers to the sum of contract and packer-owned hogs in this section), W_{FI} is an index (Fisher Ideal) of wage rates for slaughtering and energy prices, Y is production of pork, and u is an error term. The theoretical basis of this equation is based on the framework of Schroeter (1988). The form of the particular equation in Eq. (3.1) is new to the literature and is based on a quadratic cost function, which seems to fit the circumstances of the industry quite well. The first two terms on the right-hand side of the equation (i.e., the intercept and term involving *amashare*) can represent the effect of any market power that may arise from either market power in the output market for pork, the input market for hogs, or a combination of the two markets. Notice that *amashare* can have an influence on market power. Also notice that *amashare* interacts with both

[1] It needs to be stressed that the disaggregate model used for the simulation analysis in Section 6 does account for changes in imperfect competition. However, the equations estimated contain both market power and differential cost effects from the AMAs, so additional analysis is required to separate the source of change.

the index of marketing prices and the output in costs. By interacting this variable with terms in the cost function, we are able to measure and test how cost economies and efficiencies vary by AMA.[2]

As in the other econometric analyses conducted, unit roots were found to be present, so we used Phillips and Loretan's (1991) method of dynamic ordinary least squares (DOLS) to estimate the parameters. This means that first differences in lags and leads of the right-hand side variables were included as explanatory variables in the model to purge the model of transient dynamics and any endogeneity effects. Initially, monthly binary variables were also included in the model, but the variables were deleted after they were not found to be statistically significant as a group. Also, the intercept was found to be very insignificant and was dropped.[3]

The estimated equation was as follows:

$$\left(\frac{\hat{P}}{W_1}\right)_t = \underset{(0.0406)}{1.278235}\, amashare_t - \underset{(14888.8)}{21806.8}\left(\frac{W_{FI}^2}{W_1^2}\right)_t + \underset{(17138.9)}{27004.8}\, amashare_t \left(\frac{W_{FI}^2}{W_1^2}\right)_t$$

$$+\underset{(0.1153)}{0.348274}\left(\frac{W_{FI}^2}{W_1^2}\right)_t Y_t - \underset{(0.1324)}{0.3956}\, amashare_t \left(\frac{W_{FI}^2}{W_1^2}\right)_t Y_t$$

$$+\underset{(8887.1)}{19220.8}\,\Delta\left[\left(\frac{W_{FI}^2}{W_1^2}\right)_t\right] - \underset{(10266.9)}{22217.7}\,\Delta\left[amashare_t\left(\frac{W_{FI}^2}{W_1^2}\right)_t\right]$$

$$-\underset{(0.0708)}{0.23965}\,\Delta\left[\left(\frac{W_{FI}^2}{W_1^2}\right)_t Y_t\right] + \underset{(0.0814)}{0.273775}\,\Delta\left[amashare_t\left(\frac{W_{FI}^2}{W_1^2}\right)_t Y_t\right] \qquad (3.2)$$

$$R^2 = 0.9668$$
$$\hat{\rho} = \underset{(0.1345)}{0.622802},$$

[2] Initially, we attempted to separate contract share from packer owned share in the model, but this separation led to extreme multicollinearity that affected any ability to separate AMAs from other variables in the model.

[3] In addition, as a group, the first differences in leads were not found to be significant nor did exclusion of these variables affect the parameter estimates in any major way. Thus, the first differences in leads also were deleted from the model.

where $\hat{\rho}$ is the estimated standard error of the first-order autocorrelation parameter. Values in parentheses are estimated standard errors of the parameters of the model.

As indicated, the AMA supplies variable (*amashare*) has a positive and significant effect on market power (i.e., the first term in Eq. [3.2]), as anticipated. A higher proportion of AMA supplies leads to an increase in market power. At the sample means (August 2001 through September 2005), the average markup/markdown is 1.10814, with a standard error of 0.035196. For the null hypothesis of price-taking behavior (coefficient estimate equal to one), the t-value is 3.07146. Therefore, we strongly reject price-taking behavior, although the degree of market power is quite modest.[4][5]

The other terms in the first and second rows of the model (other than the estimated first term on the right-hand side of Eq. [3.2]) provide an estimate of the effect of marginal processing costs on the wholesale–farm price ratio of pork. The marginal effect of a change in output (*Y*) on the price ratio is 7.36302×10^{-5}. In elasticity form, a 1% increase in output at the sample means is estimated to increase marginal costs by 0.04%. This estimate is not statistically significantly different from zero at the sample means, suggesting that the average packer in the industry operated very nearly at the point of constant returns to scale. However, this relationship is not independent of AMAs. In particular, for each 1% increase in AMA supplies, marginal costs with respect to output decline by 0.00148%, with a standard error of 0.000495. This implies a t-value of –2.98, indicating a significant economies of scale effect from increases in the share of AMA supplies.

The effects of changes in AMAs on market power and marginal processing costs can be identified and measured separately from Eq. (3.2). The estimated covariances of the parameter estimates, together with the parameter estimates of Eq. (3.2), were used to estimate the effect of AMA supplies on market

[4] We also expect this estimate to be an upper-bound value for market power, based on the analysis of Wohlgenant (2001), because of the assumption that packers cannot alter the proportion of hogs in relationship to marketing inputs in response to changes in the price of hogs.

[5] We consider this market power estimate to be modest in the sense that many studies have found markups of 20% or more in other industries (see, for example, Bhuyan and Lopez [1997]).

power, the effect on marginal costs, and the net effect on the price ratio. Put in terms of elasticities, a 1% increase in AMA supplies share leads to a 0.735% increase in market power, with a standard error of 0.020, holding marginal costs constant. A 1% increase in AMA supplies leads to a –4.99% change in marginal costs, with a standard error of –1.67, holding the degree of market power constant. The net effect of market power and efficiency gains from increased AMA supplies is –1.47%, with a standard error of –0.40 for each 1% increase in AMA supplies. Thus, the benefits from increased AMA supplies outweigh increases in market power through decreased cost in procuring and processing pork. This means that reducing AMA supplies would have a net effect of increasing, not decreasing, costs of procuring and processing pork. This finding is consistent with the simulation results in Section 6, pointing to losses to producers from policies aimed at restricting the share of AMA supplies.

3.1.2 Packers' Individual Transactions Data Approach

In this approach we use structural econometrics to formally test whether the use of AMAs is the source of market power in the pork packing industry. We extend Schroeter's (1988) beef packing industry model and specify the packers' conjectures of the change in market output with respect to their own outputs as explicit functions of their own AMA supply stocks and the stocks of their competitors. Testing whether these stocks are significant determinants of the packers' equilibrium conjectures can be taken as a test on whether the use of the AMAs is a source of market power in this industry. The test is carried out using the firm-level individual transactions data, which enables us to relax the restrictive assumption that all firms have the same conjectural elasticities that has been regularly employed in all market power studies that rely on the aggregated industry-level data.

The Model

We modeled the industry as comprising *N* firms (packers) producing a homogenous output (pork) using a single homogenous material input (live hogs). Following Schroeter (1988), Azzam (1997), and other economics literature on meat packing, we assumed a fixed proportion production technology. As a result, with an appropriately chosen scale of prices, the quantities of the material input and the output can be represented by the same variable q^i, where (i =1,...,N). Packers compete against each other by setting the output quantities. We assumed that there are only two procurement channels: the cash or spot market, q_1, and the AMA supply channel, q_2, where the latter includes marketing contracts, production contracts, and packer-owned hogs. The main characteristic of the AMA supply channel is that when packers come to the spot market to buy live hogs, the AMA supply hogs are already fixed as the packers' stocks. The principal reason for this is the fact that AMA supplies represent packers' long-term supply chain management decisions where some of those contracts are written for 5 to 10 years, whereas our individual transactions data cover only 2.5 years.

Each time period t, given the stock of hogs q_{2t}^i from the AMA supply channel, packer i decides on how many hogs to procure through the cash channel (q_{1t}^i) and then converts all the hogs to pork and sells the pork in the downstream market. Therefore, packer i's payoff in period t is given by

$$\pi_t^i = W_t\left(q_{1t}^i + q_{2t}^i\right) - P_{1t}q_{1t}^i - P_{2t}q_{2t}^i - C_p\left(q_{1t}^i + q_{2t}^i\right), \qquad (3.3)$$

where W_t is the price of pork, $P_{1t}q_{1t}^i$ is the payment to the live hog suppliers through the spot channel, $P_{2t}q_{2t}^i$ is the payment to the live hog suppliers through the AMA supply channel, and $C_p\left(q_{1t}^i + q_{2t}^i\right)$ is packer i's production costs. Although q_{2t}^i is the packers' long-term decisions and is taken as given, the price P_{2t} will be determined in period t. This captures the fact that many marketing contracts use formula pricing where the contract price is linked to the current period spot price P_{1t}.[6]

To complete the model, we need to specify the cost function, the downstream inverse demand function for pork, the upstream inverse supply function for live hogs through the spot channel, and the rule for determining the price of live hogs in the AMA supply channel. Following Porter (1983), we specify the cost functions as

$$C_p\left(q_{1t}^i + q_{2t}^i\right) = \left[\theta_1 + \frac{1}{2}\theta_2\left(q_{1t}^i + q_{2t}^i\right)\right]\left(q_{1t}^i + q_{2t}^i\right) + F, \qquad (3.4)$$

[6] An example of this type of pricing, called "top-of-the-market clause" used in the beef sector, is found in Xia and Sexton (2004).

where the first part of C_p reflects the fact that the cost function is convex in quantities, and F represents the fixed cost. The inverse demand function for pork is given by

$$\log W_t = \gamma_0 + \eta \log(Q_t) + \gamma_1 \log p_{bt} + \gamma_2 \log p_{ct} + e_{dt}, \quad (3.5)$$

where Q_t is the total number of hogs that N packers procure through all the channels, that is, $Q_t = \sum_{i=1}^{N} (q_{1t}^i + q_{2t}^i)$; p_{bt} and p_{ct} are the prices for beef and poultry, the two main substitutes for pork; and e_{dt} is a shock with the property that $E(e_{dt}) = 0$. η represents the inverse demand elasticity for pork. The inverse supply function for live hogs through the cash channel is given by

$$\log P_{1t} = \delta_0 + \varepsilon \log(Q_{1t}) + \delta_1 \log p_{wt} + \delta_2 \log p_{et} + e_{1t}, \quad (3.6)$$

where Q_{1t} is the total number of hogs that N packers procure through the cash channel, that is, $Q_{1t} = \sum_{i=1}^{N} q_{1t}^i$; p_{wt} and p_{et} are the wages of production workers and the price of energy, which approximate input costs in the production of live hogs; e_{1t} is a shock with the property that $E(e_{1t}) = 0$; and ε is the inverse supply elasticity for live hogs through the cash channel. Finally, the rule for determining the price of live hogs in the AMA supply channel is approximated as

$$\log P_{2t} = \lambda_0 + \mu \log(P_{1t}) + e_{2t}, \quad (3.7)$$

where e_{2t} is a shock with the property that $E(e_{2t}) = 0$.

In every period, given its own stock of hogs through the AMA supply channel and the stocks of other packers, q_{2t}^i ($I = 1,\ldots,N$), packer i chooses q_{1t}^i to maximize its current period profit π_t^i. Using Eq. (3.3) and Eq. (3.4), the first-order condition for profit maximization is as follows:

$$0 = \frac{\partial \pi_t^i}{\partial q_{1t}^i} = \frac{\partial W_t}{\partial Q_t}\frac{\partial Q_t}{\partial q_{1t}^i}(q_{1t}^i + q_{2t}^i) + W_t - P_{1t} - \frac{\partial P_{1t}}{\partial Q_{1t}}\frac{\partial Q_{1t}}{\partial q_{1t}^i} q_{1t}^i$$
$$- \frac{\partial P_{2t}}{\partial P_{1t}}\frac{\partial P_{1t}}{\partial Q_{1t}}\frac{\partial Q_{1t}}{\partial q_{1t}^i} q_{2t}^i \,\theta_1 - \theta_2 (q_{1t}^i + q_{2t}^i). \quad (3.8)$$

From Eq. (3.5) and Eq. (3.6), it follows that $\frac{\partial W_t}{\partial Q_t} = \eta\frac{W_t}{Q_t}$ and $\frac{\partial P_{1t}}{\partial Q_{1t}} = \varepsilon\frac{P_{1t}}{Q_{1t}}$, and $\phi_t^i = \frac{\partial Q_t}{\partial q_{1t}^i} = \frac{\partial Q_{1t}}{\partial q_{1t}^i}$ since $Q_{2t} = \sum_{i=1}^{N} q_{2t}^i$ is taken as given. ϕ_t^i can be interpreted as packer i's perceived change of market output (material input) when its own market output (material input) changes. It is a measure of the market power packer *i* enjoys in the industry. If the packer is a price-taking firm, then $\phi_t^i = 0$, because he expects that changes in his own output will leave the market output unchanged. In another extreme, when packer *i* is a monopolist, then $\phi_t^i = 1$, because there is a one-to-one correspondence between packer i's output and the market output. In general, $\phi_t^i > 0$ indicates that packer *i* enjoys some degree of market power. To test whether the use of AMAs is the source of packers' market power, we model ϕ_t^i as

$$\phi_t^i = \theta_3 + \theta_4 q_{2t}^i + \theta_5 \sum_{j \neq i} q_{2t}^i + \theta_6 t, \tag{3.9}$$

where *t* is a time trend included as a proxy for the underlying market conditions. This specification approximates packer *i*'s conjecture in period *t* as a function of his own stock of live hogs from AMAs and the stocks of his competitors' AMAs supplies. If indeed the use of AMAs is the source of market power, then we should not reject the hypothesis that at least one of the two coefficients θ_4 and θ_5 is nonzero.

Incorporating all required changes in notation, Eq. (3.8) can be rewritten as

$$\eta \frac{W_t}{Q_t} \phi_t^i \left(q_{1t}^i + q_{2t}^i\right) + W_t = P_{1t} + \varepsilon \frac{P_{1t}}{Q_{1t}} \phi_t^i q_{1t}^i + \mu \frac{P_{2t}}{P_{1t}} \varepsilon \frac{P_{1t}}{Q_{1t}} \phi_t^i q_{2t}^i + \theta_1 + \theta_2 \left(q_{1t}^i + q_{2t}^i\right). \tag{3.10}$$

The term $\eta \frac{W_t}{Q_t} \phi_t^i \left(q_{1t}^i + q_{2t}^i\right)$ can be interpreted as a measure of packers' market power in the downstream pork market. In addition, the market power potentially benefits the packers in the upstream live hog markets in two ways. First, the term $\varepsilon \frac{P_{1t}}{Q_{1t}} \phi_t^i q_{1t}^i$ can be interpreted as the price markdown due to packers' market power in the spot market. The term $\mu \frac{P_{2t}}{P_{1t}} \varepsilon \frac{P_{1t}}{Q_{1t}} \phi_t^i q_{2t}^i$ represents the price markdown in the AMA supply channel due to packers' market power as well as various formula pricing clauses in marketing contracts. If the packer does not enjoy any market power, that is, $\phi_t^i = 0$, then Eq. (3.10) reduces to the equality between the marginal benefit of converting an additional live hog into pork, W_t, and the marginal costs, which include the cost of live hogs, P_{1t}, and the marginal production cost $\theta_1 + \theta_2 \left(q_{1t}^i + q_{2t}^i\right)$.

Estimation

Appending the first-order condition Eq. (3.10) with an additive optimization error term e_t^i with the property $E(e_t^i) = 0$, we can form the following moment condition

$$m_t^i(\theta) = e_t^i, \tag{3.11}$$

where

$$\begin{aligned} e_t^i = {} & \eta\frac{W_t}{Q_t}\phi_t^i\left(q_{1t}^i + q_{2t}^i\right) + W_t - P_{1t} - \varepsilon\frac{P_{1t}}{Q_{1t}}\phi_t^i q_{1t}^i \\ & - \mu\varepsilon\frac{P_{2t}}{Q_{1t}}\phi_t^i q_{2t}^i - \theta_1 - \theta_2\left(q_{1t}^i + q_{2t}^i\right). \end{aligned} \tag{3.12}$$

In fact, we form a moment condition for each of the N major packers; hence, there are N such moment conditions.

We also form the moment conditions for the inverse demand function for pork:

$$m_2(\theta) = Z_{dt}' e_{dt}, \tag{3.13}$$

where

$$e_{dt} = \log W_t - \gamma_0 - \eta\log(Q_t) - \gamma_1\log p_{bt} - \gamma_2\log p_{ct} \tag{3.14}$$

and Z_{dt} is a vector of instruments. To account for endogeneity of the market price for pork W_t and the output quantities Q_t, we form instruments Z_{dt} using supply-side cost shifters: the prices for soybean and corn, together with the exogenous variables in Eq. (3.14), that is, p_{bt} and p_{ct}.

Similarly, we form the moments for the inverse supply function of live hogs in the spot channel:

$$m_3(\theta) = Z_{1t}' e_{1t}, \tag{3.15}$$

where

$$e_{1t} = \log P_{1t} - \delta_0 - \varepsilon\log(Q_{1t}) - \delta_1\log p_{wt} - \delta_2\log p_{et} \tag{3.16}$$

and Z_{1t} is a vector of instruments. To account for endogeneity of the spot market price for live hogs P_{1t} and the quantities supplied Q_{1t}, we form instruments Z_{1t} using demand-side shifters: the price of poultry and the price of beef, together with the exogenous variables in Eq. (3.16), that is, p_{wt} and p_{et}.

Then, we form the moments for the relationship between the prices in two channels:

$$m_4(\theta) = Z_{4t}^{\prime} e_{2t}, \tag{3.17}$$

where

$$e_{2t} = \log P_{2t} - \lambda_0 - \mu \log(P_{1t}) \tag{3.18}$$

and Z_{4t} is a vector of instruments. Because of various formula pricing clauses in marketing contracts, P_{1t} is an exogenous determinant of P_{2t}. As a result, there is no endogenous variable in Eq. (3.18). Thus, we form instruments Z_{4t} using the same variables in Eq. (3.18), that is, P_{1t}.

Finally, we stack all the moments together and form the following GMM estimator:

$$\theta = \operatorname{argmin} U_T(\theta) = \left(T^{-1} \sum_{t=1}^{T} m(\theta)\right)' A \left(T^{-1} \sum_{t=1}^{T} m(\theta)\right), \tag{3.19}$$

where A is an appropriately chosen weighting matrix, and

$$m(\theta) = \begin{bmatrix} m_1^1(\theta) \\ \cdots \\ m_1^N(\theta) \\ m_2(\theta) \\ m_3(\theta) \\ m_4(\theta) \end{bmatrix}. \tag{3.20}$$

In this set up, we need to estimate 16 parameters: 6 from Eq. (3.12), 4 from Eq. (3.14), 4 from Eq. (3.16), and another 2 from Eq. (3.18). We use 20 moments: 8 for each of the major packers, 5 from Z_{dt}, 5 from Z_{1t}, and 2 from Z_{4t}. So the model is overidentified and allows us to perform an overidentification test to see whether the model and its specification can be rejected by the data or not.

The model has been estimated using company-level data, which means that in cases where one company operates multiple processing plants, the data have been aggregated across plants. We use the data for eight companies. These are eight of the top nine packers in terms of firm size. One packer, whose data were not used, never used spot markets for procuring live hogs during the time period covered by the data set. We used monthly data for the period October 2002 through March 2005 with a total of 30 observations per firm. In addition to company-level individual transactions (purchase) data, we also used Bureau of Labor Statistics indexes for U.S. city average prices of beef, veal, and poultry; total private-sector average hourly earnings of production workers; and the electric power price index.[7]

Table 3-1 provides the estimation results for the downstream inverse demand function for pork. All the estimates have the expected signs. The own price elasticity is negative. As the prices for beef and poultry increase, the price for pork also increases because they are substitutes.

Table 3-1. Estimation Results for Downstream Inverse Demand Function

Variable	Estimate	t-stat
γ_0	–10.0930	–1.18
γ_1	0.5501	1.55
γ_2	3.6392	4.02
η	–0.4317	–0.73

Table 3-2 presents the estimation results for the upstream inverse supply function for live hogs through the cash channel. Again, all the estimates have the expected signs. The own price supply elasticity is positive. As the price for live hogs goes up by 1%, the supply of live hogs through the cash channel will go up by approximately 0.23%. Also, as wages and the price of electricity go up, the prices farmers ask for their hogs will also go up.

Table 3-2. Estimation Results for Upstream Inverse Supply Function in the Cash Channel

Variable	Estimate	t-stat
δ_0	–34.90010	–3.95
δ_1	10.57840	6.01
δ_2	1.41260	2.10
ε	0.22674	0.91

[7] The data were obtained from the U.S. Department of Labor, Bureau of Labor Statistics Web site (www.bls.gov).

Estimation results for the price determination rule in the AMA supply channel are presented in Table 3-3. As expected, as a consequence of the formula pricing clauses in marketing contracts, the AMA supply price is closely related to the spot price. A 1% increase in the cash price corresponds to a 0.85% increase in the AMA supply price.

Table 3-3. Estimation Results for Price Determination Rule in the AMA Supply Channel

Variable	Estimate	t-stat
λ_0	0.6150	7.90
μ	0.8499	44.45

Finally, Table 3-4 summarizes the estimation results for the cost function and the market power function. Two main results are worth emphasizing. First, the results indicate the presence of statistically significant market power in the industry because the constant term in the market power function, θ_3, is positive and significant. This reinforces the result previously obtained with the aggregate data. Second, the two main parameters of interest in this study, θ_4 and θ_5, are not statistically significant, thus indicating that AMAs may not be a source of market power in pork packing. This is different from the result previously obtained using the aggregated industry-level data. Further investigation into possible sources of market power could be interesting but is beyond the scope of the study.

Table 3-4. Cost Function and Market Power Estimation Results

Variable	Estimate	t-stat
θ_1	50.15690	108.46
θ_2	–0.00001	–5.81
θ_3	0.48160	3.20
θ_4	–2.79e-08	–0.56
θ_5	2.28e-08	0.57
θ_6	0.00090	0.39

3.2 ECONOMIES OF SCALE IN PORK PACKING

Returns or economies to scale are most appropriately measured by the relationship between total cost and output along the expansion path where input prices are constant and costs are minimized at every level of output (Hanoch, 1975). For this study we chose the translog cost function because it allows the economies of scale to vary with the level of output. This feature enables the average cost curve to attain the classical U-shape.[8] Once the estimates of the total cost function are obtained, the economies of scale measure is obtained as unity minus the elasticity of total cost with respect to output:

$$ES \equiv 1 - \frac{\partial logC}{\partial logY} \tag{3.21}$$

which results in positive numbers for the increasing (positive) returns to scale and negative numbers for the decreasing (negative) returns to scale. The elasticity of total cost with respect to output, however, has to be positive because the theoretically correct cost function must be nondecreasing in output. Multiplying Eq. (3.21) by 100 yields estimates of economies of scale expressed in percentage terms. This approach has been prominently used in various industry studies of cost efficiency and economies of scale; see, for example, Christensen and Greene (1976) and Atkinson and Halvorsen (1984).

3.2.1 Econometric Model

The limited availability of information dictates the specification of a cost function that exhibits three problems, none of which is in our opinion very severe. First, the only separate cost component that can be disentangled from the rest of the total cost is the cost of live animals. Therefore, we assume that the production of pork is a function of the number of animals slaughtered and some other generic production input that jointly represents labor, capital, energy, and other intermediary inputs used in meat packing. Therefore, we can only identify the percentage cost shares of live animals and the other generic production input in the total cost structure of packing plants.

[8] The translog functional form provides a convenient second-order approximation to an arbitrary continuously twice-differentiable cost function (see Diewert [1974]).

Second, we assume that firms/plants produce the homogeneous product called "pork," which is measured by the total carcass or hot weight of slaughtered animals. Because the P&L statements generally do not report carcass weight data, we calculated the average monthly, plant-level, carcass weight per incoming animal and applied that number to the number of head killed as reported in the plant's P&L statements to obtain the measurement of pork output.[9]

Finally, estimation of the standard cost function requires having data on input prices. The price of live animals was recovered from the individual transactions data. The problem is getting the price for the generic input mentioned above. Because the labor cost appears to be the most important component in the mix of production inputs other than live animals, we used the average weekly earnings of production workers (not seasonally adjusted) for the industry "Meat Processed from Carcasses" (NAICS 311612) and "Rendering and Meat Byproduct Processing" (NAICS 311613) from the Bureau of Labor Statistics data.

The translog cost function for the two inputs case can be written as

$$\begin{aligned} logC = {} & \alpha_0 + \alpha_Y logY + \frac{1}{2}\gamma_{YY}(logY)^2 + \alpha_1 logP_1 + \alpha_2 logP_2 + \\ & \frac{1}{2}[\gamma_{11}(logP_1)^2 + \gamma_{12}logP_1logP_2 + \gamma_{21}logP_2logP_1 + \\ & \gamma_{22}(logP_2)^2] + \gamma_{Y1}logYlogP_1 + \gamma_{Y2}logYlogP_2, \end{aligned} \tag{3.22}$$

where $\gamma_{12} = \gamma_{21}$, C is total cost, Y is pork output, P_1 is the price of market hogs, and P_2 is the wage rate. To correspond to a well-behaved production function, a cost function must be homogenous of degree 1 in input prices, which requires imposing the following set of restrictions on the parameters:

$$\begin{aligned} \alpha_1 + \alpha_2 &= 1 \\ \gamma_{Y1} + \gamma_{Y2} &= 0 \\ \gamma_{11} + \gamma_{12} &= \gamma_{21} + \gamma_{22} = \gamma_{11} + \gamma_{12} + \gamma_{21} + \gamma_{22} = 0. \end{aligned} \tag{3.23}$$

[9] The month-by-month comparison of the number of purchased market hogs from the individual transactions data and the number of hogs killed from the P&L data indicate that the two series are reasonably close to each other. The average 30-month ratio of two numbers is between 0.9 and 1 for all but two plants.

In addition to imposing the linear homogeneity in input prices, we also test whether our cost function is based on a homothetic production structure. A cost function corresponds to a homothetic production function if and only if the cost function can be written as a separable function in output and factor prices (see Diewert [1974]). For the translog cost function, the homotheticity restriction translates into the requirements that

$$\gamma_{Y1} = 0 \quad \text{and} \quad \gamma_{Y2} = 0. \tag{3.24}$$

If this restriction is valid, it is preferable to adopt the simplified model.

The optimal procedure to estimate the above cost function and obtain the estimates of the economies of scale is to jointly estimate the cost function and the cost share equations as a multivariate regression system. The cost share equations for each factor input are easily obtainable using Shephard's lemma:

$$\frac{\partial logC}{\partial logP_1} = S_1 = \alpha_1 + \gamma_{Y1} logY + \gamma_{11} logP_1 + \gamma_{12} logP_2$$

$$\frac{\partial logC}{\partial logP_2} = S_2 = \alpha_2 + \gamma_{Y2} logY + \gamma_{21} logP_1 + \gamma_{22} logP_2. \tag{3.25}$$

The estimation procedure that we use involves estimating the translog cost function Eq. (3.22) together with one of the two share equations Eq. (3.25) by imposing the cross-equation restrictions on the identical parameters in the cost function and the share equation, using iterative Zellner seemingly unrelated regression (ZSUR).[10] The linear homogeneity in input prices restrictions Eq. (3.23) is imposed throughout, and the homotheticity restrictions are tested separately. All restrictions are tested using likelihood ratio tests.

Based on the estimated parameters of the translog cost function, the economies-of-scale measure can be calculated as follows:

$$ES = 1 - (\hat{\alpha}_Y + \hat{\gamma}_{YY} logY + \hat{\gamma}_{Y1} logP_1 + \hat{\gamma}_{Y2} logP_2). \tag{3.26}$$

[10] Barten (1969) has shown that maximum-likelihood estimates of a system of share equations with one equation deleted are invariant to which equation is deleted. Dhrymes (1970) has shown that iteration of the ZSUR procedure until convergence results in maximum-likelihood estimates.

In cases when the homotheticity assumption holds, the returns-to-scale formula will differ by $\gamma_{Y1} = 0$ and $\gamma_{Y2} = 0$.[11] The returns to scale can be calculated for the industry as a whole by evaluating Eq. (3.26) at the sample means for output and input prices. Alternatively, the economies of scale can be calculated for each plant by evaluating Eq. (3.26) at the plant-level means for output and input prices.

3.2.2 Empirical Results

In addition to the packers' survey data and the individual transactions data, we used the monthly P&L data from 18 plants. In cases where packers reported weekly P&L data, the numbers were aggregated to obtain monthly observations. All but two plants are involved in slaughter, fabrication, and processing of live hogs; the remaining two are engaged only in slaughter and fabrication.

The econometric model is estimated using two data sets. The large data set contains 16 plants that are involved in all three stages of production (slaughter, fabrication, and processing), and the small data set contains the remaining two plants that are involved only in the first two stages and have no further processing. The estimation results for the large group are presented in Table 3-5. The estimation results for the small group cannot be reported because of the violation of confidentiality rules. The results show that the linear homogeneity in input prices Eq. (3.23) is a valid restriction (i.e., we cannot reject that null hypothesis). Second, based on the results from the nonhomothetic specification (Model A), we cannot reject the null hypothesis that the underlying production technology is homothetic, so we estimated the homothetic version of the model as well (Model B).

The estimated economies of scale under two different specifications of technology are represented in Table 3-6. We partitioned the large sample of 16 plants into three groups according to size. Each row in the table presents the results for a hypothetical representative plant that belongs to that size group. The results confirm our expectation that economies of scale diminish as plant size increases. The estimates indicate

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[11] An even simpler model can be obtained by restricting a homothetic production structure to be homogeneous. This will be the case if and only if the elasticity of cost with respect to output is constant and equal to α_Y.

Table 3-5. Translog Cost Function Parameter Estimates: 16 Hog Slaughter Plants with All Three Production Stages

Parameter	Model A Estimate	Model A t-Ratio	Model B Estimate	Model B t-Ratio
α_0	21.039	1.28	21.714	1.32
α_y	–1.878	–1.01	–1.974	–1.07
γ_{yy}	0.160	1.53	0.166	1.60
α_1	1.125	2.78	0.611	11.82
α_2	–0.125	–0.31	0.389	7.53
γ_{11}	–0.050	–2.02	–0.052	–2.09
γ_{12}	0.050	2.02	0.052	2.09
γ_{22}	–0.050	–2.02	–0.052	–2.09
γ_{y1}	–0.029	–1.28		
γ_{y2}	0.029	1.28		
R^2	0.6926		0.6923	
Restriction[a]	**Homogeneous of Degree 1 in Input Prices**		**Homotheticity**	
			LM = –56.8598	t-ratio = –1.28 P value = 0.2009

[a] The restriction for homotheticity is not significant (p = 0.2009), which implies that the data are consistent with the restriction.

Table 3-6. Hog Slaughter Plant Economies of Scale Measures

Plant Size	Capacity[a]	Model A Economies of Scale	Model A Efficient Scale[b]	Model B Economies of Scale	Model B Efficient Scale[b]
Large plants	91,111	–0.070	46,562	–0.031	60,123
Medium plants	52,675	–0.012	46,485	0.030	60,123
Small plants	41,311	0.065	44,327	0.118	60,123

[a] Capacity is expressed as monthly carcass weight in 1,000 pounds.
[b] Efficient scale is the point of minimum average cost in 1,000 pounds.

that scale economies are exhausted well within the sample output range such that the largest plants already exhibit negative economies of scale. For example, based on Model A, for a plant with a capacity of producing 91 million pounds of carcass weight per month (that would correspond to a slaughter capacity of approximately 110,000 market hogs per week),[12] the economies of scale are –7.0%, which means that an increase in output of 1% will increase the total cost by

[12] The capacities expressed in monthly carcass weights were obtained by multiplying the weekly slaughter capacities (in number of hogs) by 4.25 weeks per month and then multiplied again by the plant average monthly carcass weight per head.

1.07%. The result based on the homothetic production technology is –3.1%.

As plant size decreases, the negative economies of scale monotonically converge towards constant returns to scale. For example, for a plant that processes about 53 million pounds of carcass weight per month (about 65,000 hogs per week), according to Model A, the negative economies of scale amount to –1.2%, whereas according to the homothetic specification, the same plant already exhibits positive economies of scale in the amount of 3.0%. Finally, for the smallest plants, the economies of scale are clearly positive. Based on Model B, the plant that processes about 41 million carcass pounds per month (about 50,000 hogs per week) exhibits positive returns to scale in the amount of 11.8%, which means that an increase in output of 1% would increase the total cost by 0.882%.

A convenient way to summarize scale economies is to present the average cost curves facing various size plants. The cost curves are derived by evaluating the average cost function for a range of outputs holding the factor prices fixed at the sample means. The slope of the average cost curve is sufficient to infer the presence of economies of scale since $SE = 1 - (MC/AC)$. Declining average costs indicate increasing returns to scale, whereas rising average costs indicate decreasing economies of scale. The average cost curves for three representative plants are presented in Figures 3-1 through 3-3. Inspection of these graphs indicates that different size plants operate on different segments of their average cost curves,[13] but that their efficient scales of operations (minimum average cost) are narrowly clustered around 44 to 47 million pounds per month. As Table 3-6 shows, the efficient scale of production under homothetic technology is quite a bit larger (60 million pounds of carcass weight per month) and the same for all plants irrespective of size.[14]

[13] Black diamonds indicate the values of the average cost curves fitted with the output levels within the data range, whereas the paler squares indicate out-of-sample fits.

[14] Constant efficient scale of production is an algebraic artifact of the homothetic production technology. In our opinion, nonhomothetic technology, which was statistically refuted in favor of the homothetic technology, represents a more realistic description of meat processing than homothetic technology, precisely because under nonhomothetic technology the efficient scale of production varies with the size of the operation.

Figure 3-1. Average Cost for a Representative Plant in the Small Size Group

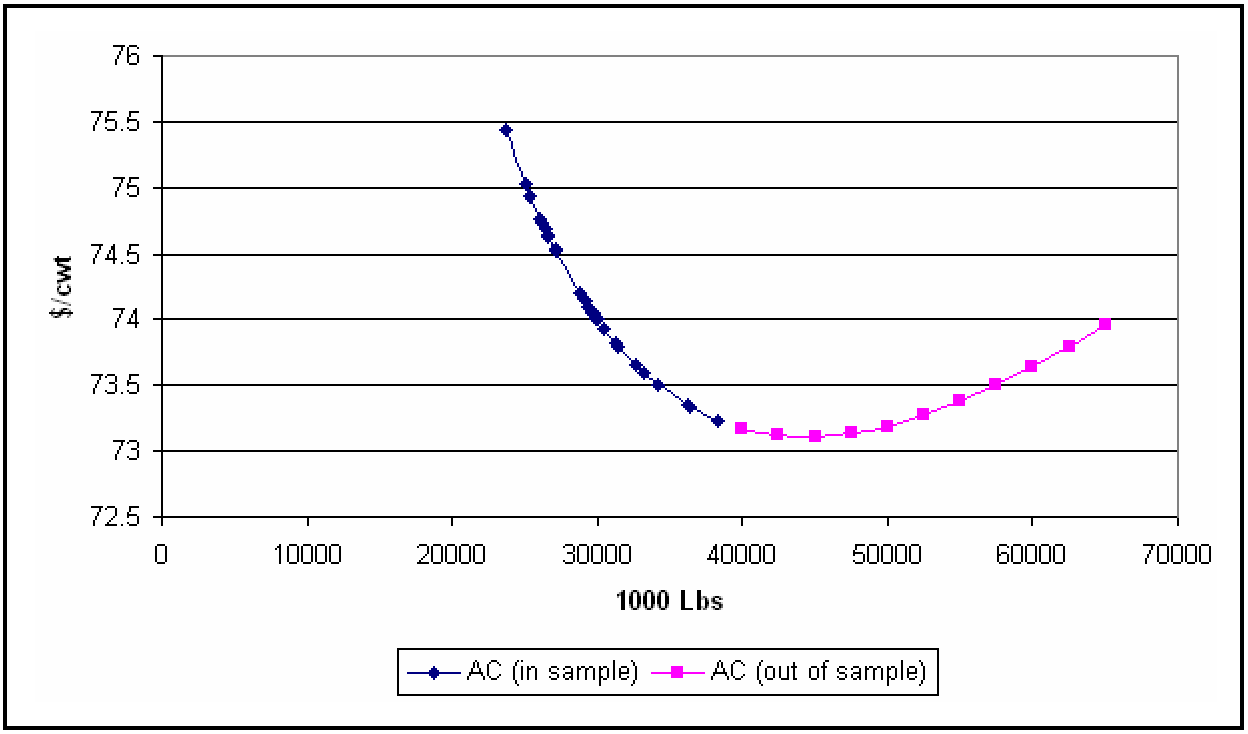


Figure 3-2. Average Cost for a Representative Plant in the Medium Size Group

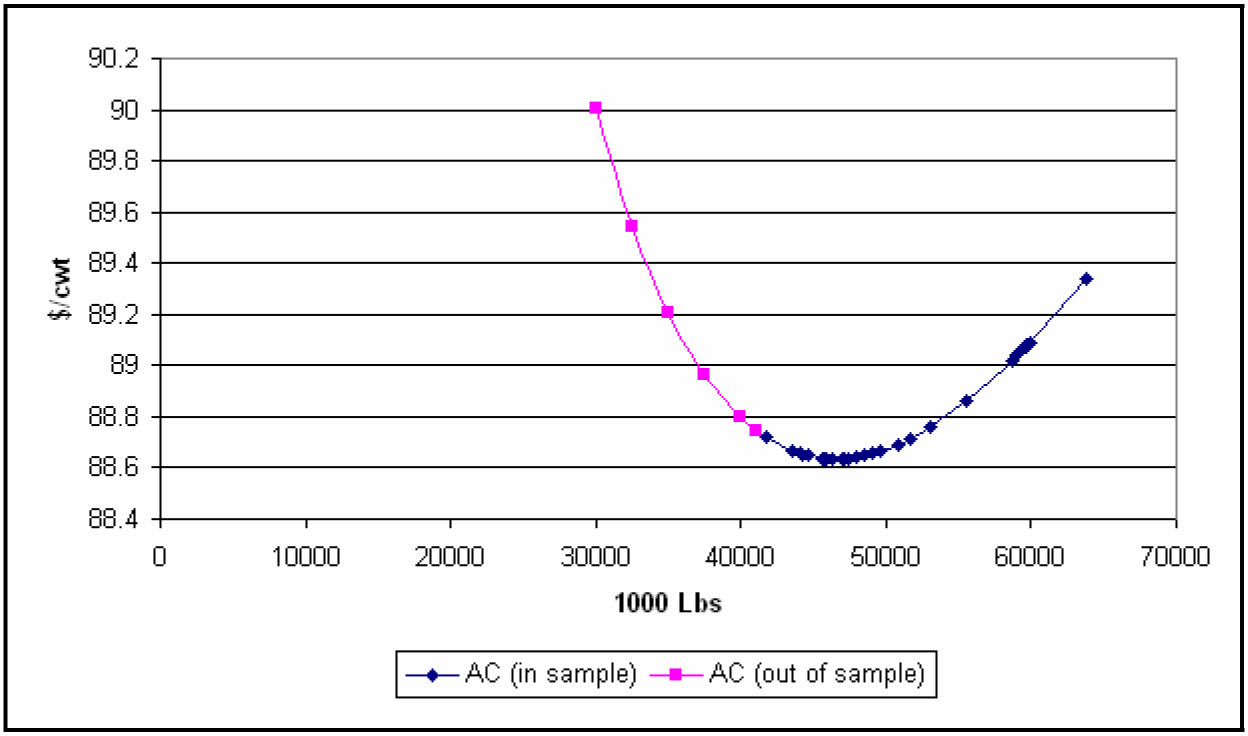
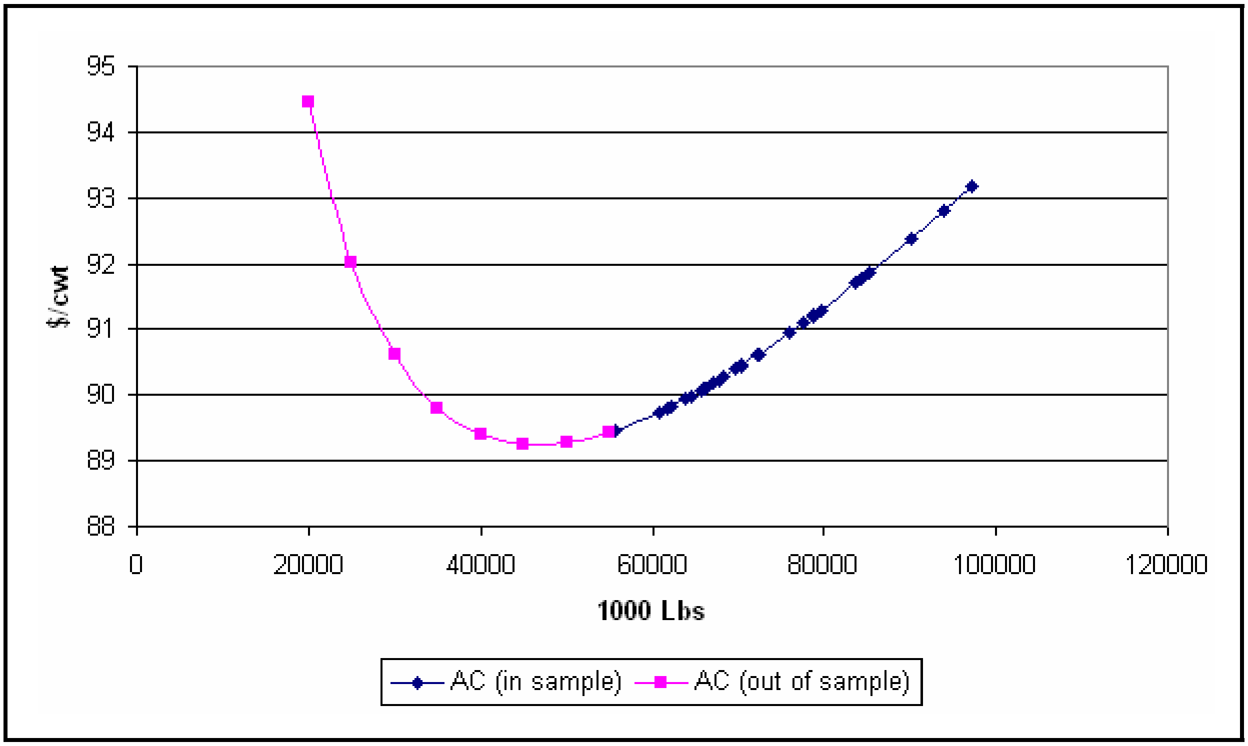


Figure 3-3. Average Cost for a Representative Plant in the Large Size Group



3.3 COMPLEMENTARITY OF MARKETING ARRANGEMENTS

The modern theory of the firm has made considerable progress in explaining the determinants of vertical integration and firm boundaries, assuming that the level of vertical integration results from independent transactional choices by the firm. However, for most organizations, firm boundaries are not determined by independent vertical integration decisions but depend on interrelated choices spanning functional activities. A common finding of the early empirical literature on organizations in firms (e.g., Arora and Gambardella [1990]; MacDuffie [1995]) was that organizational design practices are clustered, meaning that adopting one practice is correlated with adopting other practices; consequently, clusters of practices consistently appear together. The interdependencies among practices can be crucial for determining the payoffs for individual practices (Milgrom and Roberts, 1990; Levinthal, 1997).

In a frequently cited paper, Milgrom and Roberts (1990) developed a theoretical model of the firm that allows them to explore complementarities in modern manufacturing firms. The nonconvexities (some decision variables are naturally integer valued), together with the fact that the firm's objective function itself may be nonconcave, nondifferentiable, and even discontinuous at some points, prevent the use of differential calculus techniques to derive the comparative statics results. Instead they use purely algebraic (lattice-theoretic) methods based on the concept of supermodularity, which provides an exact formalization of the idea of groups of complementary activities. Complementarities lead to predictable relationships among activities. A decision to increase the level of one activity will raise the profitability of any contemplated increases in levels of any complementary activities. Therefore, high levels for all the elements of a group of complementary activities go together.

Complementarity between continuous practices can be defined using the second-order cross partial derivatives. Let f be a function of practices $(x_1, x_2, \ldots, x_n)$. Practices x_i and x_j are complementary in the function f if and only if $\partial^2 f/\partial x_i \partial x_j \geq 0$ and strict inequality holds at least one value of $(x_1, x_2, \ldots, x_n)$. In other words, complementarity exists if the implementation of one practice increases the marginal return of the other practice.

In the case where the practices $(x_1, x_2, \ldots, x_n)$ are measured by the discrete measure, complementarity between two practices can be defined using the concept of the supermodularity. A function f is supermodular if, for all x, $x' \in R^n$,

$$f(x \vee x') + f(x \wedge x') \geq f(x) + f(x'), \tag{3.27}$$

where $x \vee x'$ is the vector whose ith element is $max(x_i, x_i')$ and $x \wedge x'$ is the vector whose ith element is $min(x_i, x_i')$. Note that supermodularity is defined in terms of ordinal rank. Based on the definition of supermodularity, the condition for complementarity between the practices x_1 and x_2 is written as

$$f(x_1 + 1, x_2 + 1, x_3, \ldots, x_n) + f(x_1, x_2, x_3, \ldots, x_n) \geq$$
$$f(x_1 + 1, x_2, x_3, \ldots, x_n) + f(x_1, x_2 + 1, x_3, \ldots, x_n). \tag{3.28}$$

In the rest of this section, we explore whether various marketing arrangements in pork procurement and packing may be complementary to each other. In particular, we are interested in determining whether the efficient scale of production systematically varies with the portfolio of marketing arrangements used by the plant to acquire hogs. In addition, we also investigate the relationship between use of marketing arrangements and two other firm-level performance measures: the gross margin defined as the total revenue minus the cost of live animals and earnings before interests and taxes (EBIT).

3.3.1 Correlation Results

As a preliminary step in testing for complementarities, one can look at the unconditional associations among marketing arrangements (see Miravete and Pernias [2006]). We performed two different tests: the unconditional association of strategies using the Kendall Tau correlation coefficient,[15] and the conditional association among strategies using a multivariate probit model.

The marketing arrangement data are from the packers' survey and from the individual transactions (purchase) data. In the packers' survey data set, we have marketing arrangement data from 85 plants, and from the individual transactions data set, we have observations from 29 large plants. The data sources differ substantially primarily because the size of the plants differs. According to the packers' survey, the most widely used purchase method is MA1 (spot market only), followed by the MA1–MA2 (spot-marketing contracts) portfolio. Production contracts (MA4), which do not exist as a separately defined category in the individual transactions data set, occur only rarely in the MA3–MA4 portfolio and in the MA1–MA2–MA4 portfolio. According to the individual transactions (purchase) data, the most frequently used portfolio is MA1–MA2, followed by MA1–MA2–MA3, and then MA2–MA3–MA4.[16] For the group of 18 plants for which P&L data are available, the marketing arrangement portfolios are used in the following order of frequency: MA1–MA2, MA1–MA2–MA3, MA2–MA3–MA4, and MA1.

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[15] For the discussion about the advantages and disadvantages of using various correlation coefficients, see Miravete and Pernias (2006, pp. 8-9).

[16] Notice that MA4 in the individual transactions data is the category "Other" and is therefore different than MA4 in the packers' survey, where it represents production contracts. To the extent that the "Other" category may include production contracts as well, the difference between these two definitions may not be that large.

The Kendall Tau was computed using the data on marketing arrangement portfolio choices from the packers' survey data set (85 observations) and from the individual transactions (purchase) data set for plants for which we also have usable P&L data (18 observations). The multivariate probit model was estimated with the packers' survey data only (82 observations). All tests were performed using three channels: MA1—cash/spot markets, MA2—marketing contracts, and MA3—packer owned and production contracts (in the survey data set) or packer owned and other (in the individual transactions data set). The reasons for collapsing the original four channels into three channels were strictly numerical (some matrices were singular or solution algorithms did not converge). All results, summarized in Table 3-7, are qualitatively identical.

Table 3-7. Hog Slaughter Plant Association of Marketing Arrangements

	Unconditional Association		Conditional Association
Marketing Arrangement	**Kendall Tau P&L Data**	**Kendall Tau Packers' Survey Data**	**Multivariate Probit[a] Packers' Survey Data**
MA1, MA2[b]	–0.108 (0.655)[c]	–0.342 (0.002)	–0.930 (0.000)
MA1, MA3	–0.500 (0.039)	–0.330 (0.003)	–0.647 (0.001)
MA2, MA3	0.217 (0.371)	0.378 (0.001)	0.590 (0.008)
N	18	85	82

[a] The numbers shown are correlation coefficients between the residuals with P values in parentheses.

[b] MA1: Cash/Spot Sales; MA2: Marketing Contracts; MA3: Packer Owned/Other (for P&L data) and Packer Owned/Production Contract (for packers' survey)

[c] Asymptotic P values in parentheses.

The Kendall Tau statistics show that MA1–MA2 and MA1–MA3 are substitutes (negative values for τ), but MA2–MA3 are complements (positive values for τ). The results are significant in the packers' survey data and not significant in the P&L data. The conditional association test was performed by estimating a multivariate probit model. In this approach, we test for the conditional correlation of the residuals obtained from estimating the system of three equations with the left hand side (LHS) variables representing firms' choice, defined as D_{ij} = 1 if plant i, (i =1, 2,…, 85) uses marketing arrangement j, (j =1, 2, 3), and D_{ij} = 0 otherwise, on a vector of observable exogenous control variables. The vector of exogenous variables includes the capacity of the plant, the size of the company measured by the number of plants it operates, and two regional binary variables.[17] The results are essentially the same as before, showing that only the MA2–MA3 pair may be complements.

3.3.2 Performance Approach

The performance approach to complementarity testing involves regressing some firm-level performance measure (π_i) on all combinations of marketing arrangements (i.e., portfolios) and a vector of exogenous control variables *X* (see, for example, Ichniowski, Shaw, and Prennushi [1997]). In estimating the impact of various marketing arrangement portfolios on a performance measure, we want to avoid any possible selection bias resulting from nonrandom selection of marketing arrangement portfolios. The most likely reason for nonrandom selection of marketing arrangements is that most innovative plants will choose the most innovative procurement practices.

In a panel data framework, one can control for this potential source of bias with a plant-level fixed-effects specification. Alternatively, to deal with endogeneity, one can use a two-stage discrete/continuous procedure outlined in Train (1993, pp. 87-91). In the first stage, one would estimate the multinomial logit (or probit) where the LHS variable is a categorical variable for each of the existing combinations (portfolios) of marketing arrangements, and the right hand side (RHS) variables are some exogenous variables explaining the choice. The obtained coefficient estimates from the first stage are used to generate the expected values for each firm adopting a certain portfolio. In the second stage, these predictions are used as the explanatory variables in the performance equation. OLS is a consistent estimator for this performance equation. However, these estimates may not be efficient, requiring the use of bootstrapping to obtain correct confidence intervals.

The estimated coefficients associated with various marketing arrangement portfolio variables, even if they show significant positive effects on some performance measure, do not compare the effects of individual marketing arrangements with those of portfolios of marketing arrangements, and therefore do not provide unambiguous evidence on whether the individual

[17] The coefficient estimates of the multivariate probit model and their standard errors are suppressed for brevity but are available upon request.

marketing arrangements that comprise the portfolio are complementary. Complementarity among marketing arrangements implies that the magnitude of the productivity effect of the portfolio of marketing arrangements is larger than the sum of the marginal effects from adopting each marketing arrangement. A formal test of complementarity requires adding the individual marketing arrangement binary variables to the regressions containing marketing arrangement portfolio binary variables and comparing the magnitudes of individual versus portfolio effects.

3.3.3 Empirical Results

The performance equations are estimated using three different performance measures. First, based on the estimated cost function parameters for nonhomothetic technology (Model A), we computed the efficient scale of operations (minimum average cost) for 18 plants in the data set (see Table 3-6). The efficient scale of operation may be influenced by the portfolio of marketing arrangements used to procure live hogs for two reasons. The portfolio of marketing arrangements may affect the average cost function through increased capacity utilization, through lower average factor prices (live hogs prices), or through both. The performance equation using efficient scale is estimated using 18 observations only.

The other two performance measures are gross (meat) margin and EBIT (profit). For both of those, the portfolio of marketing arrangements used to procure hogs may be important because, in addition to influencing the cost side, it can also potentially impact the revenue side of the meat margin or profit. The idea is that different portfolios of marketing arrangements may result in the procurement of different average-quality live hogs, which when slaughtered and processed may yield higher quality pork that will be sold at higher market prices. These two performance equations are estimated using the panel data with 30 monthly observations for 18 plants. The 18 plants included in this data set differ significantly according to their size. The largest plant has a maximum weekly slaughter capacity several times larger than that of the smallest plant. Thus, we standardized the gross margin and the EBIT variables based on the plant capacity.

Table 3-8 provides the estimates of all three performance equations where no attempt was made to correct for a possible endogeneity of marketing arrangement portfolios. Portfolio 1, which contains only cash/spot purchases of live hogs, was left out of the regression to avoid perfect collinearity. Aside from portfolio binary variables, the only other RHS variables included in the regressions performed with the panel data are time and time squared. Time is included to account for all possible macroeconomic influences that may be affecting the plants' performance. The efficient scale regression is performed with cross-sectional data and hence does not have time as explanatory variable. The units of the portfolio coefficients for the efficient scale regression are expressed in thousands of pounds of monthly carcass weight capacity, and those in the gross margin and EBIT regressions are in dollars per hog.

Table 3-8. Estimated Performance Effects of Different Marketing Arrangement Portfolios

Marketing Arrangement Portfolio	Efficient Scale (18 Observations)	Gross Margin/Capacity (540 Observations)	EBIT/Capacity (540 Observations)
Portfolio 2[b]	37086.85[a] (11081.34)*	34.512 (13.95)*	1.712 (0.9583)
Portfolio 3	40202.7 (11516.07)*	100.315 (14.497)*	0.204 (0.9959)
Portfolio 4	43421.95 (12139)*	27.579 (15.281)	6.971 (1.05)*
Time		0.9862 (1.49)	0.1568 (0.1023)
Time squared		–0.0107 (0.0466)	–0.0055 (0.0032)
Constant	2536.472 (10512.69)	–1.719 (16.302)	1.032 (1.12)
Adjusted R^2	0.3922	0.1641	0.1735

[a] The numbers shown are estimated coefficients with standard errors in parentheses. An asterisk indicates significance at the 0.05 level.

[b] Portfolio 1: Cash/Spot Sales; Portfolio 2: Cash/Spot + Marketing Contracts; Portfolio 3: Cash/Spot + Marketing Contracts + Packer Owned/Other; Portfolio 4: Marketing Contracts + Packer Owned/Other.

The results are relatively similar across all three performance equations. All portfolio binary variables are positive and most are significant at the 5% level. These results indicate that various combinations of marketing arrangements improve plant performance relative to the situations in which the plant uses only cash/spot markets to purchase all of its live hogs.

Because the adoption of different marketing arrangement portfolios is likely to be nonrandom, the problem of selection bias needs to be addressed. In our panel data (30 monthly observation times 18 plants), the plant-level marketing arrangement portfolios do not change over time. In this case, subtracting the plant-specific time series mean would zero out all marketing arrangement portfolio binary variables, rendering the fixed effects estimation impossible. On the other hand, because our cross-sectional data set has only 18 observations, estimating the multinomial logit in the first stage of the Train (1993) procedure is fairly unreliable. Therefore, we use the 2SLS estimator. Because we have three endogenous variables (portfolios 2, 3, and 4), we must include at least three instruments. We use the size of the company as measured by the number of plants that it operates, size squared (to capture some nonlinearities), and the interaction between the size of the plant and the region where it is located. We do not include simple regional binary variables because including them causes collinearity problems. We hypothesize that all of these variables influence a company's decision about which portfolio of marketing arrangements to select.[18] The results of estimation are presented in Table 3-9.

Table 3-9. Instrumental Variable (2SLS) Estimates of Performance Equations

Marketing Arrangement Portfolio	Efficient Scale (18 Observations)	Gross Margin/Capacity (540 Observations)	EBIT/Capacity (540 Observations)
Portfolio 2[b]	43622.34[a] (22727.91)	217.544 (36.612)*	10.584 (1.828)*
Portfolio 3	40911.03 (19833.6)*	154.614 (31.95)*	5.035 (1.595)*
Portfolio 4	31749.24 (23130.3)	314.837 (37.261)*	16.908 (1.86)*
Time		0.9862 (2.325)	0.1568 (0.1161)
Time squared		–0.01067 (0.0728)	–0.0055 (0.0036)
Constant	1017.42 (20047.32)	–156.194 (35.548)*	–6.402 (1.775)*
R-squared	0.0858	0.1238	0.1864

[a] The numbers shown are estimated coefficients, with standard errors in parentheses. An asterisk indicates significance at the 0.05 level.

[b] Portfolio 1: Cash/Spot Sales; Portfolio 2: Cash/Spot + Marketing Contracts; Portfolio 3: Cash/Spot + Marketing Contracts + Packer Owned/Other; Portfolio 4: Marketing Contracts + Packer Owned/Other.

[18] It is interesting to note that the portfolios of marketing arrangements do not change across different plants owned by the same company. Based on this observation, we believe that the live hogs procurement strategy is determined at the company level rather than at the plant level.

The coefficients associated with various binary variables are all positive and most of them are significant at the 5% level, indicating that relative to the left-out binary variable for the spot market only, all other portfolios improve the economies of scale, the normalized gross margin, and the normalized EBIT. However, the magnitudes of the coefficients do not monotonically increase as expected. In other words, the magnitude of the Portfolio 3 binary variable, which contains all three marketing arrangements (cash, marketing contracts, and packer owned), is smaller than the Portfolio 2 binary variable, which includes only two marketing arrangements (cash and marketing contracts), signaling that including packer-owned hogs in the portfolio that already includes spot procurement and marketing contracts does not increase the performance of the plant. Interestingly, for both financial indicators (gross margin and EBIT), the magnitude of the Portfolio 4 coefficient is higher than the other two, indicating that the combination of marketing contracts and packer owned arrangements improves the performance of the plant relative to portfolios that include only spot market procurement. Therefore, based on these results, it is impossible to unambiguously conclude whether different marketing arrangements are actually complementary to each other.

As mentioned before, the rigorous test of complementarity among marketing arrangements would require adding the individual marketing arrangement binary variables to the regressions in Table 3-9 to compare the magnitudes of individual versus portfolio effects. Unfortunately, this procedure is not feasible because the individual marketing arrangement binary variables can only be assigned to individual observations (lots). Because this model has been estimated with monthly data, the monthly aggregation of marketing arrangements across lots gives exactly the portfolio of marketing arrangements that has already been used in estimation. This type of test can only be carried out using disaggregated individual lot data. However, it is not feasible to construct such a disaggregated performance measure unless one is willing to use purchase price for this purpose. Such a model has been estimated in Section 2, where we explain the sources of price differences across marketing arrangements.

3.4 SUMMARY

In this section, we identify and measure cost and efficiency differences associated with different marketing arrangements used to procure hogs. Procurement costs, operating costs, and selling costs can all be associated with different marketing arrangements. They can have differing effects on economies of scale and other performance measures, such as profitability or gross (meat) margin. The main difficulty in identifying cost and efficiency differences is separating any market power effects from purely cost changes associated with changes in marketing arrangements. For the purposes of testing whether market power exists and whether the source of that market power could be related to the use of AMAs in procurement of market hogs, we estimated two models. The first model is based on the industry-level data, and the second approach relies on the individual transactions data from large packers. Both approaches found a statistically significant presence of market power in procuring live hogs. The results regarding the significance of AMAs in explaining the sources of that market power are inconclusive. Whereas the industry-level data model, based on the farm–wholesale price spread, shows that a higher proportion of AMA supplies leads to increased market power, the model estimated with the company-level individual transactions data tells us that the use of AMA supplies may not be a source of market power in pork packing.

The estimated total and average cost functions confirm our expectations that economies of scale diminish as firm size increases. The estimates indicate that the scale economies are exhausted well within the sample output range such that the biggest plants already exhibit negative returns to scale (i.e., they operate on the upward-sloping portions of their average cost curves). As plant size decreases, the negative economies of scale monotonically converge toward constant returns to scale. The observed patterns of procurement portfolio choices by packers also indicate that certain combinations of marketing arrangements may reduce cost or increase economies of scale. In particular, relative to the use of spot market procurements alone, all other marketing arrangement portfolios increase the efficient scale of production.

Based on the observation that packers use marketing arrangements in clusters (portfolios), we started with a notion that marketing arrangements may be complementary to each other in the sense that implementing one procurement practice may increase the marginal return of the other practice. Testing for complementarities turns out to be important for measuring the economic effects of a regulation. If marketing arrangements are complements, a restriction that would ban or constrain the use of one marketing arrangement would have a direct effect reflected in an economic loss, because the practice is no longer available. It also will have an indirect effect arising from the fact that the regulated practice may be complementary to some other unregulated practice, and the efficiency of the unregulated practice may be diminished as its complementary practice use is reduced or eliminated.

The analyses of the complementarity of marketing arrangements produced inconclusive results. Although some simpler tests based on the correlation/association approach indicate that marketing contracts are in fact complementary to production contracts and/or packer owned arrangements, the portfolio coefficients in the performance equations based on either EBIT or gross margin do not monotonically increase with the portfolio order. In other words, all marketing arrangement portfolios improve plant performance relative to the simple spot market purchases, but the coefficient associated with the portfolio of three marketing arrangements is smaller than the coefficient associated with portfolios of two marketing arrangements. More conclusive formal tests were not feasible given data limitations.

4 Quality Differences Associated with Alternative Marketing Arrangements

This section analyzes the differences in the quality of finished market hogs (barrows and gilts) intended for slaughter across marketing arrangements through which they were procured. Regardless of the marketing arrangement used to procure the finished market hogs, the animals are shipped to a packer, and after being slaughtered, the carcasses are inspected for wholesomeness by USDA/FSIS or by a state government inspection system. Unlike beef, pork is rarely quality graded by USDA/AMS.[1] Instead packers rely on other measures of quality.

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[1] See the official standards for swine in the Official United States Standards for the Grades of Slaughter Swine promulgated by the Secretary of Agriculture under the Agricultural Marketing Act of 1946 (60 Stat. 1087; 7U.S.C. 1621-1627), with amendments effective January 14, 1985. The USDA standards segregated swine according to intended use (slaughter or feeder), class (sex), and grade (apparent relative excellence and desirability for particular use). Grades of slaughter barrows and gilts were predicated on the same two general considerations that provided the basis for the grades of barrow and gilt carcasses: quality (which includes characteristics of the leanness and firmness of fat) and characteristics related to the combined carcass yields of the four lean cuts (ham, loin, picnic shoulder, and Boston butt). With respect to quality, two general levels were considered. Barrows and gilts with characteristics indicating that the carcass will have acceptable belly thickness and lean quality and acceptable firmness of fat receive grades U.S. No. 1–4, whereas others are graded as U.S. Utility. The grades U.S. No. 1–4 were based entirely on the

The pork industry began using its own measurements and away from grades in the early 1990s. The main problem with the USDA standards was that slaughtered animals were not well differentiated by quality, so approximately 85% or more of the hogs were graded as U.S. No. 1–2.

In this section, we first test whether the average quality attributes are significantly different across marketing arrangements. We use seven different quality characteristics: average lean percentage, loin-eye area, average loin depth, average backfat, average sort loss, average carcass weight, and fat-free lean index. The results show that alternative marketing (procurement) channels generate hogs of different quality, and the ordering of AMAs is not unique but varies across quality attributes. We then try to establish the relationship between the procurement methods for live hogs intended for slaughter and the quality of obtained meat products. We assume that higher quality live hogs should yield a higher proportion of higher priced meat cuts in the total sales bundle. We calculate a simple correlation coefficient between the meat quality index and the percentage share of purchases in the total purchases of live hogs. The obtained positive and statistically significant correlation coefficient supports our hypothesis.

The analyses in this section are based on MPR data. Individual transactions data were not used because the only quality attribute that we could consistently recover from the majority of records was the loin-eye depth, whereas the MPR data allowed as to look at seven different quality attributes.

4.1 RANKING OF MARKETING ARRANGEMENTS BY QUALITY ATTRIBUTES

For the analysis of live hog quality differences across various marketing channels, we used *USDA/AMS Mandatory Price*

combination of factors that predict the expected combined carcass yields of the mentioned four lean cuts. The official grade for slaughter barrows and gilts having acceptable quality was determined by considering two characteristics: backfat thickness over the last rib and the muscling score. Values of these factors were then used in a mathematical equation to arrive at the final grade.

Reports (hereafter, MPR).[2] As described in Section 2, the marketing channels are as follows:

- **Negotiated Purchases (MA1)**
- **Other Market Formula Purchases (MA2)**
- **Swine or Pork Market Formula Purchases (MA3)**
- **Other Purchase Arrangements (MA4)**
- **Packer Owned (MA5)**
- **Packer Sold (MA6)**

The definitions of quality indicators used in this study based on MPR data are as follows:

- **Average lean percentage (in percent):** Value equal to the average percentage of the carcass weight comprising lean meat.
- **Loin-eye area (in square inches):** The surface area of the Longissimus dorsi muscle at the tenth rib of a pork carcass.
- **Average loin depth (in inches):** Average muscle depth measured between the third and fourth rib from the last rib, 7 cm from the carcass split.
- **Average backfat (in inches):** Average fat thickness measured between the third and fourth rib from the last rib, 7 cm from the carcass split.
- **Average sort loss (in $/cwt carcass weight):** Average discount for hogs slaughtered resulting from the fact that the hogs did not fall within the individual packer's established carcass weight range or lot variation range.
- **Average carcass weight (in pounds):** Weight obtained by dividing the total carcass weight of the hogs slaughtered at the packing plant during the applicable reporting period by the number of hogs.
- **Fat-free lean index:** Index measuring the final carcass fat-free lean as a percentage of the carcass. This index can be calculated and estimated from a fat probe between the third and fourth rib, 7 cm off the midline of the hot carcass. The fat-free lean index is calculated as follows: $51.537 + (0.035 \times \text{Carcass, lb}) - (12.260 \times \text{Backfat, inch})$.

[2] MPR is available at http://mpr.datamart.ams.usda.gov.

The data used in this analysis are daily observations for the period between August 3, 2001, and September 30, 2005. The summary statistics for seven different quality attributes are reported in Table 4-1. The highest quality hogs typically come from the other purchase arrangements (MA4). This is true for three out of seven quality measurements: the thinnest average backfat (0.7455 inches), the lowest average sort loss (−0.98$/cwt), and the largest fat-free lean index (49.216). The second highest quality hogs come through the other market formula purchases (MA2) that also have three highest quality attributes: the largest loin-eye area (7.36 square in), the thickest average loin depth (2.45 in), and the highest average carcass weight (201.99 lbs). We ranked MA4 ahead of MA2 because MA2 is also associated with the two worst quality attributes (the thickest average backfat of 0.7675 inches and the lowest fat-free lean index of 48.947), while MA4 is never ranked last in any of the considered quality attributes. The only remaining quality attribute is the average lean percent. According to this attribute, the highest ranked marketing arrangement is the swine or pork market formula purchases (MA3) with the highest average lean percent of 54.31%.

Judging by the same seven quality attributes, the lowest quality hogs are recorded in the packer sold category (MA6). In three out of seven quality attributes (average lean percent, loin-eye area, and average loin depth), MA6 ranked last, which seems to indicate that packers typically sell rather than slaughter lower quality hogs.

Next, we test whether the means of a given quality attribute are statistically different across marketing arrangements. We use the *paired observation* procedure, which applies to samples that are not independent and has variances of the two populations that are not necessarily equal. A $(1 - \alpha)$ 100% confidence interval for $\mu_D = \mu_1 - \mu_2$ for paired observations is given by

$$\overline{d} - t_{\frac{\alpha}{2}} \frac{s_d}{\sqrt{n}} < \mu_D < \overline{d} + t_{\frac{\alpha}{2}} \frac{s_d}{\sqrt{n}} \tag{4.1}$$

where $\overline{d}$ and s_D are the mean and standard deviation of the normally distributed differences of n random pairs of measurements, and $t_{\frac{\alpha}{2}}$ is the t-value with $(n - 1)$ degrees of freedom (see Walpole and Myers [1989], p. 254).

Table 4-1. Quality Attributes by Marketing Arrangement in the Hog Sector: Summary Statistics, August 2001–September 2005

Quality Attributes		Marketing Arrangement[a]					
		MA1	MA2	MA3	MA4	MA5	MA6
Average lean percentage	*Sample size*	1,059	1,059	1,059	1,059	1,059	1,055
	Mean	53.38	53.95	54.31	54.09	53.40	53.23
	St. Dev.	0.35	0.36	0.26	0.27	0.34	1.06
	C. V.	0.65	0.66	0.49	0.50	0.63	1.99
Loin-eye area	*Sample size*	1,060	1,060	1,060	1,060	294	1,055
	Mean	6.73	7.36	7.33	6.79	6.66	6.52
	St. Dev.	0.12	0.23	0.12	0.15	0.09	0.36
	C. V.	1.80	3.15	1.68	2.22	1.37	5.47
Average loin depth	*Sample size*	1,060	1,060	1,060	1,060	1,058	1,055
	Mean	2.24	2.45	2.44	2.26	2.22	2.18
	St. Dev.	0.04	0.08	0.04	0.05	0.03	0.12
	C. V.	1.77	3.10	1.65	2.19	1.47	5.37
Average backfat	*Sample size*	1,060	1,060	1,060	1,060	1,058	1,055
	Mean	0.7668	0.7675	0.7474	0.7455	0.7666	0.7535
	St. Dev.	0.02	0.02	0.02	0.02	0.02	0.04
	C. V.	2.78	2.51	2.42	2.06	2.68	5.20
Average sort loss	*Sample size*	1,060	1,060	1,060	1,060	n.a.	992
	Mean	–1.18	–1.04	–1.23	–0.98	n.a.	–1.20
	St. Dev.	0.28	0.30	0.25	0.13	n.a.	0.66
	C. V.	–23.60	–29.21	–20.46	–13.70	n.a.	–54.74
Average carcass weight	*Sample size*	1,060	1,060	1,060	1,059	1,059	1,055
	Mean	194.83	201.99	198.74	198.94	197.32	200.97
	St. Dev.	3.12	3.86	3.20	3.03	3.58	8.00
	C. V.	1.60	1.91	1.61	1.52	1.82	3.98
Fat-free lean index	*Sample size*	1,060	1,060	1,060	1,060	1,058	1,055
	Mean	48.955	48.947	49.193	49.216	48.957	49.118
	St. Dev.	0.29	0.23	0.24	0.21	0.27	0.50
	C. V.	0.59	0.48	0.50	0.42	0.54	1.01

[a] Marketing arrangements are defined as follows:

MA1: Producer-Sold Negotiated

MA2: Producer-Sold Other Market Formula

MA3: Producer-Sold Swine/Pork Market Formula

MA4: Producer-Sold Other Purchase Arrangement

MA5: Packer Owned

MA6: Packer Sold

[b] C. V. = Coefficient of variation

Tables 4-2 through 4-8 present the rankings of the marketing arrangements by their average quality attributes. For example, Table 4-2 presents the ranking of marketing arrangements with respect to average lean percentage. The hogs with the highest average lean percentage of 54.31% came from swine or pork market formula (MA3), followed by the other

Table 4-2. Ranking of Marketing Arrangements by Average Lean Percentage

Average Lean Percentage Decreasing Quality Rank	Mean[a] (%)	Are means pairwise different at $\alpha = 0.05$?				
		MA4	MA2	MA5	MA1	MA6
1. Swine/pork market formula (MA3)	54.31	Yes	Yes	Yes	Yes	Yes
2. Other purchase arrangement (MA4)	54.09		Yes	Yes	Yes	Yes
3. Other market formula (MA2)	53.95			Yes	Yes	Yes
4. Packer owned (MA5)	53.40				Yes	Yes
5. Negotiated (MA1)	53.38					Yes
6. Packer sold (MA6)	53.23					

[a]Higher mean indicates higher quality.

Table 4-3. Ranking of Marketing Arrangements by Loin-Eye Area

Loin-Eye Area Decreasing Quality Rank	Mean[a] (in^2)	Are means pairwise different at $\alpha = 0.05$?				
		MA3	MA4	MA1	MA5	MA6
1. Other market formula (MA2)	7.36	Yes	Yes	Yes	Yes	Yes
2. Swine/pork market formula (MA3)	7.33		Yes	Yes	Yes	Yes
3. Other purchase arrangement (MA4)	6.79			Yes	Yes	Yes
4. Negotiated (MA1)	6.73				Yes	Yes
5. Packer owned (MA5)	6.66					Yes
6. Packer sold (MA6)	6.52					

[a]Higher mean indicates higher quality.

Table 4-4. Ranking of Marketing Arrangements by Average Loin Depth

Loin Depth Decreasing Quality Rank	Mean[a] (in)	Are means pairwise different at $\alpha = 0.05$?				
		MA3	MA4	MA1	MA5	MA6
1. Other market formula (MA2)	2.45	Yes	Yes	Yes	Yes	Yes
2. Swine/pork market formula (MA3)	2.44		Yes	Yes	Yes	Yes
3. Other purchase arrangement (MA4)	2.26			Yes	Yes	Yes
4. Negotiated (MA1)	2.24				Yes	Yes
5. Packer owned (MA5)	2.22					Yes
6. Packer sold (MA6)	2.18					

[a]Higher mean indicates higher quality.

Table 4-5. Ranking of Marketing Arrangements by Average Backfat

Backfat Decreasing Quality Rank	Mean[a] (in)	Are means pairwise different at α = 0.05?				
		MA3	MA6	MA5	MA1	MA2
1. Other purchase arrangement (MA4)	0.7455	Yes	Yes	Yes	Yes	Yes
2. Swine/pork market formula (MA3)	0.7474		Yes	Yes	Yes	Yes
3. Packer sold (MA6)	0.7535			Yes	Yes	Yes
4. Packer owned (MA5)	0.7666				No	No
5. Negotiated (MA1)	0.7668					No
6. Other market formula (MA2)	0.7675					

[a]Higher mean indicates higher quality.

Table 4-6. Ranking of Marketing Arrangements by Average Sort Loss

Sort Loss Decreasing Quality Rank	Mean[a] ($/cwt)	Are means pairwise different at α = 0.05?				
		MA2	MA1	MA6	MA3	MA5
1. Other purchase arrangement (MA4)	–0.98	Yes	Yes	Yes	Yes	NA
2. Other market formula (MA2)	–1.04		Yes	Yes	Yes	NA
3. Negotiated (MA1)	–1.18			No	Yes	NA
4. Packer sold (MA6)	–1.20				No	NA
5. Swine/pork market formula (MA3)	–1.23					NA
6. Packer owned (MA5)	NA					

[a]Lower mean indicates higher quality.
NA = Not available

Table 4-7. Ranking of Marketing Arrangements by Average Carcass Weight

Carcass Weight Decreasing Quality Rank	Mean[a] (lb)	Are means pairwise different at α = 0.05?				
		MA6	MA4	MA3	MA5	MA1
1. Other market formula (MA2)	201.99	Yes	Yes	Yes	Yes	Yes
2. Packer sold (MA6)	200.97		Yes	Yes	Yes	Yes
3. Other purchase arrangement (MA4)	198.94			Yes	Yes	Yes
4. Swine/pork market formula (MA3)	198.74				Yes	Yes
5. Packer owned (MA5)	197.32					Yes
6. Negotiated (MA1)	194.83					

[a]Higher mean indicates higher quality.

Table 4-8. Ranking of Marketing Arrangements by Fat-Free Lean Index

Fat-Free Lean Index Decreasing Quality Rank	Mean[a]	Are means pairwise different at α = 0.05?				
		MA3	MA6	MA5	MA1	MA2
1. Other purchase arrangement (MA4)	49.22	Yes	Yes	Yes	Yes	Yes
2. Swine/pork market formula (MA3)	49.19		Yes	Yes	Yes	Yes
3. Packer sold (MA6)	49.12			Yes	Yes	Yes
4. Packer owned (MA5)	48.96				No	No
5. Negotiated (MA1)	48.96					No
6. Other market formula (MA2)	48.95					

[a]Higher mean indicates higher quality.

purchase arrangement (MA4). In the right-hand side panel of the table, we test whether quality means are pairwise different across marketing arrangements at the 5% confidence interval. As the results suggest, almost all lean percentage means are different from each other. Testing for the pairwise differences across means produced similar results for other quality attributes. Most of the means are statistically significantly different from each other.[3]

Finally, the actual measurements of the daily fluctuations in various quality attributes of the best and the worst marketing arrangements are graphed in Figures 4-1 through 4-8. For example, in Figure 4-3 the data exhibit a fairly large difference in loin depths between the best and the worst marketing arrangement (in this case other market formula and packer sold), whereas in Figure 4-4, one sees that the difference between the best and the worst marketing arrangement (in this case, other purchase arrangements and other market formula) in terms of backfat is rather small.

4.2 QUALITY MEASUREMENT USING HICKS' COMPOSITE COMMODITY INDEX

In this section, we use national MPR data for current volumes by purchase type (daily observations on head count, barrows

[3] The loin-eye area pairwise difference of any channel with the *packer owned* channel is calculated based on the smaller sample because the packer owned data have a lot of missing values for loin-eye area.

Figure 4-1. Average Lean Percentage, January 2002–September 2005

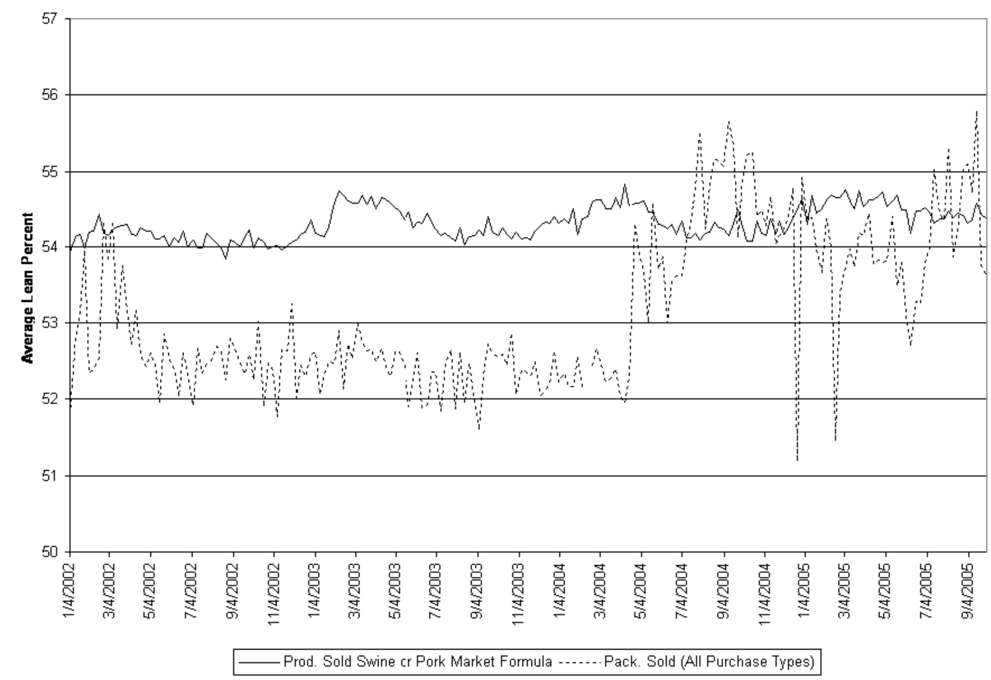


Figure 4-2. Loin-Eye Area, January 2002–September 2005

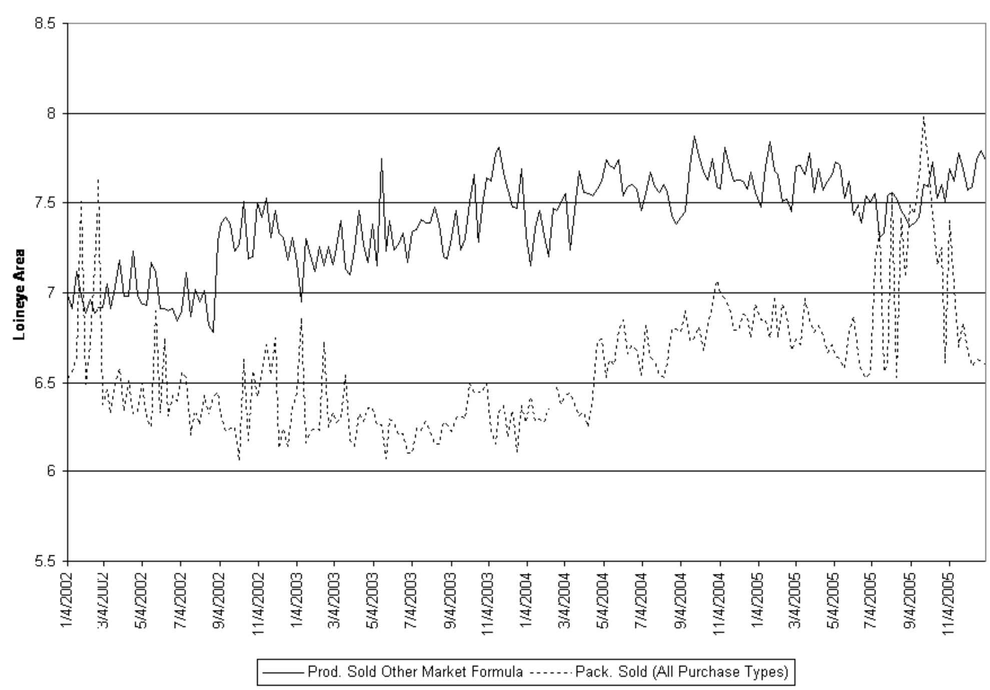


Figure 4-3. Average Loin Depth, January 2002–September 2005

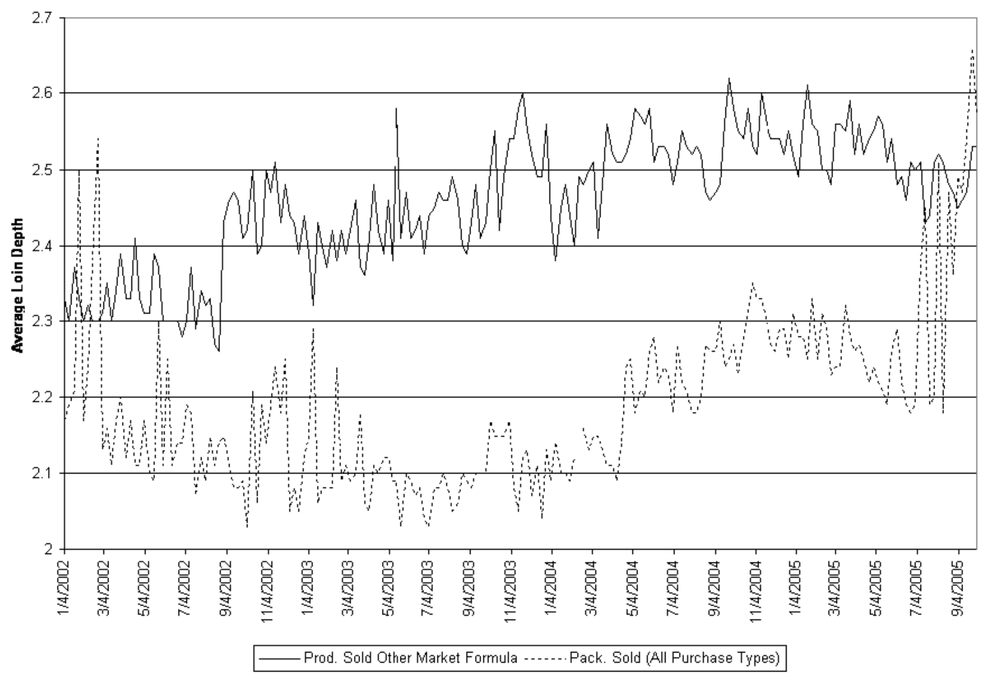


Figure 4-4. Average Backfat, January 2002–September 2005

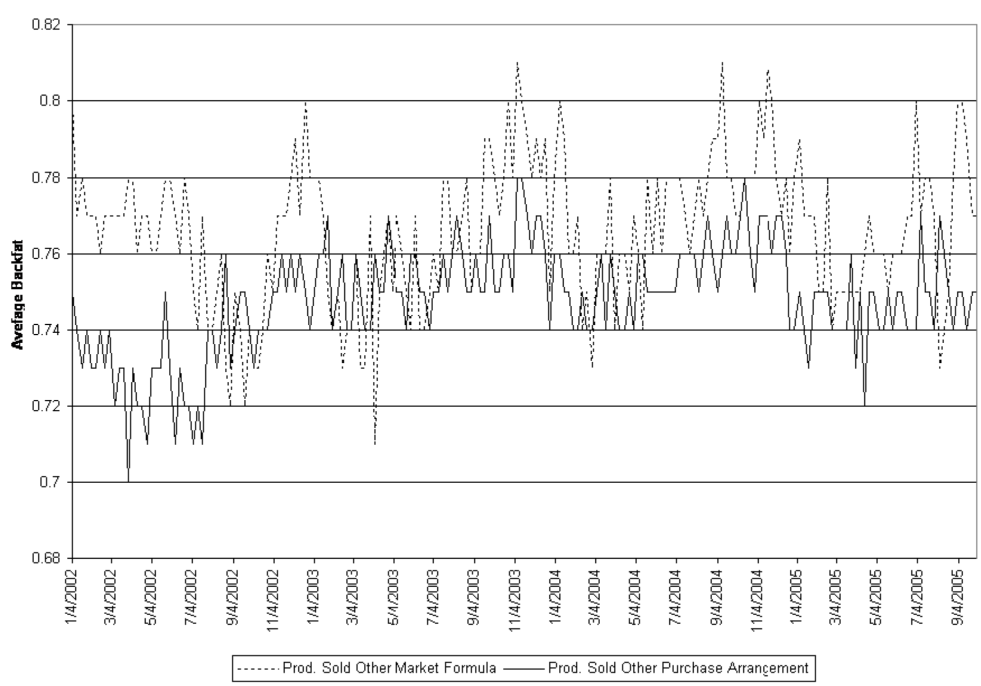


Figure 4-5. Average Sort Loss, January 2002–September 2005

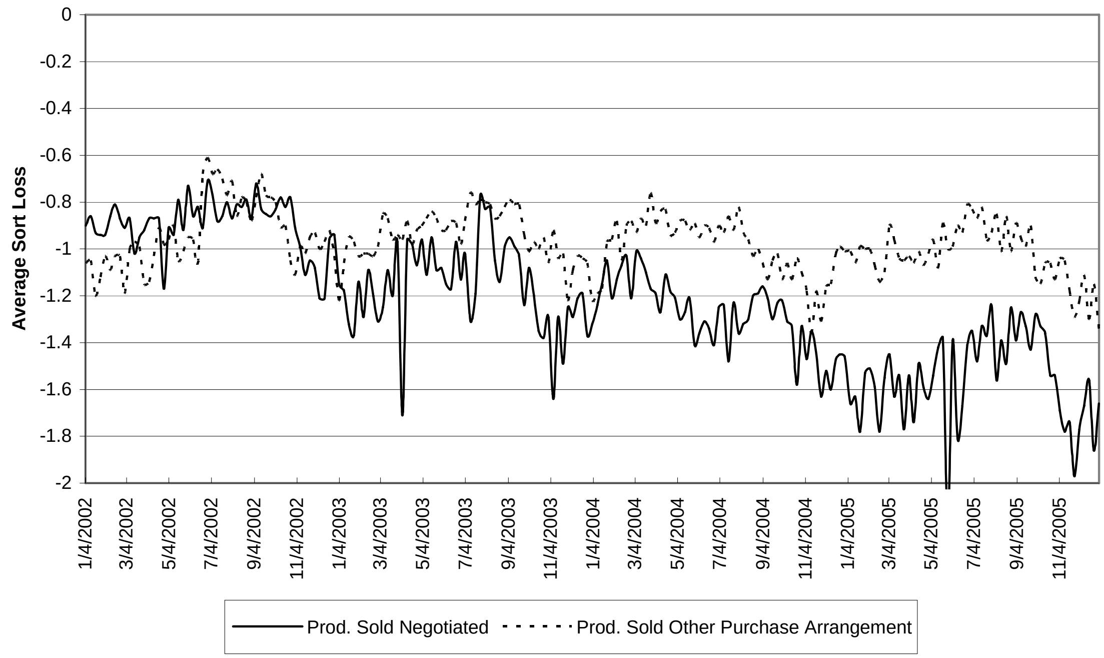


Figure 4-6. Average Carcass Weight, January 2002–September 2005

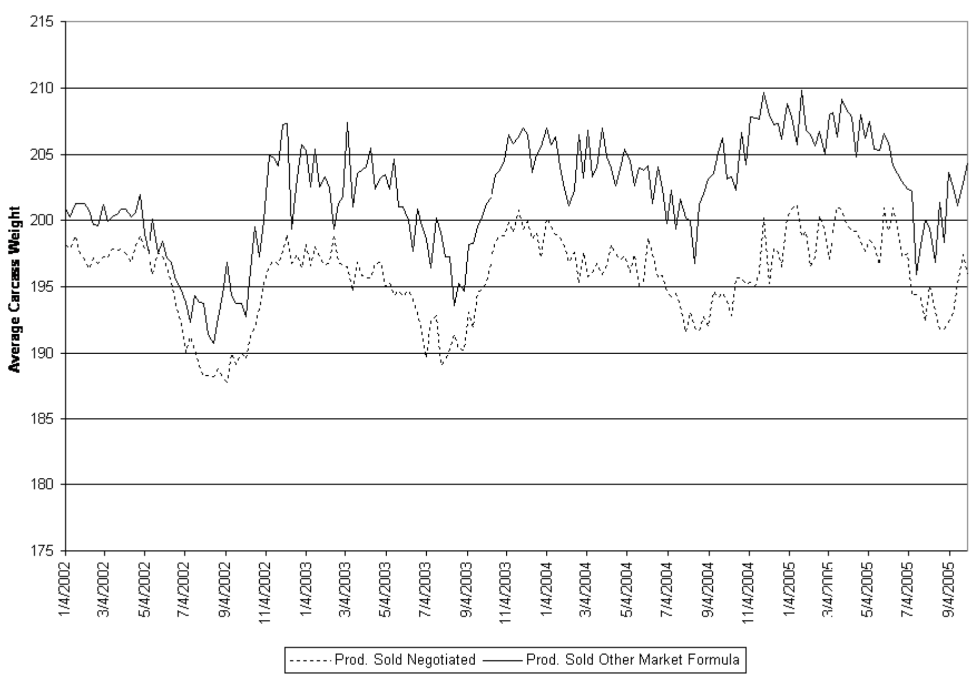


Figure 4-7. Fat-Free Lean Index, January 2002–September 2005

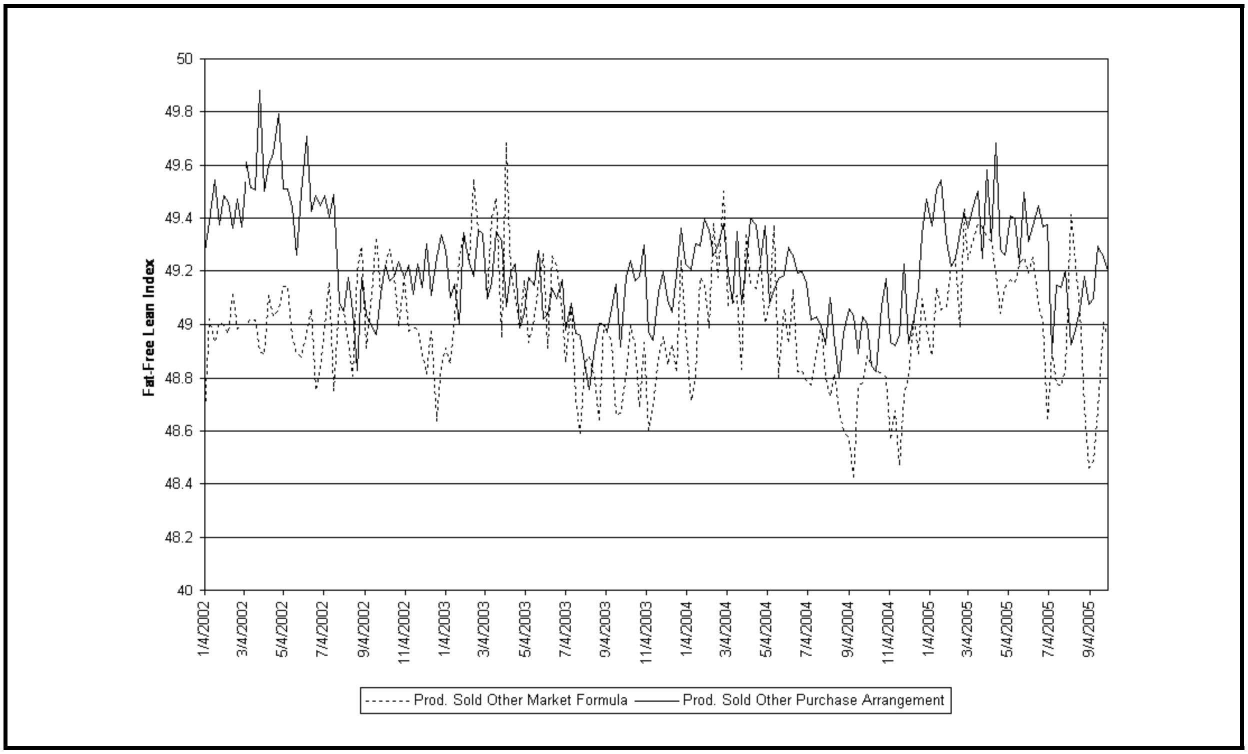
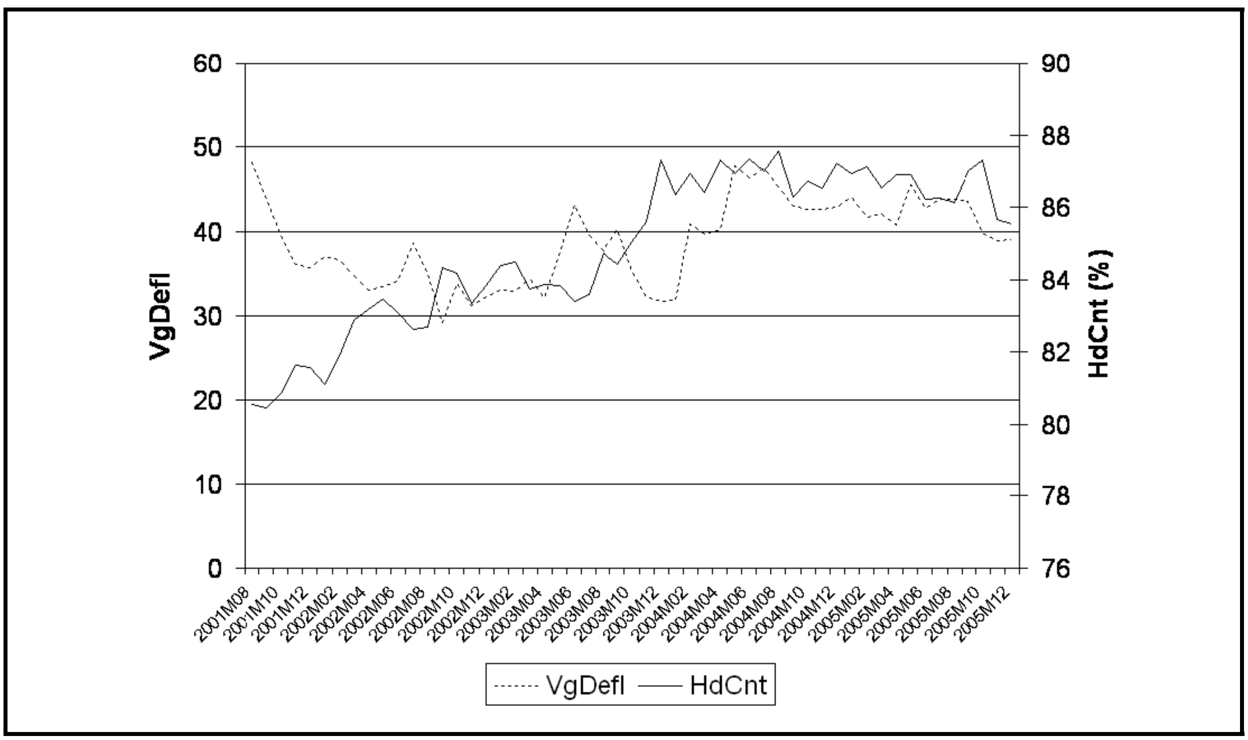


Figure 4-8. *VgDefl* and *HdCnt*, January 2002–September 2005



VgDefl = pork quality index using Hicks' composite commodity formula

HdCnt = percentage of AMAs

and gilts)[4] and pork carcass cut-out (weekly observations on primal values and load counts for the August 3, 2001, to September 30, 2005 period).[5] The data have been aggregated into 50 monthly observations by calculating monthly sums of quantity variables and monthly simple averages of primal cuts values. The values of various pork cuts are deflated using the consumer price index for pork (1982–84 = 100).[6]

First, we construct the average quality index based on Hicks' composite commodity formula (Theil, 1952–1953; Cramer, 1973; and Nelson, 1991. This quality index is formulated as

$$V_G = \frac{\sum_{i \in G} p_i x_i}{q_G} \quad , \tag{4.2}$$

where x_i are the quantities of elementary goods (various pork cuts: loin, butt, picnic, rib, ham, belly) that belong to the same commodity group G, p_i are the prices of various pork cuts, and $q_G = \sum_{i \in G} x_i$ is the heterogeneous commodity group (pork meat). Based on this measure, the larger the proportions of higher priced cuts in the total sales bundle, the higher the measure of quality. Measuring quality associated with different AMAs would ideally require that the sales data contain some indicator of the marketing arrangement used to get this product to the market. However, even if sales data do not include AMA indicators, one can still calculate aggregate V_G as described above and then look at the composition of AMAs for the upstream segment. This will give us some indication of the pork quality differences caused by different combinations of upstream AMAs.

To implement this method, we calculated the percentage share of all marketing arrangements other than negotiated purchases (MA1) and packer sold (MA6) in the total volume of live animals purchased. The variable is constructed as the ratio between (other market formula purchases + swine/pork market formula purchases + other purchase arrangement + packer owned) and total purchases, where the total purchases contain all of the above methods plus negotiated (spot) purchases and packer

[4] These observations are available at the MPR Datamart Web site (http://mpr.datamart.ams.usda.gov).

[5] These observations were obtained from various issues of USDA National Meat Trade Review (http://www.ams.usda.gov/LSMNpubs/PDFMonthly/composite.htm).

[6] These data were obtained from the Bureau of Labor Statistics Web site (http://www.bls.gov).

sold. The prediction here is that all AMAs should on average enable packers to acquire higher quality hogs (and hence produce higher quality pork) than those acquired on an open negotiated (spot) market or via the packer sold channel.

The time plot of both series is presented in Figure 4-8. As the figure shows, the percentage of AMA purchases (HdCnt) exhibits a time trend, while the pork quality index (VgDefl) does not. Also, in two subsample periods—August 2001 to September 2002 and March 2003 to December 2003—the two series are moving in the opposite direction. Because our purpose is to examine the qualitative relationship between the two time series, we then calculated the correlation coefficient. The estimated sample correlation coefficient between the two series is 0.3661, with a 95% confidence interval of (0.098, 0.5849). Therefore, we reject the null hypothesis of no correlation between the pork quality and the share of AMAs in the total market hog purchases at the 5% significance level.[7] Based on this result, we conclude that more hogs are purchased through AMAs, thus translating into higher quality pork products that can be sold on the meat market.

4.3 SUMMARY

This section analyzes quality differences in live market hogs across alternative procurement methods. First, we tested if various quality attributes used by the industry are signi•cantly different across marketing arrangements. Test results indicate that different marketing arrangements yield different quality hogs. Even though the rankings are not unique, we found that marketing contracts (especially other purchase arrangements and other market formula purchases) consistently yield higher quality hogs than negotiated (spot) purchases.

Second, we examined the relationship between the proportion of the higher level procurement methods in the total acquisition of live market hogs and the quality of resulting pork products. We measured pork quality by Hicks' composite commodity index and assumed that a higher percentage share of the AMAs (essentially marketing contracts and packer-owned hogs) should produce higher quality pork products. The correlation coefficient showed that these two series are positively correlated, confirming our hypothesis.

[7] The t-test statistic (2.726) is greater than the critical value (2.01).

5 Risk Shifting Associated with Alternative Marketing Arrangements

In this section, we address the issue of risk allocation among various economic agents (farmers, integrators, packers) involved in the hog industry. The standard assumption in the industrial economics literature is that firms are risk neutral. This is especially the case for publicly traded firms that can diversify risk by spreading it among a large number of shareholders. On the other side of the hog industry, there is a large number of farmers who are generally ill equipped to bear risk and therefore frequently seek various avenues to reduce their risk exposure. Hog farmers are concerned with several types of risk. The most important is price risk (both on the input side as well as on the output side), followed by various types of production risks (common and idiosyncratic), and finally market access risk. In this context, the type of risk shifting that needs to be analyzed is the transfer of risk from risk-averse farmers to risk-neutral (or less risk-averse) integrators or packers.

The mechanisms through which this risk shifting occurs include AMAs. Various types of marketing arrangements are associated with different levels of risk, and they can transfer different components of the total risk from the producer/farmer to the contractor (packer or integrator). Production contracts usually eliminate the entire price risk, as well as the market access risk, from the responsibility of the producer. In cases where the payment is based on the relative performance (tournaments), production contracts eliminate the common production risk as well, such that the only risk left is the producer's own individual, or idiosyncratic, risk. In cases where the payment is based on the absolute performance (say feed conversion brackets), production contracts do not eliminate the common production shock. Marketing contracts generally eliminate market access risk, could sometimes eliminate some of the price risk, but would generally not eliminate production risk. Finally cash or spot market sales expose the producer to all types of risk associated with hog production.

The analysis of risk shifting in this section proceeds in three directions. First, we measure the variances of payments received by producers selling their hogs through different marketing channels, and we test whether the pairwise differences among those variances are statistically significant. Next, because of the inability to obtain sufficient data on production contract settlements through the data collection procedures for this study, we instead extracted some of the relevant results on risk shifting from the existing literature (Martin, 1994). Finally, using Agricultural Resource Management Survey (ARMS) data, we were able to estimate the risk-aversion parameters for different groups of producers; based on these estimates we performed a counterfactual simulation to measure the extent of the utility associated with forcing farmers out of their risk-aversion-preferred marketing arrangement choice.

5.1 RISK REDUCTION THROUGH MARKETING ARRANGEMENTS

For the analysis of risk reduction between marketing arrangements and cash market sales, we used *USDA/AMS Mandatory Price Reports* (hereafter, MPR).[1] As described in Section 2, the marketing channels are Negotiated Purchases (MA1), Other Market Formula Purchases (MA2), Swine or Pork Market Formula Purchases (MA3), Other Purchase Arrangements (MA4), Packer Owned (MA5), and Packer Sold (MA6). Because we are interested in comparing the volatilities in the marketing contracts channels against the spot/cash

[1] MPR is available at http://mpr.datamart.ams.usda.gov.

market, we exclude MA5 and MA6 because these two arrangements likely include production contracts and packer-owned farms.

Assuming that the variance of the price through each arrangement over time represents the risk of that particular arrangement, we compiled the daily average net prices of each arrangement over the period of August 3, 2001, through March 27, 2006, and conducted a pairwise test of equal variance. The prices are base prices for barrows and gilts, carcass basis expressed in $/cwt. Greater variance of payments indicates higher risk (see Table 5-1).

Table 5-1. Variance-Covariance Matrix of Hog Prices, by Marketing Channel

Marketing Channel	MA1	MA2	MA3	MA4
MA1[a]	132.89	71.64	126.13	75.63
MA2[b]		52.71	68.03	39.52
MA3[c]			120.18	72.37
MA4[d]				47.78

[a] MA1: Negotiated purchases
[b] MA2: Other market formula purchases
[c] MA3: Swine/hogs market formula purchases
[d] MA4: Other purchase agreements

Based on the computed variances (main diagonal elements in Table 5-1), we ordered the marketing arrangements according to the magnitude of risk they carry: MA1, MA3, MA2, and MA4. This order is quite intuitive: MA1 is spot/cash market sales, which should obviously have the greatest risk; MA3 is marketing contracts whose pricing formula is based on different spot markets; MA2 is another type of marketing arrangement for which the pricing formula is based on some futures or options price; and MA4 contains ledgers, windows, and other pricing mechanisms, which all serve to moderate price volatility.

To test the null hypothesis that the variances of the payments are identical under two different types of arrangements, we can use the asymptotic Wald test proposed by Knoeber and Thurman (1995). The test statistic is given by

$$T = \frac{s_1^2 - s_2^2}{\left[\frac{2}{n}(s_1^4 + s_2^4 - 2s_{12}^2)\right]^{1/2}} , \qquad (5.1)$$

where s_1^2 and s_2^2 are the sample variances for two different payment time series and s_{12} is the sample covariance. Under the null, T is asymptotically standard normal. This test is needed when the two price series of interest are statistically dependent on each other (otherwise, a standard F-test could be used for testing the equal variances).

For different combinations of i and j, the null and alternative hypotheses are given as

$$\begin{aligned} H_0 &: \ Var(\text{price of MA}_i) = Var(\text{price of MA}_j) \\ H_1 &: \ Var(\text{price of MA}_i) > Var(\text{price of MA}_j). \end{aligned} \qquad (5.2)$$

The results are summarized in Table 5-2.

Table 5-2. Tests for Risk Reduction: Cash Sales and AMAs

Tests[a]	Wald Test Statistic	p value
MA1[b] vs. MA2[c]	19.37	.000
MA1 vs. MA3[d]	18.42	.000
MA1 vs. MA4[e]	22.49	.000
MA3 vs. MA2	18.42	.000
MA3 vs. MA4	22.31	.000
MA2 vs. MA4	2.73	.003

[a] Test (MA_i vs. MA_j) hypotheses are
H_0 : Var(price of MA_i) = Var(price of MA_j)
H_1 : Var(price of MA_i) > Var(price of MA_j)

[b] MA1: Negotiated purchases

[c] MA2: Other market formula purchases

[d] MA3: Swine/hogs market formula purchases

[e] MA4: Other purchase agreements

The results indicate that all null hypotheses were rejected at 1% level of significance. The pairwise testing of the differences in prices across various marketing arrangements thus confirmed that all price variances are statistically different from each other. Therefore, we conclude that the magnitude of risk that hog producers are exposed to varies with the marketing arrangements through which hogs are transacted.

5.2 RISK REDUCTION THROUGH PRODUCTION CONTRACTS

Martin (1994) conducted an analysis of risk reduction in the hog industry when production contracts are employed. The data came from a North Carolina integrator and cover the period between September 1985 and December 1992. The data set contains 805 observations on individual contract settlements of 123 contract growers. The number of observations per farmer (i.e., herds or groups per grower) varies from 2 to 37 with a mean of 6.5 observations. This data set is rather old but still relevant because the actual payment mechanisms used in hog finishing contracts have not changed much since production contracts were originally introduced. To the best of our knowledge, this is the only detailed hog production contracts settlement data in the public domain.

In a finishing contract, the compensation to the grower i for the batch of hogs under contract t is paid on a per-pound of gain basis with bonuses earned on a per-head basis. Bonuses are paid only to the farmers whose feed conversion ratio (pounds of feed divided by pounds of gain, $\frac{F_{it}}{g_{it}}$) is less than a standard feed conversion ratio (denoted by ϕ). If the grower's ratio is below the standard ratio, the difference is multiplied by a constant ζ to determine the per-head bonus measure. This number is multiplied by the total heads shipped (Q_{it}) to obtain the total bonus. Otherwise, the growers will receive no bonus. Regardless of their performances, all growers earn the piece–rate, ξ, multiplied by the total pounds gained, g_{it}. Now, compensation under a production contract can be mathematically expressed as

$$P_2 = \xi g_{it} + \max\left[0, \varsigma\left(\phi - \frac{F_{it}}{g_{it}}\right)\right] Q_{it} \quad . \qquad (5.3)$$

Note that this payment is based on the absolute performance and contains both idiosyncratic and common production shocks, but price shock risk is completely eliminated because neither the prices of inputs (corn, soybeans) nor the price of output (live hogs) enters the payment formula.

To see if contract farmers face less risk than independent farmers, we simulated the payments to the independent farmers (P_1).[2] Risk reduction then is analyzed by conducting a test for the null hypotheses of equal variances of two payment series, P_2 and P_1. The test can be described as follows:

$$H_0 : \sigma^2_{P_1} = \sigma^2_{P_2}$$
$$H_1 : \sigma^2_{P_1} > \sigma^2_{P_2} \quad , \tag{5.4}$$

where $\sigma^2_{P_2}$ is the variance of the actual production contract payment and $\sigma^2_{P_1}$ is the variance of the simulated spot market payment. Because 123 farmers in the sample are heterogeneous, this test is performed for each farmer. Because contract payments (P_2) and the constructed market payments (P_1) are not statistically independent of each other, the conventional F–test is not applicable. Hence, the asymptotic Wald test described in Eq. (5.1) is used. When contract farmers are compared with independent hog–finishing farmers, the null of equal variances is rejected for 74% of the farmers. The null hypothesis is not rejected only for those farmers with small number of observations (contract settlements). Because applying the asymptotic Wald test in Eq. (5.1) in small samples might be misleading anyway, the evidence for risk reduction via production contracts relative to spot markets is overwhelming.

Next, we decompose the variance of grower income into production shock (ϵ_Q) and price variability (ϵ_P). The payments to contract farmers (P_2) and independent farmers (P_1) can be expressed as

$$P_2 = \mu_2 + \epsilon_Q$$
$$P_1 = \mu_1 + \epsilon_Q + \epsilon_p \ . \tag{5.5}$$

In matrix form, Eq. (5.5) can be rewritten as $P = \mu + \omega\epsilon$, where P, μ, and ϵ are (2×1) vectors and $\omega = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$. Using

[2] The assumption was that independent farmers buy all their inputs on an open market and sell their hogs on a cash/spot market. For the details of the simulation, see Martin (1994, Section 6.1, pp. 55–59).

the covariance matrix of observable payment series (V_P), the covariance matrix of unobservable shocks (V_ϵ) can be recovered as follows:

$$V_\epsilon = \omega^{-1} V_P (\omega^{-1})' = \begin{bmatrix} \sigma_Q & \sigma_{QP} \\ \sigma_{PQ} & \sigma_P^2 \end{bmatrix}. \tag{5.6}$$

Assuming that the maximum income variability is the same as the income variability associated with the cash/spot marketing of hogs, the total risk measured by the variance of cash/spot market payments (V_{P_1}) can be decomposed as

$$V_{P_1} = Var(\epsilon_Q + \epsilon_P) = \sigma_Q^2 + \sigma_P^2 + 2\sigma_{QP} \tag{5.7}$$

and the relative importance of the three risk components can be calculated as

$$\alpha_Q = \frac{\sigma_Q^2}{V_{P_1}}, \quad \alpha_P = \frac{\sigma_P^2}{V_{P_1}}, \quad \alpha_{QP} = \frac{2\sigma_{QP}}{V_{P_1}}. \tag{5.8}$$

Based on Martin's (1994) results with 77 farmers who have five or more observations, we obtain the following decomposition results. Price shocks, which get completely eliminated from the contract payment, are the largest source of risk and represent about 94.17% of the total income variability. The pure contribution of production shocks is relatively small at 1.78% of the total variation. The interactive effect from the production and price shocks represents about 4.05% of the total variability. Hence, one can conclude that production contracts would eliminate about 94% of the total income variability to which an independent farmer selling hogs on the spot market would be exposed.

5.3 FARMERS' RISK AVERSION AND CONSEQUENCES FOR CONTRACT CHOICE

In this section, we model the decision process of a risk-averse hog farmer who must decide whether he wants to be an independent producer or a contract operator and then, conditional on the choice of marketing arrangement, decide how many hogs to produce.[3]

[3] Our approach is reminiscent of the models used in the health insurance literature, see for example Bajari, Hong, and Khwaja (2005), where an individual first decides which health plan to purchase and then conditional on the choice of health plan and the

5.3.1 Model Specification

We use this model as the basis for analyzing the relationship between contract choice and risk tolerance. Without any loss of generality, we assume that there are only two time periods. In the first time period, farmers face a menu of choices from a set of available marketing arrangements that depends on the location of the farm. In some states/regions, farmers can choose between cash/marketing arrangements and production contracts; in other regions, production contracts may not be available because no packers or integrators offer them. Each farmer forms expectations about the profits he will earn in different marketing arrangements and, given his choice set, chooses a marketing arrangement $d \in D$ that maximizes his utility of profits from hog production that will occur in the second period. Formally, this can be represented as follows:

$$\max_{d \in D}(V_1,\ldots, V_D),$$
$$\text{with } V_d = E_{t=1}U_d(\pi^{d*}) \tag{5.9}$$

where V_d is the expected utility (expectations formed in the first period) of the second period profit $\pi^{d*} = R^{d*} - C^{d*}$ associated with the optimal production decision q^{d*}.[4]

In the second period, conditional on the chosen marketing arrangement, and after learning his price or contract payment and his costs, each farmer makes a decision about the production level q that will maximize his utility. Formally we assume that the farmer's utility function is given by

$$U(R(q),C(q),\gamma)$$
$$= U(R(q),\ \gamma_1) - \gamma_3 U(C(q),\ \gamma_2)\ . \tag{5.10}$$

where the parameter vector $\gamma = (\gamma_1, \gamma_2, \gamma_3)$ is additively separable in the revenue of production $R(q)$ and the cost of production $C(q)$. This assumption implies that a farmer's risk

observed state of her own health, decides how much health care to purchase.

[4] Our theoretical model allows the first stage choice of marketing arrangements; however, in our empirical analysis we do not estimate the first stage model for two reasons. First, the procedure for structural estimation of the two-stage model is quite involved, see Cardon and Hendel (2001), and outside the scope of this project. Second, the price data on the farmers' choice sets and outside opportunities would be difficult to assemble.

aversion could vary differently with revenue through parameter γ_1 than with costs through a different parameter γ_2 and could also carry different weights for the two utilities through γ_3.[5] This generality is important in this particular context because the producer's revenue is always expressed in monetary units, whereas the cost of production could be a combination of monetary (money used to buy inputs) and nonmonetary costs (e.g., operator's own or his family members' effort exerted to manage the farm efficiently). Therefore, it is conceivable that the utilities associated with two components of the profit function may take different forms.

To solve the maximization problem, we further assume that the utility function of the revenue side exhibits constant relative risk-aversion (CRRA) preference structure

$$U(R(q),\gamma_1) = (pq)^{\gamma_1} \tag{5.11}$$

with parameter $0 < \gamma_1 < 1$, and that the disutility of costs can be adequately represented by the following reduced-form specification

$$\gamma_3 U(C(q),\gamma_2) = \alpha_0 + \alpha_1 q + \frac{\alpha_2}{2} q^2 + \varepsilon q, \quad \alpha_2 > 0 \tag{5.12}$$

where ε captures the unobserved (to the econometrician) heterogeneity in farmers' disutilities of production costs.[6]

With these specifications, the maximization problem for a farmer using marketing arrangement *d* can be written as

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[5] This specification, which is fairly common in the information economics literature (see, for example, Bajari, Hong, and Khwaja [2005]), ensures that the risk aversion parameter(s) does not drop out from the first order condition for utility maximization. This would render the first order conditions under risk aversion empirically indistinguishable from the risk neutral case. The ability to estimate the risk aversion parameters is an important part of our estimation strategy, as we show later.

[6] Alternatively, one can specify $\gamma_3 U(C(q), \gamma_2)$ as $\gamma_3 (C(q))^{\gamma_2}$ and then use the same reduced-form specification for $C(q)$ like $C(q) = \beta_0 + \beta_1 q + \frac{\beta_2}{2} q^2 + \varepsilon q$. The advantage of this specification is that it enables the recovery of the cost function and the risk aversion parameters γ_2 and γ_3. However, the problem is that the second order condition for maximum is not guaranteed. We estimated this model and found that for about 30% of observations, the second order condition is violated.

$$\max_{q^d} = \left(p^d q^d\right)^{\gamma_1^d} - \alpha_0^d - \alpha_1^d\, q^d - \frac{\alpha_2^d}{2}(q^d)^2 - \varepsilon^d q^d \ , \quad (5.13)$$

where the superscript d is used to denote the different sets of parameters in different marketing arrangements. The implied first order condition is

$$\gamma_1^d \left(p^d q^{d*}\right)^{\gamma_1^d - 1} p^d - \alpha_1^d - \alpha_2^d q^{d*} - \varepsilon^d = 0 \ . \quad (5.14)$$

We use Eq. (5.14) as the basis for developing our estimation strategy below.

5.3.2 Model Estimation

In the econometric investigation adopted in this section, the statistical inference is based on the assumption that the number of farmers approaches infinity. Therefore, possible farmers' heterogeneity needs to be taken into account. This issue can be addressed by modeling disutilities of costs to depend on farmers' socioeconomic characteristics. Specifically, let farmers be indexed by (i = 1,..., N^d) where N^d denotes the number of farmers in the data set using marketing arrangement d, and specify

$$\alpha_{1i}^d = x_i \phi^d \quad (5.15)$$

where x_i is a vector of variables characterizing the observed heterogeneity for farmer i. Also, let's assume that the unobserved heterogeneity (to the analyst) in the disutility of production costs ε_i^d is normally distributed with mean 0 and variance $\left(\sigma_\varepsilon^d\right)^2$.

The first order condition Eq. (5.14) can be rewritten as

$$\varepsilon_i^d = \gamma_1^d \left(p_i^d q_i^{d*}\right)^{\gamma_1^d - 1} p_i^d - \alpha_{1i}^d - \alpha_2^d q_i^{d*} \quad (5.16)$$

where p_i^d is the price per live hog received by farmer i and q_i^{d*} is his optimal production-level decision. Hence, the likelihood function for the sample of farmers using marketing arrangement d can be written as

$$L = \prod_{i=1}^{N^d} f\left(\varepsilon_i^d \mid \gamma_1^d,\ \phi^d,\ \alpha_2^d,\ \left(\sigma_\varepsilon^d\right)^2\right) \left| \frac{\partial \varepsilon_i^d}{\partial q_i^d} \right| \quad (5.17)$$

where $f(\cdot)$ is the normal density and

$\left| \frac{\partial \varepsilon_i^d}{\partial q_i^d} \right| = \left| \gamma_1^d \left(\gamma_1^d - 1\right) \left(p_i^d q_i^{d*}\right)^{\gamma_1^d - 2} \left(p_i^d\right)^2 \right|$ is the Jacobian part of the derived likelihood. The purpose of the estimation is to recover the model primitives, that is, the farmers' risk aversion parameter, the cost function parameters, and the distribution of the unobserved heterogeneity. More specifically, we must estimate the parameter vector $\Delta = \left(\gamma_1^d, \phi^d, \alpha_2^d, \left(\sigma_\varepsilon^d\right)^2\right)$ from the data on individual hog farmer's production-level choices. The estimation method used is maximum likelihood.

To assess how our specification fits the data, we performed a formal statistical model selection test against an alternative specification. Here, using the same reduced form specification for the cost function, we consider the case of a risk-neutral farmer whose maximization problem can be written as

$$\max_q \quad pq - C(q)$$

$$= \max_q \quad pq - \lambda_0 \quad \lambda_1 q \ \frac{\lambda_2}{2} q^2 - \epsilon q. \tag{5.18}$$

This specification is a special case of our model with $\gamma = 1$. It is also empirically indistinguishable from the specification $(pq - C(q))^\gamma$ because the two have the same first order conditions. As we show in the next section, the data reject this specification in favor of Eq. (5.13).

5.3.3 Estimation Results

We estimated the model using ARMS data for 2004. The details about the data set are presented in Appendix C, and the estimation results are summarized in Table 5-3. We estimated two models: one with the subsample of farmers who are using the cash/marketing arrangements and another with the subsample of farmers who are using production contracts. As mentioned in Appendix C, to account for possible systematic differences across farmers, we choose x = {cons, farmtype, farmsize, east, midwest, offincome, age, educ, nfamily, nfasset}. The log likelihood at convergence is positive because at the estimated parameter values, the log of the Jacobian part of the likelihood function Eq. (5.17) is positive. Several estimation results are worth emphasizing.

Table 5-3. Estimation Results for the Risk and Contract Choice Model

	Cash/Marketing Arrangements		Production Contracts	
Variable	**Estimate**	**t-stat**	**Estimate**	**t-stat**
constant	81.0420	9.4151	6.2387	4.6690
farmtype	–14.6510	–10.8580	–2.4581	–4.8477
farm acreage	–2.1846	–7.5809	–0.3879	–4.2154
east location	9.0361	3.2341	–1.1372	–2.2441
midwest location	–0.8324	–0.3766	0.3891	0.7161
off farm income	1.0520	11.6200	0.1208	3.3841
age	1.9903	2.1857	0.0327	0.1969
education	0.4190	0.4601	–0.4685	–2.1385
number family members	–0.2258	–0.4909	0.0563	0.4188
nonfarm assets	–0.9473	–3.8243	–0.0517	–0.9903
α_2	2.9910	4.9307	1.5669	6.5526
σ_ε^2	541.9300	13.5360	5.4501	5.6229
γ_1	0.8187	88.7710	0.5047	14.0090
Log likelihood	629.6880		85.9631	
Number of Observations	457		279	

First, whether the hog operation is the main enterprise on the farm has a significant negative effect on the marginal disutility of production costs, both for cash/marketing farmers and for production contract farmers. This indicates that farms can achieve economic efficiency by specialization. For example, the marginal disutility of production costs is lower by 14.65 utility units for a cash/marketing farmer with specialization in hogs compared with a farmer who does not specialize.

Second, the farm size also has a significant negative effect on the marginal disutility of production costs, both for cash/marketing farmers and for production contract farmers. This indicates that there are returns to scale in hog production. For example, the marginal disutility of costs for a production contract farmer decreases by 0.39 units when the log of his farm acreage increases by 1.

Third, interestingly, the geographic location also affects the farmer's marginal disutility of production costs. Specifically, if a farmer who uses cash/marketing arrangements is located in the East, which includes North Carolina, Virginia, and Georgia, all of which have a limited tradition in hog farming, his marginal disutility is significantly higher compared with the farmers in other regions. However, for a contract operator in the East, which includes North Carolina, the cradle of production contracts, the marginal disutility of production costs is significantly lower compared with farmers in other regions.

Next, the more off-farm income the farmer has, the higher his marginal disutility of producing hogs, whether or not he uses cash/marketing arrangements or production contracts. Having higher off-farm income means having better opportunities for earning income outside of agricultural production.

Also, age has a significant positive effect on the farmer's marginal disutility of production costs if he uses cash/marketing arrangements, but age does not have a significant effect if the farmer is a contract producer. Using this result, we predict a growing popularity of production contracts relative to independent livestock production as the farming population grows older. On the other hand, whether a farmer/operator has at least some college education does not have a significant effect on his marginal disutility of production costs if he uses cash/marketing arrangements but has a significant negative effect if the farmer/operator uses production contracts. Perhaps farmers who have some college education are capable of better understanding contract terms, especially the payment mechanisms, which sometimes can be fairly complicated, and take advantage of the process much better than less educated people.

Finally, the risk adverse parameter γ_1 is estimated to be 0.8187 for farmers who use cash/marketing arrangements and 0.5047 for farmers who use production contracts. Both estimates are highly significant. Also, we strongly reject the hypothesis that $\gamma_1 = 1$ in both groups, which lends strong support for the model specifications in Eq. (5.13). Based on the estimated values of the relative risk aversion coefficients, one can conclude that those farmers who use production contracts are more risk averse than those farmers who use cash/marketing arrangements. The obtained results are consistent with the economic intuition that those farmers who are more risk averse self-select themselves into less risky arrangements.[7]

In production contracts, a significant amount of risk is transferred from a farmer to an integrator or a packer, because payment mechanisms typically insulate contract operators from market price volatilities. The companies that offer contracts are typically quite large and sometimes publicly owned and are therefore better positioned to bear risk than small farmers.

On the other hand, those farmers who use cash/marketing arrangements are exposed to substantially more risk than their contract counterparts. In fact, those farmers who sell their hogs on the spot market bear the entire enterprise risk that consists of price risk, production risk, and market access risk, whereas those using marketing contracts may be able to transfer market access risk and perhaps a portion of the price risk to the contractors.

5.3.4 Risk Aversion and Contract Choice

One way to look at the importance of risk aversion for contract choice is to perform a counterfactual experiment whereby production contracts would be eliminated as a contract choice for a group of farmers. Farmers who originally self-selected themselves into production contracts would suffer a utility loss as a result of being forced into a contract not reflective of their type. To quantify the effects of such a restriction on producers' utility, we run a counterfactual experiment as follows. First, with the estimated model primitives, we can use Eq. (5.16) to recover the unobserved heterogeneity in the disutility of production costs for each farmer in the data set in the following manner:

$$\hat{\varepsilon}_i^d = \hat{\gamma}_1^d \left(p_i^d q_i^d\right)^{\hat{\gamma}_1^d - 1} p_i^d - \hat{\alpha}_{1i}^d - \hat{\alpha}_2^d q_i^d \ . \qquad (5.19)$$

[7] This result is also consistent with the channel contract behavior literature. For example, Pennings and Wansink (2004) also found that risk attitudes varied widely among Dutch hog producers; 39% were risk averse, 4% risk neutral, and 57% were risk seeking. Pennings and Smidts (2000) found that the degree of risk aversion is important in explaining owner-managers' choice between relatively safe fixed-price contracts versus spot market transactions. However, as shown in Pennings and Smidts (2003), more structural organizational behavior, such as owners-managers' design of the production process, is not related to the degree of risk aversion but rather to the global shape of the utility function.

Next, we compute the payoff premium (mark-up) for each farmer as

$$m_i = \frac{p_i^d}{\overline{p}^d} \quad , \tag{5.20}$$

where $\overline{p}^d$ is the average transaction payoff for farmers who use the marketing arrangement *d*. In the rest of this section, we use d = 1 to denote the joint cash (negotiated) and marketing contracts arrangement and d = 2 for production contracts. If the farmer uses cash/marketing arrangements, the payoff is the spot or marketing contract price he received for delivered live hogs. If the farmer uses production contracts, the payoff is the contract payment (service fee) per hog for the husbandry services rendered to the principal.[8]

At this point, we compute the market equilibrium by bringing the packers' derived demand for live hogs into the model. We assume that the inverse factor demands for the live hogs through different channels satisfy the following relationship:

$$\begin{aligned} \overline{p}^c &= \alpha_0 + \alpha_1 Q^c + \alpha_2 Q^p + \alpha_3 \overline{P} + e^c \\ \overline{p}^p &= \beta_0 + \beta_1 Q^c + \beta_2 Q^p + \beta_3 \overline{P} + e^p \quad , \end{aligned} \tag{5.21}$$

where $\overline{p}^c$ and $\overline{p}^p$ are the average prices packers pay for live hogs in cash/marketing and production contracts arrangements, respectively; Q^c and Q^p are quantities of hogs coming through the two channels; $\overline{P}$ is the average price of pork in the downstream market; and e^c and e^p are error terms. Notice that the average contract payment for farmers who use production contracts, $\overline{p}^2$, is different from the average price packers pay for hogs coming from the production contracts channel $\overline{p}^p$. This is because packers also need to pay for feeder pigs, feed, and other inputs they are responsible for supplying under the contract terms. We assume a fixed proportion between the two prices specified by $\overline{p}^2 = f\overline{p}^p$. To

[8] Notice also that the unobserved heterogeneity in the disutility of production costs $\hat{\varepsilon}_i^d$, recovered from Eq. (5.19), can be used to predict q_i^d for each value of p_i^d for all farmers in the data set. The supply response of an increase in price is obtained by using the relationship $q_i^d = q(p_i^d, \hat{\varepsilon}_i^d, \hat{\gamma}_1^d, \hat{\alpha}_{1i}^d, \hat{\alpha}_2^d)$ where $q(p_i^d, \hat{\varepsilon}_i^d, \hat{\gamma}_1^d, \hat{\alpha}_{1i}^d, \hat{\alpha}_2^d)$ is implicitly defined by Eq. (5.19). The corresponding supply elasticity for the cash/marketing channel is 3.02.

close the model, we further assume that the consumers' inverse demand for pork takes the form

$$\overline{P} = \gamma_0 + \gamma_1 Q^c + \gamma_2 Q^p + \gamma_3 \overline{B} + e^P \quad , \tag{5.22}$$

where $\overline{B}$ is the average price of beef, a substitute for pork. This specification captures the fact that hogs through different marketing arrangements may be of different qualities and hence affect pork prices differently. Appendix D describes in detail the data and the estimation procedure used to obtain the estimates of the above factor demand equations for live hogs and the final demand equations for pork.

Now, as an example, let's eliminate the use of production contracts in North Carolina and compute the new market equilibrium prices and quantities. Farmers in North Carolina who originally used production contracts must now use cash/marketing arrangements or shutdown. The new set of average prices $(\overline{p}_n^c, \overline{p}_n^p, \overline{P}_n)$ is found based on the following relationships:

$$\overline{p}_n^c = \hat{\alpha}_0 + \hat{\alpha}_1 \left[\sum_{i=1}^{N^c} \omega_i q_{i,n}^1 (p_{i,n}^1, \varepsilon_{i,n}^1) + \sum_{i=1}^{N^{switch}} \omega_i q_{i,n}^1 (p_{i,n}^1, \varepsilon_{i,n}^{switch}) \right]$$

$$+ \hat{\alpha}_2 \sum_{i=1}^{N^p} \omega_i q_{i,n}^2 (p_{i,n}^2, \varepsilon_{i,n}^2) + \hat{\alpha}_3 \overline{P}_n + \hat{e}^{c,2004}$$

$$\overline{p}_n^p = \hat{\beta}_0 + \hat{\beta}_1 \left[\sum_{i=1}^{N^c} \omega_i q_{i,n}^1 (p_{i,n}^1, \varepsilon_{i,n}^1) + \sum_{i=1}^{N^{switch}} \omega_i q_{i,n}^1 (p_{i,n}^1, \varepsilon_{i,n}^{switch}) \right]$$

$$+ \overline{\beta}_2 \sum_{i=1}^{N^P} \omega_i q_{i,n}^2 \, (P_{i,n}^2, \varepsilon_{i,n}^2) + \hat{\beta}_3 \overline{P}_n + \hat{e}^{p,2004}$$

$$\overline{P}_n = \hat{\gamma}_0 + \hat{\gamma}_1 \left[\sum_{i=1}^{N^c} \omega_i q_{i,n}^1 (p_{i,n}^1, \varepsilon_{i,n}^1) + \sum_{i=1}^{N^{switch}} \omega_i q_{i,n}^2 (p_{i,n}^2, \varepsilon_{i,n}^{switch}) \right]$$

$$+ \hat{\gamma}_2 \sum_{i=1}^{N^p} \omega_i q_{i,n}^2 (p_{i,n}^2, \varepsilon_{i,n}^2) + \hat{\gamma}_3 \overline{B} + \hat{e}^{P,2004} \quad . \tag{5.23}$$

Here, N^c is the number of farmers who used the cash/marketing arrangement in the old scenario and continue using this channel in the new scenario, N^{switch} is the number of farmers who originally used production contracts in the state affected by the hypothetical restriction and now have to switch to the cash/marketing arrangement, N^p is the number of farmers in other states who originally used and will continue to use production contracts because they are not affected by the hypothetical restriction, ω_i is the individual farmer's expansion weight, $q_{i,n}(p_{i,n},\varepsilon_{i,n})$ is the predicted output for farmer i in the new scenario with new price $p_{i,n}$ and new unobserved heterogeneity $\varepsilon_{i,n}$.

The prices that individual farmers will receive in this new scenario are determined as

$$p_{i,n}^1 = m_i \times \overline{p}_n^c; \quad p_{i,n}^2 = m_i \times \hat{f} \times \overline{p}_n^p \tag{5.24}$$

and the unobserved heterogeneity is determined as

$$\varepsilon_{i,n}^1 = \hat{\varepsilon}_i^1; \quad \varepsilon_{i,n}^2 = \hat{\varepsilon}_i^2; \quad \varepsilon_{i,n}^{switch} = \frac{(\hat{\sigma}_\varepsilon^2)^1}{(\hat{\sigma}_\varepsilon^2)^2}\hat{\varepsilon}_i^2 \ , \tag{5.25}$$

with $f = \dfrac{\overline{p}^2}{\overline{p}^p}$. Eq. (5.25) says that for a farmer who is not affected by the restriction, the unobserved heterogeneity will remain the same. However, for a farmer who originally used production contracts in the state with the new restriction, the new unobserved heterogeneity will be equal to his recovered unobserved heterogeneity in production contracts scaled by the variances of the unobserved heterogeneity in the two channels. All above assumptions are reasonable. They imply that a high ability contract grower who received better than average contract payments will transfer his superior skills to another type of marketing arrangement and will remain a high ability producer whose price will exceed the average market price by the same margin. The same argument applies to the unobserved heterogeneity in the disutility of production costs. Finally, we calculate $q_{i,n}$ for all farmers using the first order condition Eq. (5.14) and numerically search for the new set of average prices that clear the market. With the new set of market equilibrium prices, we can predict each farmer's output level and then compute the change in his utility.[9]

The effects associated with this hypothetical restriction can be measured by the *compensating variation*, defined as the amount of money that, when taken away from a farmer after the hypothetical restriction, leaves the farmer just as well off as before. In the case of a gain, it is the maximum amount that the farmer would be willing to pay for the restriction. In the case of a loss, it is the negative of the minimum amount that the farmer would require as compensation for the imposed restriction. The *CV* measure is obtained as the solution to the following relationship:

$$U(R(q_o),C(q_o),\gamma) = U(R(q_n) - CV,C(q_n),\gamma) \ , \qquad (5.26)$$

where q_o is a farmer's production level in the old equilibrium and q_n is a farmer's production level in the new equilibrium under a restriction.[10] A positive *CV* means the farmer benefits from the restriction; a negative *CV* means the farmer loses under the restriction.

The relevant results can be summarized as follows. As a result of a hypothetical ban of production contracts in North Carolina, the average national price in the cash/marketing arrangement will increase from $119.75 to $125.61 per hog. On the other hand, the average contract payment would decrease by about 2%. Different farmers respond to the new market conditions differently. Cash farmers, both those in North Carolina and outside, produce more hogs because the cash price would go up. On the other hand, production contracts farmers in North Carolina, who are the target of this hypothetical restriction, are forced to switch to cash/marketing arrangements, which are inherently more risky than production contracts. Because they

[9] Notice that this model could be used to compute the overall farm-level effects associated with different types of regulatory proposals, provided that the first stage of the model can be estimated. The fact that we do not estimate the first stage of the model forces farmers in unaffected states to remain in their originally chosen marketing arrangements. However, in reality, farmers could switch from cash marketing to production contracts or *vice versa* if the change in relative prices of hogs in two marketing channels is sufficiently large to justify the switch.

[10] For those farmers who switch from the production channel to the cash/marketing channel because of the hypothetical restriction, the revenue function and the cost function also change along with the production level.

are risk averse, they react by reducing their risk exposure and thus reducing their supply by almost 99%.[11] As the result, a typical North Carolina contract farmer's utility loss would amount, on average, to $80,892 per year. This is because highly risk-averse farmers are forced to switch to riskier cash/marketing arrangements. To reduce their risk exposure, they reduce their volume of output and consequently earn much less than before.

5.4 SUMMARY

In this section, we analyzed the transfer of risk from risk-averse farmers to risk-neutral (or less risk-averse) firms (integrators and packers), and the importance of producers' risk aversion for the choice of marketing arrangements in the hog industry. We were able to show the following:

- Different types of marketing arrangements exhibit different price volatilities as measured by the variance of price; thus, they may subject the producers selling their hogs through these channels to different levels of risk. The ordering of marketing arrangements by the risk they carry is quite intuitive:
  - spot/cash market sales;
  - marketing contracts whose pricing formula is based on different spot markets;
  - marketing arrangements whose pricing formula is based on some futures or options price; and
  - other purchase arrangements containing ledgers, windows, and other pricing mechanisms, which may serve to moderate price volatility.

  Most of those variances are statistically significantly different from each other.
- Related to risk shifting associated with production contracts, we found that in a typical contract settlement formula, production contracts eliminate about 94% of the total income variability if one uses income volatility of an independent market hog producer as the benchmark. This is because production contracts insulate growers from both input price and output price

[11] The contract production also drops outside North Carolina by about 4% as a result of slightly lower contract grower payments, and the total number of hogs produced in the United States drops by about 7%.

risks, so the only component of risk remaining is production risk, which is quite small.

- Finally, we showed that farmers who use production contracts are more risk averse than farmers who use cash/marketing arrangements. The obtained results are consistent with the economic intuition that those farmers who are more risk averse self-select themselves into less risky activities. The difference in risk exposure between contract producers and independent farmers is substantial as production contracts eliminate all but 6% of total income volatility. Therefore, it is not surprising that the losses utility associated with forcing producers to market their hogs through channels different from their risk-aversion-preferred marketing arrangement choice are substantial.

6 Measurement of the Economic Effects of Restricting Alternative Marketing Arrangements

This section reports on the effects of restricting AMAs on the markets for hogs and pork. The analysis is comprehensive in the sense that all economic agents are accounted for in the analysis, from the farm gate through retail level. We describe the modeling approach followed by the results of three simulation scenarios below.

6.1 MODELING APPROACH FOR CONDUCTING SIMULATIONS OF RESTRICTIONS ON AMAS IN THE PORK INDUSTRY

The model used to conduct simulations consists of 18 equations—six demand equations for primal pork cuts; six price equations for the primal pork cuts; three input demand equations for negotiated, contract, and packer-owned hogs; and three equations describing supply response of producers in each of the three hog categories. Although the demand equations are strictly at the wholesale level, they are specified as derived demand equations from retail demand for pork and therefore account for any effects of changes in the composition of AMAs on marketing channels downstream from the wholesale level. The main reason for using a disaggregated model is to account for the fact that the three sources of hogs are substitutes in packing and processing of pork, and that these marketing instruments can have different effects on the productivities and cost efficiencies of slaughtering and processing hogs. Moreover, the composition of primal pork cuts produced can be affected by the composition of hogs from the three different sources. Therefore, by disaggregating demand and prices of these cuts, we account for any changes in quality that might occur as a result of altering the composition of the portfolio of hogs slaughtered.

The econometric model used in the analysis is described in detail in Appendix B, and only an overview of its structure is provided here. Particular attention was given to developing the packer behavior component of the model. Specifically, the model developed is built on a general theory of a firm that is engaged in acquiring different inputs (the three types of market hogs), producing, and selling the six different primal pork cuts. Firms are assumed to choose inputs and outputs to maximize profit. Firms are also allowed to be imperfectly competitive in the markets for hogs and markets for the pork cuts. Therefore, care is taken to allow for the influence of packer behavior on pricing of both inputs and outputs. On the input side, market prices adjust to changes in quantities of the three types of hogs and anticipated demand for pork; on the output side, market prices adjust to changes in quantities of the six different pork cuts, given the supply of slaughtered hogs available for processing. Dynamic seemingly unrelated regressions method (DSUR) is used to estimate the nine packer relationships. The reason for selecting this method is to simultaneously account for unit roots in the explanatory variables, dynamics in the weekly behavioral equations, and endogeneity arising from both nonstrict exogeneity of the regressors and possible joint determination of prices and quantities in the market. The DSUR method deals with these issues while at the same time providing for correction of the model so that classical hypothesis testing can be used for hypothesis testing.

Wholesale demand models for the pork cuts were estimated using the absolute price version of the Rotterdam Model. This model produced very reasonable estimates, and the results indicated that the theoretical restrictions held. Parameter estimates of the model were integrated with external estimates of demand for pork as a group to develop unconditional uncompensated demand parameters to use in the analysis.

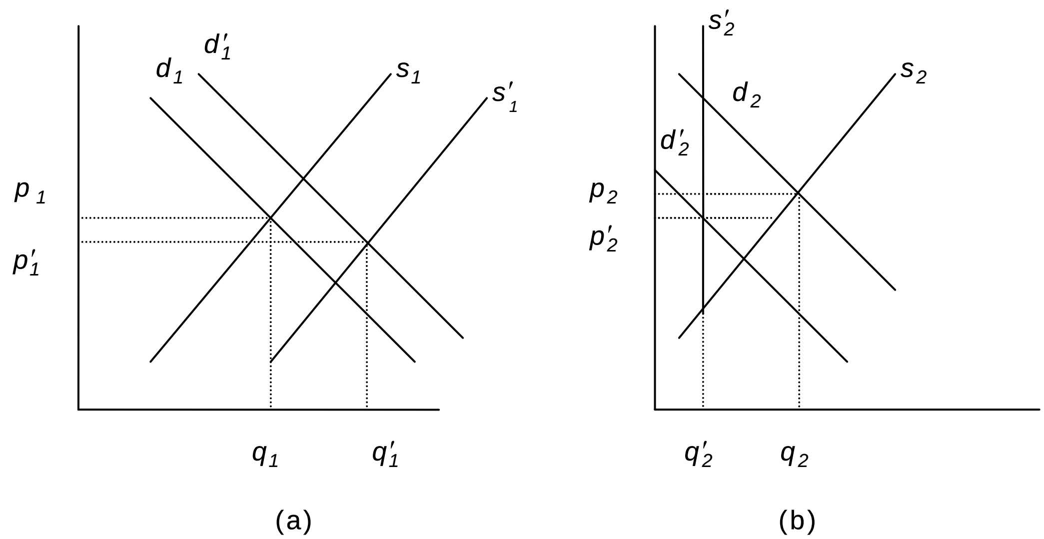
The model was closed with three input supply specifications. The parameter estimates for supply response were developed for two lengths of run—the short run and long run. The short-run estimates assume approximately 1 year for adjustment to any imposed restrictions. The long-run estimates assume a 10-year adjustment to a permanent regulatory change. The supply elasticities for these different lengths of run were obtained from two other detailed studies on producer response in the short run and the long run, both described in Appendix B.

Once the parameter estimates of the 18 equation model were obtained, they were used together with assumed restrictions to simulate changes in prices and quantities of the six pork primals and the three hog types. The quantity and price changes computed are equilibrium changes, meaning that they account for effects on all economic agents—producers, processors, and consumers. Moreover, the markets interact in such a way that new equilibrium levels are reached in response to the regulatory change that occurs.

To understand what is entailed in the analysis, consider a simple scenario where the supply of hogs through AMAs as a group is decreased by a given amount because of restrictions on AMA use. As shown in Figure 6-1, a decrease in supply of hogs from AMAs due to a restriction (panel b) causes the supply curve s_2 to fall and become kinked as shown by s_2'. Because of reduced availability of supplies from that source, packers bid up the price of hogs on the spot market, causing demand to increase from d_1 to d_1' (panel a). In response to the higher price on the spot market, producers will shift out of the AMA supplies market and increase supply of hogs to the spot market causing supply to increase in that market. At the same time, an increased availability of hogs from the spot market causes packers to reduce demand for hogs from AMA supplies causing demand for hogs from AMA markets to decrease.

It is important to recognize that the supply shifts in both markets come about because of the restriction that total supply must equal the sum of supplies to both markets. Even if the supplies in both markets are independent of one another (i.e., do not depend directly on price on the other outlet), it is the

Figure 6-1. Effect on Negotiated Sales and AMA Supplies from a Restriction Reducing Availability of Hogs in the AMA Supplies Market



case that, if supply in one market decreases at a given price (which is the case for AMA supplies), then supply in the other market must increase by that same amount at its original price. *This is because the supply reduction is not voluntary but would come about through a required restriction. Producers are willing to supply the original quantity at the going price in the AMA supplies market so they must be willing to supply the same quantity at that price (net of any transfer costs) in the negotiated market.* Additional adjustments along the supply curves occur as the demand curves shift in response to changes in quantities marketed.

The above description assumes (a) that the different AMAs are substitutes in demand, and (b) that the increase in supply in the spot market exceeds the increase in demand resulting from restricting sales in the AMA supplies market. As shown below in the simulations, both of these assumptions are validated, although for other applications the assumptions may not be valid.

The economic effects of restricting sales for AMA supplies consist of (a) effects on producers selling in the spot market, (b) producers selling in the AMA supplies markets, (c) effects on consumers buying pork products, and (d) effects on packers' net revenues. Comparative static formulas to compute equilibrium changes in the quantities and prices of the six pork cuts and the three hog AMAs were derived from the 18-equation econometric model of the pork/hog industry. Formulas for computing changes in economic surplus on producers, consumers, and packers were then developed. Appendix B provides details on these computations.

Table 6-1 shows the reduced-form, inverse industry derived demand flexibilities for the alternative sources of hog procurement. The total effects show strong substitution among the different AMAs. This pattern of substitution is consistent with the commonly observed phenomena that increased quantities or shares of contract and packer-owned hogs have a depressing effect on the spot price.[1]

Table 6-1. Reduced-Form, Inverse Industry Derived Demand Flexibilities for Hogs from Alternative Market Sources

Market Source	Negotiated	Contract	Packer Owned
Negotiated	–0.26698155	–0.875654	–0.281093
Contract	–0.14678056	–0.536174	–0.166386
Packer Owned	–0.17248395	–0.620852	–0.176251

6.2 RESULTS OF SIMULATIONS OF RESTRICTIONS ON AMAS IN THE PORK INDUSTRY

Three types of simulations were performed: (a) 25% reduction in both contract and packer-owned hogs, (b) increase of the spot/cash market share to 25%, and (c) complete banning of packer-owned hogs. The simulations were performed over both the short run and the long run (10-year adjustment period). The results for changes in prices and quantities are presented as percentage changes from the baseline prices and quantities. The results in the tables for economic surplus effects are presented in terms of percentages of total revenue of hog production or pork production, depending on the economic surplus measure.

[1] See Section 2 for analysis of this issue.

Table 6-2 shows the short-run effects on prices and quantities from Scenario (a)—25% reduction in both contract and packer owned supplies. Over the sample period, August 10, 2001, through September 30, 2005, contract supplies (an aggregate of marketing and production contracts) accounted for approximately 67.3% of the value of all hog marketings, and packer owned supplies accounted for about 19.8%, leaving about 12.9% sold on the spot market. Contract supplies over this time period ranged from about 62.6% to 72.0%, packer owned supplies ranged from approximately 15.4% to 22.5%, and negotiated supplies ranged from approximately 8.9% to 18.5%. At the sample means, 25% reductions in contract and packer owned supplies mean that the share of contract supplies would decline to 50.5% and packer owned supplies would decline to 14.5%, holding total supply fixed. Of course, total supply would be expected to decline somewhat because prices would also be expected to decline. Therefore, the final shares of contract and packer owned supplies would be somewhat different than 50.5% and 14.5%, respectively. At any rate, this simulation would be expected to have rather large effects on prices and quantities, as Table 6-2 shows.

Table 6-2. Percentage Changes in Wholesale Pork Prices and Hog Prices from Scenario (a) (Short Run)

Variable	Percentage Changes in Prices		Percentage Changes in Quantities	
Loin	P1	5.071995	Y1	–6.254235
Butt	P2	6.047142	Y2	–4.321752
Ham	P3	0.129534	Y3	7.824395
Rib	P4	0.811994	Y4	4.340150
Belly	P5	4.280122	Y5	–0.690170
Picnic	P6	4.038218	Y6	2.858603
Negotiated	W1	–8.993384	X1	142.073600
Contract	W2	–3.287139	X2	–25
Packer owned	W3	–4.566955	X3	–25

Negotiated prices (spot market prices) would be expected to decline almost 9%, while unit returns from contracting and packer-owned hogs would be expected to decline 3.3% and 4.6%, respectively. The fact that hog prices would be expected to decline reflects the fact that the net effect of the restriction would reduce efficiencies in processing hogs more than it would offset the decline in market power from reducing AMA supplies. We would also expect to see a rather large increase in hogs supplied on the spot market—predicted to increase some 142% from the original base. As indicated above, the increase comes from supplies diverted from contract and packer owned supplies. The rather large reductions in quantities of contract and packer-owned hogs (given the initial market shares) to meet the 25% reduction criterion mean that supply in the spot market must increase by a rather large amount because of the small initial quantity supplied to the spot market. Average pork production over the sample period was 19,792 million pounds on a per annum basis. Total pounds of hogs (in carcass weight) sold on the spot market was about 2,553 million pounds on a per annum basis. An increase of 142% translates into an increase in spot market sales to approximately 6,178 million pounds. AMA supplies (contract plus packer-owned hogs) were approximately 17,238 million pounds on average over the sample period. With a 25% reduction in supplies, AMA supplies would decrease to approximately 12,929 million pounds. Therefore, the new total quantity of pork produced would be 16,554 million pounds, approximately a 3.6% reduction in total supply of pork. The new percentages of negotiated supplies and AMA supplies would be 32.3% and 67.7%, respectively.

The effect on pork production and pork prices would not be expected to be uniform across the different pork primals. Loins, butts, bellies, and picnics would be expected to experience the largest price increases. Quantities produced and sold would decline significantly for loins and butts, but only slightly for bellies. Quantities sold of the other primal cuts would actually increase, with the largest increase occurring for hams and ribs.

A quality index has been computed to determine how much quality of pork would be affected by the restriction. The quality index is computed as the share-weighted sum of quantities of primal pork cuts, each weighted by its sample average price. The index therefore measures the effects of changes in the composition of cuts within the composite good. Shifts away from cuts with low per-unit value to cuts with high per-unit value would indicate an increase in quality, while shifts away from high-value to low-value cuts would indicate a decrease in quality.[2] The change in quality, as a percentage from its original level, would decrease by 0.9% from a regulated decrease in quantities of contract and packer-owned hogs.

For the quantity of hogs as an input into pork processing, we can also compute a change in quality in the same way we did for the change in quality of pork, by multiplying the share-weighted sum of quantities of hogs from negotiated, contract, and packer owned sources by their sample average prices. Following this procedure for the quantity of hogs slaughtered we find that quality would be expected to decrease by 0.5% from its original level.

Table 6-3 presents economic surplus effects on producers, processors, and consumers from Scenario (a). These changes are shown as percentages of total hog value for producers' surplus, and as percentages of total pork value for processors' net revenue and consumers' surplus. Both producers and consumers lose from this scenario, but processors gain from it. On the face of it, it seems counter-intuitive that processors would gain. However, it is important to understand that packers are market middlemen and can pass on some, all, or even more of the cost increase to consumers and producers. Indeed, in this scenario we find that the average pork price would increase 3.7% and the average hog price would decrease 4.3%. The price spread between farm and wholesale would increase 7.4%.[3] In general, regardless of whether the industry is composed of competitive or imperfectly competitive firms, we would expect profits to increase when input prices fall. For firms exercising market power for the raw material, profits could rise even more (Chen and Lent, 1992). Coupled with an increase in output price, if the effect from a fall in input price is large enough, it could offset the increase in marketing costs arising from a decrease in AMA supplies to cause profits to rise. This is apparently the case when both contract and packer owned supplies are reduced and diverted to the spot market. Indeed, total input expense for hogs for the industry declines by 8.6%,

[2] The quality index is due to Theil (1952–53). Nelson (1991) says that such a measure captures quality changes associated with composite goods like pork.

[3] The percentage change in the price spread is calculated as the percentage change in pork price minus the farm–wholesale farm ratio times the percentage change in hog price, 3.7–(0.85) x (–4.3).

Table 6-3. Effects on Consumer's Surplus, Processor's Net Revenue, and Producer's Surplus from Scenario (a) (Short Run)

Effect	Percentage Changes
Changes in consumer's surplus (% of total revenue of pork)	–3.91821
Changes in processor's net revenue (% of total revenue of pork)	3.220613
Changes in producer's surplus (% of total revenue of hog production)	–18.49855

or almost $1 billion. Total revenue from pork sales in the short run would increase about $0.3 billion. Thus, the increase in value added from hog slaughtering is estimated to be enough to offset the increase in costs from reallocating AMA supplies.

On the production side, it is clear that all producers would be worse off because of a uniform fall in prices received on the spot market and for hogs grown under contract.[4] Total revenue from hog production from August 2001 through September 2005 was about $12 billion. Thus, in the short run, producers would be expected to lose approximately $2.2 billion. The average number of hogs slaughtered was about 98 million, meaning producers would be expected to lose about $22 per hog.

Average total revenue of pork sold by packers was $13 billion over the sample period. The loss to consumers in the short run would be about $507 million per year. The gain to processors would be approximately $419 million per year. The total loss in surplus from the restriction would be about $2.3 billion, with a substantial portion of the burden falling on producers. As indicated at the outset, the scenario of reducing all AMA supplies by 25% is substantial for the hog industry because of the high initial proportion of hogs sold under contract and produced by companies.

The long-run effects of Scenario (a) on prices and quantities are shown in Table 6-4, while the long-run effects on consumers, processors, and producers are shown in Table 6-5.

[4] Changes in producers' surplus for packer owned hogs are included in the effects on processors' net revenue.

Table 6-4. Percentage Changes in Wholesale Pork Prices and Hog Prices from Scenario (a) (Long Run: 10-Year Adjustment Period)

Variable	Percentage Changes in Prices		Percentage Changes in Quantities	
Loin	P1	7.671774	Y1	–9.459999
Butt	P2	9.146756	Y2	–6.536973
Ham	P3	0.195929	Y3	11.83498
Rib	P4	1.228201	Y4	6.564803
Belly	P5	6.474005	Y5	–1.043934
Picnic	P6	6.108108	Y6	4.323851
Negotiated	W1	–5.26687	X1	128.152
Contract	W2	–1.24245	X2	–25
Packer owned	W3	–2.16014	X3	–25

Table 6-5. Effects on Consumer's Surplus, Processor's Net Revenue, and Producer's Surplus from Scenario (a) (Long Run: 10-Year Adjustment Period)

Effect	Percentage Changes
Changes in consumer's surplus (% of total revenue of pork)	–6.084669
Changes in processor's net revenue (% of total revenue of pork)	1.128958
Changes in producer's surplus (% of total revenue of hog production)	–10.35059

These effects, which were computed assuming a 10-year period for adjustment, indicate as one might expect that producers bear a smaller portion of the cost increase, consumers bear a larger portion of the cost increase, and that the effect on processors is now almost neutral. The dollar loss to consumers would be expected to be $791 million, an increase of 56% from the short run. Processors would still gain $147 million after 10 years, although as more time passed they would eventually neither gain nor lose. Producers would lose $1.24 billion, or an average of about $12 per hog marketed.

As a check on the calculations performed for Scenario (a), we developed an alternative model that is more transparent on the workings of the markets. The model consists of monthly supply/demand relationships for hogs and pork. An aggregate farm–wholesale price relationship was estimated as a function of the aggregate price of hogs, production of pork, and index of marketing costs (consisting of labor and energy costs) and the proportion of hogs sold as AMA supplies. A wholesale demand function for pork was also estimated, and the supply elasticities of hogs used for the 18-equation disaggregated model were also used in the analysis to compute short-run and long-run effects. It is difficult to compute economic surplus effects with such an aggregate model because of the diversion of supplies from contracts and packer owned sources to the spot market. However, estimates of changes in prices and quantities can be computed to see what the relative magnitudes are and to compare them with the results we have in Tables 6-2 and 6-4. Appendix B develops these relationships in detail. The reason this model seems appropriate for Scenario (a) is that both contract and packer owned supplies are each changed by the same proportion so the assumptions of the simulation fit with the aggregate model pretty well.

The elasticity of demand for pork at the wholesale level was estimated to be –0.38. The supply elasticity of hogs in the aggregate for the short run was estimated to be 0.79. The parameters of the farm–wholesale price spread include the elasticity of price transmission between the farm and the wholesale level, estimated to be 0.86 and the elasticity of wholesale price with respect to a 1% change in AMA supplies, estimated to be –1.5.[5] Assuming the proportional change in quantity of hogs slaughtered equals the proportional change in quantity of pork produced, we estimate that a 1% decrease in AMA supplies decreases the spot price of hogs by about 0.5%. For the scenario of a 25% reduction in AMA supplies, this would translate into about a 12.5% reduction in the spot price. Note that this price decrease prediction compares with a reduction of about 9% predicted from the disaggregated model (Table 6-2). The main reason for the difference is that the disaggregated model yields a larger elasticity of demand for hogs of about –0.9 by accounting for substitution among different sources of hog procurement. Certainly, this prediction with the monthly

[5] There is also an elasticity of wholesale price with respect to quantity (estimated to be 0.04), but it was ignored in the calculations because it has negligible effects on the results.

model indicates that the predictions from the disaggregated model are not overstated.[6]

Table 6-6 shows the short-run effects on prices and quantities from Scenario (b)—decrease in shares of contract and packer owned supplies to achieve a 25% market share for negotiated sales. To achieve the goal of a 25% market share for spot sales, both contract and packer owned sales would each have to decline by about 14%. This would lead to an increase in hog sales on the spot market by about 71.4%, from approximately 2,553 million pounds to 4,375 million pounds on a per annum basis. AMA supplies would decline from 17,238 million pounds to approximately 14,825 million pounds.

Table 6-6. Percentage Changes in Wholesale Pork Prices and Hog Prices from Scenario (b) (Short Run)

Variable	Percentage Changes in Prices		Percentage Changes in Quantities	
Loin	P1	2.824217	Y1	–3.482518
Butt	P2	3.367203	Y2	–2.406462
Ham	P3	0.072128	Y3	4.356823
Rib	P4	0.452139	Y4	2.416707
Belly	P5	2.383281	Y5	–0.384305
Picnic	P6	2.248583	Y6	1.591743
Negotiated	W1	–5.007746	X1	79.1102
Contract	W2	–1.830363	X2	–13.92064
Packer owned	W3	–2.542997	X3	–13.92064

Spot market prices would be expected to decline about 5% under this scenario, while unit returns for contracting and packer ownership would be expected to decline by 1.8% and 2.5%, respectively. As before, the fact that hog prices would be expected to decline reflects the fact that the net effect of the restriction would be to reduce efficiencies in processing hogs more than it would offset the decline in market power from reducing AMA supplies.

We see very similar effects on pork production and pork prices as Scenario (a). As before, loins, butts, bellies, and picnics

[6] See Appendix B, Attachment 3 for details on the computations with the monthly model.

would be expected to experience the largest price increases. Quantities produced and sold would decline significantly for loins and butts, but only slightly for bellies as before. Also, quantities of hams and ribs sold would increase.

Quality indexes for both pork and hogs fall as before, but by smaller amounts. Quality of pork drops only 0.5% and quality of hogs as an input drops only 0.3%.

Table 6-7 presents economic surplus effects on producers, processors, and consumers from Scenario (b). These effects have the same signs as those indicated for Scenario (a), showing both producers and consumers losing and processors gaining (slightly) in the short run. As before, we find that the average pork price would rise (about 2% on average) and the average hog price would decrease (about 2.4% on average). The price spread between the farm and the wholesale level would increase about 4%. As before, this increase in the price spread is apparently enough to offset (slightly) the increase in costs entailed from reallocating hogs from AMA supplies to the spot market.

Table 6-7. Effects on Consumer's Surplus, Processor's Net Revenue, and Producer's Surplus from Scenario (b) (Short Run)

Effect	Percentage Changes
Changes in consumer's surplus (% of total revenue of pork)	–2.131444
Changes in processor's net revenue (% of total revenue of pork)	1.711562
Changes in producer's surplus (% of total revenue of hog production)	–8.569028

Producers are worse off by about $1.03 billion or $10.50 per hog. Consumers would lose about $277 million per year, and processors would gain about $222 million per year.

The long-run effects of Scenario (b) on prices and quantities are shown in Table 6-8, while the long-run effects on consumers, processors, and producers are shown in Table 6-9. These effects, which are computed assuming a 10-year period for adjustment, indicate as in Scenario (a) that producers bear a smaller portion of the cost increase, consumers bear a larger portion of the cost increase, and the effect on processors is now

Table 6-8. Percentage Changes in Wholesale Pork Prices and Hog Prices from Scenario (b) (Long Run: 10-Year Adjustment Period)

Variable	Percentage Changes in Prices		Percentage Changes in Quantities	
Loin	P1	4.27184	Y1	–5.267569
Butt	P2	5.093148	Y2	–3.639954
Ham	P3	0.109099	Y3	6.590022
Rib	P4	0.683894	Y4	3.65545
Belly	P5	3.604892	Y5	–0.581289
Picnic	P6	3.401151	Y6	2.407631
Negotiated	W1	–2.932727	X1	71.35833
Contract	W2	–0.691827	X2	–13.92064
Packer owned	W3	–1.20282	X3	–13.92064

Table 6-9. Effects on Consumer's Surplus, Processor's Net Revenue, and Producer's Surplus from Scenario (b) (10-Year Adjustment Period)

Effect	Percentage Changes
Changes in consumer's surplus (% of total revenue of pork)	–3.272983
Changes in processor's net revenue (% of total revenue of pork)	0.59449
Changes in producer's surplus (% of total revenue of hog production)	–5.347453

almost neutral. The dollar loss to consumers is expected to be $425 million, almost a doubling from the short run. Processors would gain $77 million after 10 years, although as more time passed they would eventually neither gain nor lose. Producers would lose $642 million per year, or an average of about $6.55 per hog marketed.

Table 6-10 shows the short-run effects on prices and quantities from Scenario (c)—the effects of a complete ban on packer-owned hog production. The effect of a ban on packer owned sales would be for sales in the spot market to increase from 2,553 million pounds carcass weight to 5,967 million pounds on a per annum basis. AMA supplies would decline from 17,238 million pounds to approximately 13,172 million pounds.

Table 6-10. Percentage Changes in Wholesale Pork Prices and Hog Prices from Scenario (c) (Short Run)

Variable	Percentage Changes in Prices		Percentage Changes in Quantities	
Loin	P1	4.844295	Y1	–5.902172
Butt	P2	5.770456	Y2	–4.08273
Ham	P3	0.137115	Y3	7.453754
Rib	P4	0.781763	Y4	4.149452
Belly	P5	4.090397	Y5	–0.650994
Picnic	P6	3.877224	Y6	2.71754
Negotiated	W1	–6.64345	X1	133.8008
Contract	W2	–2.40705	X2	–1.107242
Packer owned	W3	–4.76595	X3	–100

Spot market prices would be expected to decline about 6.6% under this scenario, while unit returns for contracting would be expected to decline by 2.4%. As in the other simulations, the fact that hog prices would be expected to decline reflects the fact that the net effect of the restriction would be to reduce efficiencies in processing hogs more than it would offset the decline in market power from reducing AMA supplies.

The expected effects on pork production and pork prices are that loins, butts, bellies, and picnics would have the largest price increases. Quantities produced and sold would decline significantly for loins and butts, but only slightly for bellies. Also, quantities of hams and ribs sold would increase.

Quality indexes for both pork and hogs fall as in the other simulations. Quality of pork drops 0.8% and the quality of hogs as an input drops 1.2%.

Table 6-11 presents economic surplus effects on producers, processors, and consumers from Scenario (c). These effects have the same signs as those indicated for Scenario (a), showing both producers and consumers losing and processors gaining (slightly) in the short run. As before, we find that the average pork price would rise (on average about 3.5%) and the average hog price would decrease (on average about 3.4%).

Table 6-11. Effects on Consumer's Surplus, Processor's Net Revenue, and Producer's Surplus from Scenario (c) (Short Run)

Effect	Percentage Changes
Changes in consumer's surplus (% of total revenue of pork)	–3.73782
Changes in processor's net revenue (% of total revenue of pork)	0.704409
Changes in producer's surplus (% of total revenue of hog production)	–11.77878

The price spread between the farm and the wholesale levels would increase about 6.5%. As in the other simulations, this increase in the price spread is apparently enough to offset (slightly) the increase in costs entailed from reallocating hogs from AMA supplies to the spot market.

Producers are worse off by about $1.4 billion or $14.42 per hog. Consumers would lose about $485 million per year, and processors would gain about $91 million per year.

The long-run effects of Scenario (c) on prices and quantities are shown in Table 6-12, while the long-run effects on consumers, processors, and producers are shown in Table 6-13. These effects, which are computed assuming a 10-year period for adjustment, indicate as before that producers bear a smaller portion of the cost increase, consumers bear a larger portion of the cost increase, and the effect on processors is now negative. The dollar loss to consumers would be expected to be $736 million, an increase of over 50% from the short run. Processors would lose $108 million per year after 10 years. Producers would lose $739 million per year, or an average of about $7.54 per hog marketed.

6.3 SUMMARY

Three different simulations were performed to evaluate the effects of restricting AMA supplies on hog producers, pork producers, and pork packers. In all three simulations, hog producers lose because of the offsetting effects of hogs diverted from AMA supplies to the spot market. In addition, consumers lose as wholesale and retail pork prices rise. In the short run, packers gain, but in the long run they neither gain nor lose.

Table 6-12. Percentage Changes in Wholesale Pork Prices and Hog Prices from Scenario (c) (Long Run: 10-Year Adjustment Period)

Variable	Percentage Changes in Prices		Percentage Changes in Quantities	
Loin	P1	7.16477	Y1	–8.729382
Butt	P2	8.534572	Y2	–6.038406
Ham	P3	0.202795	Y3	11.02419
Rib	P4	1.156237	Y4	6.137088
Belly	P5	6.049745	Y5	–0.962828
Picnic	P6	5.73446	Y6	4.019274
Negotiated	W1	–3.696744	X1	125.0294
Contract	W2	–0.749186	X2	–1.798047
Packer owned	W3	–2.824136	X3	–100

Table 6-13. Effects on Consumer's Surplus, Processor's Net Revenue, and Producer's Surplus from Scenario (c) (Long Run: 10-Year Adjustment Period)

Effect	Percentage Changes
Changes in consumer's surplus (% of total revenue of pork)	–5.660309
Changes in processor's net revenue (% of total revenue of pork)	–0.829551
Changes in producer's surplus (% of total revenue of hog production)	–6.155498

The reason that producers and consumers lose in all three simulation scenarios is because of efficiency losses from reducing the proportion of hogs sold through contracts and/or packer owned channels. Although a reduction in AMA supplies leads to an improvement for hog producers through a reduction in the degree of market power, the loss in cost efficiencies offsets the gains from reduced market power. In all instances, the price spread between farm and wholesale prices would be expected to increase because of the net increase in the costs of processing. Moreover, wholesale, and hence retail, prices would increase, causing pork to become more expensive for consumers.

7 Implications of Alternative Marketing Arrangements

In this section, we describe the implications of AMAs based on the outcome of the combined set of research activities conducted for the study. First, we describe qualitative results resulting from the interviews with hog producers and pork packers regarding the implications of restricting use of marketing arrangements. Then, we assess the economic implications of and incentives for changes in the use of AMAs in the pork industry in the future.

7.1 EXPECTED EFFECTS OF CHANGES IN MARKETING ARRANGEMENTS BASED ON THE INDUSTRY INTERVIEWS

Prior to conducting the quantitative analyses for this study, we interviewed hog producers and pork packers to obtain qualitative information about the short- and long-term effects of a ban on packer ownership of livestock.

We interviewed pork producers and packers regarding their perception of the short-run and long-term impacts of a ban on packer ownership of hogs. They were asked to identify what adjustments their firm would make to such a restriction.

Three of the eight producers interviewed indicated that there would be no short-term effects on their business if packer ownership was banned. Two others indicated that they currently benefit from packer ownership of hogs through higher prices. They believe that there is competition for hogs between packers that own hogs and those that do not. Other producers thought that a ban on packer ownership of hogs would also restrict pork producers from forming a cooperative to own a packing plant. Some producers saw a benefit to packer ownership because packers could run their plant closer to capacity and because they owned hogs, they did not have an incentive to drive hog prices down.

Although they did not say how they would adjust their businesses, two producers did express concern about packer ownership. One concern was its impact on price discovery, but they felt that MPR had helped with this issue. The second concern was a general concern about the structure of the industry, the loss of medium-sized farms, and a trend toward more vertical integration. Still others believed that retailers had more market power and they were concerned about that issue.

Most of the pork producers interviewed believed that there would be no long-term impact on their firm because of a ban on packer ownership. A minority of those interviewed reported having only one buyer in the immediate area. If packers could not own hogs, they were concerned about competition for the hogs they have to sell if there is a regional monopoly.

Packers identified a variety of immediate adjustments to a ban on packer ownership depending on their current involvement in hog production. Packers that do not use contracts or own hogs said it would have no negative effect on their operations. They believed that they may benefit from having more hogs available on the open market and that the price may be less volatile with more open market hogs. Other packers reported that they would renegotiate marketing contracts with producers and convert contract growers to hog owners with long-term marketing contracts. There was a concern that some producers would not have the financial strength to own the facilities and the hogs and pay for feed and other production costs. Thus, some other party would have to own the hogs in the facilities if the packer cannot. Still other packers that currently own both hogs and packing plants said that they would have to choose which business to sell and which one to keep. Depending on who bought the packing company, or the hogs, it is possible that such a forced sale would lead to greater concentration in that sector of the industry.

As with the short-run implications, packers' perceptions of the long-term impact of a ban on packer ownership of hogs were mixed. Some thought that there would be little impact because there are successful packers that do not own hogs. Others were concerned that it would be more difficult to implement quality programs that have improved consumer demand and made pork more competitive with other meats. Two packers indicated that their greatest concern was the increased risk they face by not having a known supply of hogs for their plants. They also identified a negative impact on company returns from selling a profitable production enterprise. More importantly, they were concerned about a loss of asset value due to the ban. For some locations, the plant has much less value without a known supply of hogs; likewise, the hog facilities may have less value without a known market for the hogs.

Producers and packers were asked about the impact on costs and quality resulting from a ban on packer ownership. Producers did not have a response to either question. Although some packers said that there would be no cost impact from a ban on packer ownership, others identified increased procurement as the important cost. The cost would come from an increased procurement network of buyers and/or buying stations. These costs were estimated to be in the range of $0.20 to $0.53 per head.

The producer and packer interviews identified costs and lost revenue from a ban on packer ownership.

However, the packers that responded to the question about the effect on pork quality from restricting packer ownership felt strongly that pork quality would be negatively affected. They reported that it was very difficult to meet consumer quality expectations with spot market hogs. Specifically, they believed that quality programs like USDA Process Verified could not be met through the open market. As a result, value built in these programs would be lost. Although they recognize the value of the spot market, they believed that marketing agreements and carcass merit programs were necessary to improve pork quality.

The producer and packer interviews identified costs and lost revenue from a ban on packer ownership. Although producers did not quantify the cost, they were concerned in the short run about competition for hogs and plant efficiency that can affect their net prices. Other producers were concerned about packer ownership and its impact on industry structure and price discovery. Producers that are contract growers for a packer would also have to find another party to own the hogs or take on the financing and risk of owning the hogs in their buildings.

Producers did not believe that there would be significant long-run implications of a packer ownership ban.

Packers' responses differed by their current ownership of hogs. Some believed that they would benefit from the ban because it would make more hogs available on the open market. Those that own hogs were concerned about asset values of a forced sale or even which asset to sell—hogs or the plants. They also identified the added cost of procurement, and about half thought that pork quality would be damaged.

The model results in Section 6 estimated a significant cost to the industry from restricting packer ownership of hogs. The interview results do not appear to suggest as large an impact. Most of the producers and half of the packers did not expect there to be a major long-term impact to banning packer ownership. Producers and packers that are heavily invested in systems depending on packer ownership of hogs will have significant changes to their operations. However, they do not represent the entire industry. They and other participants expect they would be able to find ways to work through ownership restrictions over time.

7.2 IMPLICATIONS OF AND INCENTIVES FOR CHANGES IN USE OF ALTERNATIVE MARKETING ARRANGEMENTS OVER TIME

> Based on the evidence from this study, we expect the use of AMAs in the hog and pork industry to remain at levels similar to their current levels.

Based on our assessment of the pork industry from the industry interviews, industry surveys, and analyses of the transactions data as well as other public domain data sources, we expect the use of AMAs in the pork industry to remain at levels similar to their current use. Therefore, we predict that it is extremely unlikely that the industrialization of the hog industry will mimic the industrialization of the poultry industry (in particular, the broiler industry in which virtually 100% of production takes place on either packer-owned farms or via production contracts with independent growers). Instead, the combination of spot/cash markets, marketing contracts, and packer ownership is likely to prevail in the future, and substantial regional differences between the East (with predominant reliance on production contracts) and the Midwest (spot markets and marketing contracts) are likely to exist in the future.

In the subsections below, we assess the economic incentives for and implications of changes in the use of AMAs in the context of hypothetical restrictions on the use of AMAs given the current levels of AMA use and the current institutional structures within the pork industry.

7.2.1 Assessment of Economic Incentives for Increased or Decreased Use of AMAs

In this section, we summarize our findings related to the economic incentives for changes in the use of AMAs in the pork industry. This discussion is within the context of hypothetical restrictions on the use of AMAs.

Based on the survey results, producers and packers appear to have relatively few incentives to increase the use of AMAs beyond their current levels.

***Summary measure* of the economic incentives associated with use of AMAs.** Buyers and sellers of livestock and meat may have a number of different economic incentives associated with using AMAs or the cash market. Among pork producers that responded to the survey, the three most important reasons for selling their pigs and hogs using cash markets are

- independence—complete control and flexibility of own business (80% of respondents);
- ability to benefit from favorable market conditions (41%); and
- ability to sell pigs and hogs at higher prices (35%).

For the same group, the three most important reasons for using AMAs to sell pigs and hogs are

- the reduction in risk exposure (76% of respondents),
- the reduction in price variability (44%), and
- improvement in securing a buyer (39%).

For packers responding to the survey that only use cash or spot markets for procuring market hogs, the three most important reasons for doing so are

- independence—complete control and flexibility (60%);
- the ability to purchase hogs at lower prices (37%); and
- the ability to secure higher quality hogs (36%).

For packers responding to the survey that use AMAs for procuring market hogs, the three most important reasons for doing so are

- improvement in week-to-week supply management (62%),

- ability to secure higher quality market hogs (60%), and
- better market access (40%).

From these results, we can draw three conclusions. First, the push toward increased pork quality dictated by consumers is unlikely to produce any noticeable shift toward greater use of AMAs because views of different market participants about which marketing arrangement produces higher quality differ. Second, the incentives to stay independent and in full control of their own business counteract the risk-aversion considerations, with the direction of the net effect toward greater use of AMAs being ambiguous and likely very small. Finally, the only strong incentive towards greater use of AMAs seems to be the week-to-week supply management by packers.

Although a reduction in use of AMAs would lead to an improvement for hog producers through a reduction in the degree of market power, the loss in cost efficiencies offsets the gains from reduced market power.

***System-wide long-run effects* of major types of marketing arrangements on the livestock and meat industries.** To examine the long-run effects of AMAs, we calculated the economic implications of several hypothetical regulatory scenarios that would limit or completely eliminate access to one or more of the AMAs. Three types of simulations were performed: (1) 25% reduction in both contract and packer-owned hogs, (2) increase in the spot/cash market share to 25%, and (3) ban on packer ownership of hogs. The results show that, in the long run (10-year adjustment period), hog producers lose because of the offsetting effects of hogs diverted from AMA supplies to the spot market. In addition, consumers lose as wholesale and retail pork prices rise. Packers gain slightly in the first two scenarios but lose in the third scenario. The reason that producers and consumers lose in all three simulation scenarios is because of efficiency losses from reducing the proportion of hogs sold through contracts and/or packer owned channels. Although a reduction in use of AMAs would lead to an improvement for hog producers through a reduction in the degree of market power, the loss in cost efficiencies offsets the gains from reduced market power. In all instances, the price spread between farm and wholesale prices would be expected to increase because of the net increase in the costs of processing through reduction in AMAs.

The *most significant* types of spot market and alternative marketing arrangements based on the likelihood that the arrangement is or will be used extensively in the livestock and meat industries, including the types of

marketing arrangements that are likely to *grow in importance* and use and those that are likely to decrease in importance. Based on the industry survey of pork producers, pork packers, and meat processors, the following tendencies in the use of AMAs were identified:

- Pork producers used a variety of methods to sell pigs and hogs including the spot market, marketing agreements, marketing contracts, and production contracts. According to respondents, selling methods were very similar 3 years ago and are not expected to change within the next 3 years.
- Pork packers used a variety of methods to procure market hogs including the spot market, marketing agreements, marketing contracts, and production contracts. According to respondents, methods for purchasing market hogs were very similar 3 years ago and are not expected to change in the near future.
- The most common meat purchasing method by pork processors was the cash or spot market (less than 3 weeks forward), but some pork processors used forward contracts, marketing agreements and internal company transfers. The respondents expected these shares to be relatively stable over the next 3 years with perhaps a small increase in forward contracting.

We hypothesized that marketing arrangements may be complementary to each other in the sense that implementing one procurement practice may increase the marginal return of the other practice. However, the analyses of the complementarity of marketing arrangements produced inconclusive results.

Summary effects of *combinations of marketing arrangements* across different stages of the supply chain (e.g., used by a combination of producers, packers, retailers, food service operators, exporters). Based on the available data and the analyses conducted for the study, we can only draw general conclusions about the combinations of marketing arrangements used upstream. Based on the observation that packers use alternative marketing (procurement) arrangements in clusters (portfolios), we hypothesized that marketing arrangements may be complementary to each other in the sense that implementing one procurement practice may increase the marginal return of the other practice. However, the analyses of the complementarity of marketing arrangements produced inconclusive results. Although some simpler tests based on the correlation/association approach indicate that marketing contracts are in fact complementary to production contracts and/or packer owned arrangements, the portfolio coefficients in the performance equations based on either EBIT or gross margin do not monotonically increase with the portfolio order.

In other words, all marketing arrangements portfolios improve plant performance relative to the simple spot market purchases, but the three-marketing-arrangement portfolio effect is smaller than the two-marketing-arrangement portfolio effect. However, looking at the average price packers pay to procure their hogs, the results indicate that plants that use a combination of higher-order marketing arrangements on average pay lower prices for their hogs relative to plants that use the cash/spot market only. In addition, comparing the magnitudes of the portfolio effects with the magnitudes of the individual marketing arrangement effects shows that individual marketing arrangements have minimal additional impact on the average price (i.e., the portfolio system categorical variables capture almost the entire effect on lowering the average price).

Hypothetical restrictions on the use of AMAs would be expected to decrease consumer demand for pork because of reduced quality.

Major summary effects of AMAs on consumer demand. Consumer demand for meat is affected by the use of AMAs if those arrangements allow for the production of higher quality products and/or sale of pork products at lower prices. Based on the model simulations of reductions in using AMAs, we found a reduction in quantity demanded of all pork products as the average wholesale and retail prices of pork rise. The product mix of pork would be expected to shift away from loin and butts to ham and ribs under all scenarios. In addition, the analysis of the effects of AMAs on quality found that marketing contracts (especially other purchase arrangements and other market formula purchases) consistently yield higher quality hogs than negotiated (spot) purchases.

7.2.2 Implications of Expected Changes in Use of AMAs Over Time

In this subsection, we summarize our findings related to the implications of expected changes in the use of AMAs in the hog industry. This discussion is within the context of hypothetical restrictions on the use of AMAs.

Implications of changes in use of marketing arrangements on price discovery. Price discovery refers to the process by which a buyer and seller agree on a price for a specific transaction. Price discovery thus depends on the pricing method used for each type of marketing arrangement. The typical association between type of marketing arrangements and types of pricing methods in the hog and pork industries is as follows:

- Auction barns: auction pricing
- Direct trade and dealers/brokers: individually negotiated pricing
- Procurement or marketing contracts: formula pricing
- Forward contracts: formula pricing
- Marketing agreements: formula pricing
- Production contracts: compensation payment
- Packer ownership: internal transfer pricing

In the case of formula pricing, base prices are generally established based on publicly reported prices. For these types of transactions, the price reporting process is impeded only if the base price does not reflect current and expected supply and demand conditions. Because prices are reported under MPR for different types of marketing arrangements, the effect of the use of AMAs on the price discovery process is minimal.

Analyses of MPR and individual transactions data found that packers exercise some degree of market power in the procurement of live hogs. The MPR data analysis ties market power to the increased use of AMAs, whereas analysis of transactions data suggests that industry concentration might be a possible explanation of the source of market power.

Implications of expected changes in the use of marketing arrangements on *thin markets*. Markets are considered thin when the volume of transactions is so few that prices are highly volatile and transaction prices do not always reflect prices in other markets with the same quality of livestock or meat. Based on the individual transactions data, we found substantial intraday volatility in the spot market for live hogs. On average, the price dispersion is about 40% of the average value of the transaction prices each day. One part of this broad price dispersion can be explained by factors such as region, quality, or plant size. The rest must be due to organizational issues related to supply chain management or concentration in the pork processing sector. Statistical analyses of MPR data indicate that the wedge between spot price and unit returns from use of AMAs increases as the share of AMA supplies in hog slaughter increases, suggesting increased market power of packers. However, using the individual plant-level transaction data, the source of market power cannot be econometrically linked to use of AMAs for procuring live hogs, thus suggesting the traditional oligopsony story (concentration) as a possible explanation of the source of market power. The fact that spot prices are used extensively as the formula base for formula pricing in marketing contracts transmits the effect from the spot market to AMAs. The fact that increased use of AMAs may be the main source of market power transmits the effect from the AMAs to the spot market. Based on the completed analyses, the direction of the causality is ambiguous.

The most risky marketing arrangement for producers is the spot market, and the least risky marketing arrangement is production contracts.

Implications of expected changes in use of marketing arrangements on *risk management*. Different types of marketing arrangements exhibit different price volatilities; thus, they may subject the producers selling their hogs through these channels to different levels of risk. The most risky marketing arrangement for producers is the spot market, and the least risky marketing arrangement is production contracts. Regarding risk shifting associated with production contracts, we found that relative to the spot market, production contracts transfer about 94% of the total income variability from the contract grower to the integrator or packer. We also showed that producers who use production contracts are more risk averse than producers who use cash/marketing arrangements. This is consistent with the economic intuition that those economic agents who are more risk averse self-select themselves into less risky activities. Therefore, it is not surprising that economic losses associated with forcing producers to market their hogs through channels different from their risk-aversion-preferred marketing arrangement choice are substantial.

The competitiveness of pork relative to other meats, poultry, and fish will decline relative to a scenario without hypothetical restrictions on the use of AMAs.

Implications of expected changes in use of marketing arrangements on *competitiveness among meats*. Competitiveness among meats changes if prices or quality of products changes. Based on the simulations conducted in this volume, hypothetical restrictions on the use of AMAs decrease the quality and increase the price of pork products. Measures of the cross-price elasticities of demand between pork and other protein sources indicate that these products are substitutes. Thus, the competitiveness of pork relative to other meats, poultry, and fish will decline relative to a scenario without hypothetical restrictions on the use of AMAs.

Implications of expected changes in the use of marketing arrangements on *ease of entry* into each stage of the livestock and meat industries. One aspect of the problem of entry refers to whether individuals who would like to enter the business of producing and selling live hogs are easily able to do so. The other aspect refers to the ease of entry into pork packing. The ease of entry into the production of live hogs is affected by the availability of AMAs in a particular region. Historically, it has been well documented that spot markets

> The analyses conducted for this study show the industry exhibits decreasing average cost curves for a fairly wide range of outputs, thus indicating that entry may be difficult because any potential entrant will have to operate at a fairly large scale to be competitive.

were becoming thinner and that the importance of AMAs has grown over time. However, this trend seems to have stopped, and the industry interview responses and the industry survey results indicate that market participants are not expecting any major changes in the composition of procurement methods for live hogs in the near future. In terms of ease of entry into pork packing, the analyses conducted for this study show that the industry exhibits decreasing average cost curves for a fairly wide range of outputs. This indicates that entry may be difficult because any potential entrant will have to operate at a fairly large scale to be able to compete with the incumbents who will clearly have significant cost advantages as the consequence of their size.

Implications of expected changes in the use of marketing arrangements on *concentration* in livestock production and feeding and in meat packing, *structure* of the livestock industry, and *structure* of the meat packing industry. Based on the analyses conducted for this study, as well as the industry interviews and the survey results, we believe that changes in the use of AMAs in procuring live hogs will exert no significant impact on the pork industry's concentration and structure. However, given the fact that meat packing exhibits significant economies of scale and that larger plants are more likely to rely more heavily on AMAs to procure their hogs, the causality could be reversed. It is conceivable that the emergence of additional large plants might stimulate the change in the composition of procurement methods toward more significant reliance on AMAs and away from the spot markets, but the change would likely be small given that the spot market currently comprises only 11% of transactions.

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Appendix A: Summary of Hog Price Data from the Packer Transactions Data

Table A-1. Hog Price Summaries from Pork Packers' Transactions (Purchase) Data, October 2002–March 2005

	All Plants												Converted Hog Price Using Pricing Units[a]	National Hogs Weighted Average Base Price (MPR)[b]
	$/cwt, Liveweight				$/cwt, Carcass Weight						Conversion Ratio =Carcass/Live weight			
Year/ Week	(1) avg_hogp_3	Std. Dev. of (1)	(2) avg_basep_3	Std. Dev. of (2)	(3) avg_hogp_4	Std. Dev. of (3)	(4) avg_basep_4	Std. Dev. of (4)	Hog Price Ratio=(1)/(3)	Base Price Ratio=(2)/(4)	Pricing Unit=3	Pricing Unit=4		
2002W40	38.81	5.35	37.83	5.50	44.88	5.87	42.63	5.94	0.86	0.89	0.73	0.75	48.66	42.3
2002W41	38.91	5.26	37.88	5.59	45.06	5.99	42.79	5.96	0.86	0.89	0.73	0.75	48.85	43.67
2002W42	35.56	5.38	34.57	5.75	42.36	6.76	40.13	6.42	0.84	0.86	0.71	0.75	45.53	43.56
2002W43	32.15	5.35	31.18	5.52	39.72	8.07	37.63	8.11	0.81	0.83	0.72	0.75	42.07	38.74
2002W44	34.54	5.71	33.42	5.48	41.37	7.50	39.32	7.63	0.83	0.85	0.73	0.75	44.23	35.58
2002W45	34.91	5.58	33.91	5.92	42.26	7.59	40.11	7.40	0.83	0.85	0.73	0.75	45.06	38.79
2002W46	33.86	5.17	32.75	5.29	41.04	7.58	38.93	7.52	0.83	0.84	0.73	0.75	43.70	38.32
2002W47	35.62	5.25	34.43	5.30	42.40	7.01	40.31	7.09	0.84	0.85	0.73	0.75	45.25	37.58
2002W48	37.67	5.20	36.60	5.36	44.48	6.68	42.40	6.60	0.85	0.86	0.73	0.75	47.55	39.86
2002W49	37.54	5.37	36.51	5.55	44.49	7.05	42.37	6.80	0.84	0.86	0.73	0.76	47.52	42.93
2002W50	36.69	5.38	35.71	5.51	43.87	6.96	41.72	6.76	0.84	0.86	0.73	0.76	46.47	41.76
2002W51	37.02	5.39	35.62	5.49	43.46	6.81	41.30	6.69	0.85	0.86	0.72	0.76	46.30	41.31
2002W52	37.09	5.15	35.93	5.53	44.06	6.54	41.88	6.51	0.84	0.86	0.73	0.76	46.85	40.83
2003W01	37.42	5.76	36.33	6.09	44.66	6.52	42.58	6.41	0.84	0.85	0.73	0.76	47.80	42.06
2003W02	39.22	5.00	38.21	5.32	45.24	5.75	42.99	5.57	0.87	0.89	0.72	0.76	49.09	42.25
2003W03	41.34	5.86	40.26	6.44	47.54	5.59	45.21	5.24	0.87	0.89	0.73	0.76	51.24	44.85
2003W04	41.28	5.69	40.17	5.85	47.50	5.85	45.11	5.34	0.87	0.89	0.74	0.76	51.50	46.87
2003W05	41.30	5.83	40.12	6.13	47.66	5.96	45.25	5.51	0.87	0.89	0.74	0.76	51.88	46.51
2003W06	40.98	5.40	40.00	5.80	47.65	6.21	45.23	5.70	0.86	0.88	0.73	0.76	51.45	46.6
2003W07	40.97	6.29	39.71	6.36	47.76	6.07	45.22	5.54	0.86	0.88	0.74	0.76	51.26	46.48
2003W08	40.43	5.49	39.40	5.79	47.09	5.93	44.60	5.56	0.86	0.88	0.73	0.76	50.87	46.35
2003W09	40.92	5.84	39.55	5.73	47.39	5.90	44.86	5.63	0.86	0.88	0.73	0.76	51.30	45.79
2003W10	41.31	6.00	40.11	5.95	48.10	5.64	45.60	5.48	0.86	0.88	0.73	0.76	52.02	46.3
2003W11	41.93	5.69	40.72	5.87	48.85	5.79	46.29	5.50	0.86	0.88	0.73	0.76	52.67	47.82
2003W12	42.35	5.38	41.11	5.77	48.86	6.01	46.35	5.63	0.87	0.89	0.73	0.76	52.97	48.38

(continued)

Table A-1. Hog Price Summaries from Pork Packers' Transactions (Purchase) Data, October 2002–March 2005 (continued)

	All Plants													
	$/cwt, Liveweight				$/cwt, Carcass Weight						Conversion Ratio =Carcass/Live weight			
Year/ Week	(1) avg_hogp_3	Std. Dev. of (1)	(2) avg_basep_3	Std. Dev. of (2)	(3) avg_hogp_4	Std. Dev. of (3)	(4) avg_basep_4	Std. Dev. of (4)	Hog Price Ratio=(1)/(3)	Base Price Ratio=(2)/(4)	Pricing Unit=3	Pricing Unit=4	Converted Hog Price Using Pricing Units[a]	National Hogs Weighted Average Base Price (MPR)[b]
2003W13	41.07	5.64	39.75	5.91	47.44	6.23	44.99	5.90	0.87	0.88	0.73	0.76	51.58	48.16
2003W14	41.21	5.50	40.26	5.64	48.09	6.03	45.68	5.74	0.86	0.88	0.73	0.76	52.19	46.15
2003W15	41.63	5.33	40.35	5.58	47.76	6.34	45.31	5.98	0.87	0.89	0.72	0.75	51.80	47.39
2003W16	42.12	5.93	41.27	6.07	49.51	5.41	46.95	5.22	0.85	0.88	0.72	0.76	53.21	46.28
2003W17	45.35	6.06	44.69	6.29	52.88	5.81	50.27	5.25	0.86	0.89	0.72	0.76	57.26	49.79
2003W18	47.54	5.70	46.86	6.01	54.36	5.59	51.80	5.12	0.87	0.90	0.72	0.76	59.16	52.94
2003W19	50.52	6.01	49.85	6.32	57.71	5.51	54.98	4.94	0.88	0.91	0.71	0.76	62.41	56.34
2003W20	52.38	6.69	51.76	6.95	59.66	6.23	57.03	5.41	0.88	0.91	0.73	0.76	64.79	59.41
2003W21	51.34	7.03	50.64	7.33	58.08	6.44	55.50	5.54	0.88	0.91	0.70	0.76	63.24	61.11
2003W22	52.02	6.47	51.25	6.87	59.45	5.85	56.89	5.24	0.87	0.90	0.72	0.76	64.64	58.23
2003W23	55.02	6.99	54.24	7.40	62.56	6.28	60.00	5.49	0.88	0.90	0.71	0.76	67.88	61.46
2003W24	55.79	6.96	55.03	7.36	63.29	6.49	60.71	5.69	0.88	0.91	0.73	0.76	68.66	64.95
2003W25	54.88	7.24	54.15	7.66	62.02	7.08	59.43	6.01	0.88	0.91	0.72	0.75	67.25	65.39
2003W26	51.98	6.82	51.15	7.21	59.38	6.34	56.87	5.48	0.88	0.90	0.72	0.76	64.09	63.05
2003W27	51.93	6.29	51.12	6.71	59.23	5.92	56.74	5.31	0.88	0.90	0.72	0.76	64.40	59.71
2003W28	50.66	6.38	49.93	6.83	57.94	6.07	55.66	5.41	0.87	0.90	0.72	0.76	62.80	60.72
2003W29	50.48	6.59	49.67	6.97	57.65	5.85	55.29	5.31	0.88	0.90	0.72	0.76	62.17	58.44
2003W30	49.85	6.20	49.13	6.60	57.03	5.88	54.62	5.31	0.87	0.90	0.72	0.76	61.83	58.77
2003W31	49.31	6.05	48.57	6.48	56.27	5.83	53.89	5.28	0.88	0.90	0.72	0.76	61.06	57.79
2003W32	49.30	6.15	48.57	6.53	56.55	5.75	54.18	5.18	0.87	0.90	0.72	0.76	61.24	56.84
2003W33	46.37	7.85	45.70	8.08	54.55	6.28	52.21	5.60	0.85	0.88	0.72	0.76	58.87	57.17
2003W34	44.54	6.20	43.88	6.62	51.79	6.65	49.41	6.01	0.86	0.89	0.72	0.76	55.60	53.33
2003W35	42.80	5.79	42.12	6.19	50.20	6.17	47.89	5.77	0.85	0.88	0.72	0.76	54.19	49
2003W36	46.31	6.14	45.63	6.56	53.65	5.22	51.28	5.05	0.86	0.89	0.72	0.75	58.83	48.32
2003W37	49.83	6.24	49.15	6.52	56.99	5.63	54.57	5.05	0.87	0.90	0.71	0.75	62.24	55.09
2003W38	49.90	6.48	49.24	6.79	57.20	6.55	54.83	5.66	0.87	0.90	0.72	0.75	62.34	58.59

(continued)

Table A-1. Hog Price Summaries from Pork Packers' Transactions (Purchase) Data, October 2002–March 2005 (continued)

	All Plants													
	$/cwt, Liveweight				$/cwt, Carcass Weight						Conversion Ratio =Carcass/Live weight			
Year/ Week	(1) avg_hogp_3	Std. Dev. of (1)	(2) avg_basep_3	Std. Dev. of (2)	(3) avg_hogp_4	Std. Dev. of (3)	(4) avg_basep_4	Std. Dev. of (4)	Hog Price Ratio=(1)/(3)	Base Price Ratio=(2)/(4)	Pricing Unit=3	Pricing Unit=4	Converted Hog Price Using Pricing Units[a]	National Hogs Weighted Average Base Price (MPR)[b]
2003W39	47.29	6.56	46.67	6.88	54.36	6.42	52.07	5.59	0.87	0.90	0.72	0.75	58.78	57.92
2003W40	45.36	6.00	44.66	6.26	52.60	6.01	50.29	5.49	0.86	0.89	0.72	0.75	56.55	53.52
2003W41	44.47	5.76	43.78	6.08	52.12	5.95	49.85	5.53	0.85	0.88	0.73	0.75	55.80	52.12
2003W42	43.69	6.07	43.04	6.33	50.88	6.44	48.67	5.91	0.86	0.88	0.73	0.76	54.41	51.76
2003W43	40.43	5.82	39.75	6.09	47.90	6.35	45.79	6.04	0.84	0.87	0.71	0.76	51.13	49.4
2003W44	40.73	5.85	40.13	6.04	48.27	5.69	46.14	5.69	0.84	0.87	0.73	0.76	51.99	46
2003W45	41.11	5.90	40.56	6.00	48.70	5.83	46.65	5.73	0.84	0.87	0.72	0.76	52.27	47.71
2003W46	40.66	5.60	40.04	5.83	48.16	5.92	46.08	5.86	0.84	0.87	0.72	0.76	51.47	47.86
2003W47	39.63	7.11	39.05	7.20	48.06	5.96	46.00	6.10	0.82	0.85	0.73	0.76	51.10	47.39
2003W48	41.33	5.70	40.72	5.98	48.66	5.99	46.56	5.97	0.85	0.87	0.73	0.76	51.95	47.34
2003W49	41.24	5.96	40.65	6.17	48.97	6.30	46.84	6.17	0.84	0.87	0.73	0.76	52.42	47.96
2003W50	41.28	5.77	40.61	5.89	48.81	6.40	46.65	6.39	0.85	0.87	0.73	0.76	51.93	47.71
2003W51	40.45	6.03	39.77	6.24	48.24	6.76	46.02	6.66	0.84	0.86	0.73	0.76	50.94	47.63
2003W52	40.99	5.86	40.31	6.05	48.55	6.02	46.34	6.13	0.84	0.87	0.73	0.76	51.73	45.96
2004W01	43.10	5.82	42.44	6.04	50.44	5.69	48.22	5.78	0.85	0.88	0.73	0.76	54.17	47.57
2004W02	43.02	6.01	42.39	6.18	50.49	5.88	48.21	5.86	0.85	0.88	0.73	0.76	53.80	50.15
2004W03	45.20	5.74	44.52	5.97	52.60	5.44	50.29	5.50	0.86	0.89	0.74	0.76	56.63	49.64
2004W04	47.90	5.71	47.25	6.06	55.02	5.52	52.58	5.32	0.87	0.90	0.74	0.76	59.40	53.74
2004W05	49.21	6.26	48.54	6.63	56.94	5.81	54.45	5.22	0.86	0.89	0.73	0.76	61.18	55.86
2004W06	52.12	6.65	51.45	7.02	59.95	6.12	57.36	5.47	0.87	0.90	0.74	0.76	64.86	58.05
2004W07	52.33	6.86	51.68	7.21	60.05	6.37	57.45	5.66	0.87	0.90	0.74	0.76	64.84	61.45
2004W08	51.32	6.44	50.61	6.84	59.02	6.29	56.41	5.66	0.87	0.90	0.73	0.76	63.24	60.93
2004W09	53.04	6.66	52.29	7.07	60.78	6.05	58.26	5.46	0.87	0.90	0.73	0.76	65.66	59.33
2004W10	53.76	6.96	53.03	7.36	61.58	6.44	59.03	5.72	0.87	0.90	0.74	0.76	66.51	62.67
2004W11	53.57	9.79	52.90	9.95	62.88	6.06	60.36	5.57	0.85	0.88	0.74	0.76	67.80	62.65
2004W12	56.53	7.10	55.83	7.52	64.31	6.59	61.75	5.86	0.88	0.90	0.74	0.76	69.52	65.52

(continued)

Table A-1. Hog Price Summaries from Pork Packers' Transactions (Purchase) Data, October 2002–March 2005 (continued)

	All Plants													
	$/cwt, Liveweight				$/cwt, Carcass Weight						Conversion Ratio =Carcass/Live weight			
Year/ Week	(1) avg_hogp_3	Std. Dev. of (1)	(2) avg_basep_3	Std. Dev. of (2)	(3) avg_hogp_4	Std. Dev. of (3)	(4) avg_basep_4	Std. Dev. of (4)	Hog Price Ratio=(1)/(3)	Base Price Ratio=(2)/(4)	Pricing Unit=3	Pricing Unit=4	Converted Hog Price Using Pricing Units[a]	National Hogs Weighted Average Base Price (MPR)[b]
2004W13	55.49	7.35	54.77	7.74	63.26	6.78	60.72	6.07	0.88	0.90	0.74	0.76	68.35	66.4
2004W14	52.74	7.34	52.05	7.77	60.65	6.87	58.09	6.15	0.87	0.90	0.73	0.76	64.95	64.24
2004W15	53.25	6.83	52.52	7.18	61.51	5.94	58.85	5.54	0.87	0.89	0.73	0.76	66.01	60.01
2004W16	55.89	6.68	55.08	7.23	64.12	6.28	61.47	5.81	0.87	0.90	0.73	0.76	68.78	63.22
2004W17	57.52	6.77	56.77	7.24	67.00	6.36	60.82	10.18	0.86	0.93	0.74	0.76	71.33	66.23
2004W18	61.01	7.79	60.26	8.25	71.62	6.60	67.75	6.80	0.85	0.89	0.73	0.76	75.54	69.62
2004W19	64.87	6.60	64.03	7.16	75.96	6.75	73.51	6.25	0.85	0.87	0.74	0.76	78.39	74.94
2004W20	65.88	7.38	65.04	7.96	78.38	8.00	75.95	7.26	0.84	0.86	0.74	0.76	79.44	80.25
2004W21	64.10	7.86	63.36	8.45	75.19	8.29	72.76	7.48	0.85	0.87	0.73	0.76	77.58	80.6
2004W22	62.30	7.80	61.56	8.37	72.16	7.23	69.71	6.53	0.86	0.88	0.74	0.76	75.93	76.11
2004W23	63.57	6.82	62.82	7.41	73.81	6.99	71.46	6.41	0.86	0.88	0.74	0.76	76.52	73.9
2004W24	64.54	7.39	63.76	7.99	74.98	7.64	72.59	6.86	0.86	0.88	0.74	0.76	77.46	76.97
2004W25	64.82	6.98	64.07	7.49	76.56	7.25	74.11	6.59	0.85	0.86	0.74	0.76	79.01	77.03
2004W26	64.74	7.76	64.04	8.25	75.64	8.10	73.21	7.17	0.86	0.87	0.74	0.76	78.08	79.73
2004W27	63.91	8.25	63.20	8.65	74.83	7.53	72.46	6.75	0.85	0.87	0.74	0.76	77.79	77.3
2004W28	64.79	7.57	64.06	8.11	75.15	7.32	72.69	6.70	0.86	0.88	0.73	0.76	77.46	76.95
2004W29	65.12	7.96	64.35	8.47	74.70	7.40	72.43	6.74	0.87	0.89	0.73	0.76	77.58	77.35
2004W30	64.70	7.54	63.98	8.02	74.88	7.30	72.55	6.68	0.86	0.88	0.74	0.76	77.46	77.04
2004W31	64.22	7.35	63.52	7.79	75.44	7.17	73.16	6.76	0.85	0.87	0.73	0.76	78.27	77.47
2004W32	64.91	8.13	64.14	8.65	75.00	7.62	72.82	7.00	0.87	0.88	0.74	0.76	77.05	77.79
2004W33	62.99	8.27	62.32	8.84	72.31	7.38	70.13	6.83	0.87	0.89	0.74	0.76	75.86	76.03
2004W34	60.96	7.37	60.24	7.90	70.16	6.88	68.13	6.40	0.87	0.88	0.74	0.76	74.58	72.86
2004W35	59.54	7.35	58.77	7.73	68.78	6.46	66.72	6.12	0.87	0.88	0.74	0.76	73.28	71.28
2004W36	59.66	7.90	58.84	8.25	68.20	6.48	66.14	6.08	0.87	0.89	0.73	0.76	72.50	70.56
2004W37	60.49	7.20	59.72	7.63	69.73	6.00	67.67	5.74	0.87	0.88	0.74	0.76	74.14	70
2004W38	63.46	6.11	62.68	6.63	74.38	6.16	72.22	6.10	0.85	0.87	0.73	0.76	76.79	74.02

(continued)

Table A-1. Hog Price Summaries from Pork Packers' Transactions (Purchase) Data, October 2002–March 2005 (continued)

	All Plants													
	$/cwt, Liveweight				$/cwt, Carcass Weight						Conversion Ratio =Carcass/Live weight			
Year/ Week	(1) avg_hogp_3	Std. Dev. of (1)	(2) avg_basep_3	Std. Dev. of (2)	(3) avg_hogp_4	Std. Dev. of (3)	(4) avg_basep_4	Std. Dev. of (4)	Hog Price Ratio=(1)/(3)	Base Price Ratio=(2)/(4)	Pricing Unit=3	Pricing Unit=4	Converted Hog Price Using Pricing Units[a]	National Hogs Weighted Average Base Price (MPR)[b]
2004W39	63.75	7.14	63.01	7.59	75.97	7.22	73.84	6.90	0.84	0.85	0.74	0.76	77.60	79.76
2004W40	64.07	8.08	63.26	8.64	73.42	7.87	71.37	7.20	0.87	0.89	0.73	0.76	76.04	78.67
2004W41	60.48	9.08	59.76	9.51	68.98	7.72	67.06	6.93	0.88	0.89	0.73	0.76	72.40	74.03
2004W42	58.66	7.83	57.98	8.28	66.62	6.56	64.68	5.91	0.88	0.90	0.74	0.76	71.00	68.51
2004W43	58.71	7.14	57.98	7.60	67.34	6.35	65.44	5.84	0.87	0.89	0.74	0.76	72.21	68.33
2004W44	60.47	7.25	59.80	7.71	69.12	5.81	67.23	5.54	0.87	0.89	0.74	0.76	72.98	70.01
2004W45	60.84	7.03	60.10	7.48	71.15	6.61	69.37	6.16	0.86	0.87	0.74	0.76	74.16	73.96
2004W46	61.77	7.00	60.99	7.42	73.29	6.50	71.53	6.06	0.84	0.85	0.74	0.76	75.90	74.64
2004W47	62.14	7.59	61.35	8.02	73.47	7.30	71.61	6.63	0.85	0.86	0.74	0.76	75.76	77.67
2004W48	63.26	7.17	62.46	7.62	74.87	6.50	73.10	6.09	0.84	0.85	0.74	0.76	77.38	75.78
2004W49	63.63	7.49	62.97	7.97	74.79	7.94	73.10	7.31	0.85	0.86	0.74	0.76	76.35	80.33
2004W50	57.57	10.73	56.92	10.95	68.53	8.32	66.80	7.48	0.84	0.85	0.74	0.76	71.24	76
2004W51	53.46	10.68	52.79	10.94	63.14	7.32	61.37	6.54	0.85	0.86	0.74	0.76	67.40	67.39
2004W52	54.83	6.95	54.11	7.52	61.58	5.57	59.73	5.18	0.89	0.91	0.74	0.76	65.53	62.27
2005W01	57.59	7.06	56.85	7.48	65.92	5.37	64.05	5.32	0.87	0.89	0.74	0.76	70.12	63.68
2005W02	58.66	8.26	57.91	8.70	68.41	6.43	66.52	5.96	0.86	0.87	0.74	0.76	72.63	70.58
2005W03	60.88	7.52	60.08	8.06	69.60	6.20	67.72	5.85	0.87	0.89	0.74	0.76	73.65	70.23
2005W04	61.22	7.56	60.42	8.11	70.69	6.36	68.83	6.08	0.87	0.88	0.74	0.76	74.27	72.56
2005W05	60.61	8.01	59.76	8.61	70.12	7.04	68.11	6.60	0.86	0.88	0.75	0.76	73.86	73.75
2005W06	57.44	7.94	56.64	8.51	66.39	7.27	64.32	6.76	0.87	0.88	0.74	0.76	70.16	71.13
2005W07	55.77	6.93	54.94	7.53	64.28	6.04	62.26	5.71	0.87	0.88	0.74	0.76	68.51	65.61
2005W08	57.78	6.96	56.97	7.51	66.26	5.69	64.20	5.49	0.87	0.89	0.74	0.76	70.56	65.94
2005W09	58.86	7.00	57.97	7.59	66.96	5.76	64.94	5.64	0.88	0.89	0.74	0.76	71.27	69.45
2005W10	61.04	6.76	60.16	7.46	69.85	5.88	67.76	5.89	0.87	0.89	0.74	0.76	73.38	70.45
2005W11	57.79	7.76	56.96	8.37	66.99	7.36	64.96	6.79	0.86	0.88	0.74	0.76	70.13	73.75
2005W12	56.56	7.20	55.79	7.73	65.06	6.14	63.03	5.88	0.87	0.89	0.74	0.76	68.94	66.18

(continued)

Table A-1. Hog Price Summaries from Pork Packers' Transactions (Purchase) Data, October 2002–March 2005 (continued)

	All Plants													
	$/cwt, Liveweight				$/cwt, Carcass Weight						Conversion Ratio =Carcass/Live weight			
Year/Week	(1) avg_hogp_3	Std. Dev. of (1)	(2) avg_basep_3	Std. Dev. of (2)	(3) avg_hogp_4	Std. Dev. of (3)	(4) avg_basep_4	Std. Dev. of (4)	Hog Price Ratio=(1)/(3)	Base Price Ratio=(2)/(4)	Pricing Unit=3	Pricing Unit=4	Converted Hog Price Using Pricing Units[a]	National Hogs Weighted Average Base Price (MPR)[b]
2005W13	55.58	7.16	54.83	7.67	64.00	6.14	62.04	5.81	0.87	0.88	0.75	0.76	68.25	66.33
Average	50.94	6.66	50.13	7.02	59.14	6.46	56.84	6.07	0.86	0.88	0.73	0.76	62.90	59.56

[a] Simple weekly average of converted hog price ($/cwt, carcass weight) using the pricing unit variable provided in the pork packers' transaction data set.

[b] From various issues (2002, 2003, 2004, and 2005) of *Annual (Carlot) Meat Trade Review: Meat, Livestock & Slaughter Data*, USDA.

Table A-2. Testing the Hypothesis of Same Means for Three Price Series: Two-Sample Equal Mean t-test (H_o: difference=0 vs. H_a: difference ≠0)

Difference	t value	P value
mean(*avg_basep_4*) – mean(*mpr_p*)[a]	–1.86	.0634
mean(*avg_basep_4*) – mean(*convert_p*)	–4.54	.0000
mean(*convert_p*) – mean(*mpr_p*)	2.31	.0219

[a] We cannot reject the null hypothesis of equal means at the 5% significance level.

Table A-3. Correlation Coefficient Analysis for Three Price Series[a]

Variable	*avg_basep_4*	*convert_p*	*mpr_p*
avg_basep_4	1	0.9946	0.9891
convert_p	—	1	0.9850
mpr_p	—	—	1

[a] All P values are less than .0001.

B Economic Effects of Restricting AMAs in the Hog and Pork Industries

In this appendix, we present a model for estimating the economic effects associated with restricting marketing arrangements used in the hog and pork industries. We use the results of this modeling exercise in Sections 2, 3, and 6 of this report volume.

B.1 MODEL SPECIFICATION

The model to be used for estimation assumes that all commodities produced and all raw materials procured are homogenous. The profit function of the *i*th firm is

$$\begin{aligned}\pi^i &= \sum_{j=1}^{J} P_j(Y_1, Y_2, \ldots, Y_J) Y_j^i - C^i(Y_1^i, Y_2^i, \ldots, Y_J^i, X_1^i, X_2^i, \ldots, X_K^i, \mathbf{W}^-) \\ &- \sum_{k=1}^{K} W_k(X_1, X_2, \ldots, X_K) X_k^i ,\end{aligned} \tag{B.1}$$

where price of the *j*th output is P_j, quantity of firm *i*'s *j*th output is Y_j^i, W_k is the price of the raw material from the *k*th source, X_k^i is the quantity of the raw material purchased by the *i*th firm from source *k*, $P_j(Y_1, Y_2, \ldots, Y_J)$ is the demand function for output *j* facing each firm in the industry, $W_k(X_1, X_2, \ldots, X_K)$ is the supply function for raw material source *k* facing each firm in the industry, $C^i(Y_1^i, Y_2^i, \ldots, Y_J^i, X_1^i, X_2^i, \ldots, X_K^i, \mathbf{W}^-)$ is the cost function of the *i*th firm, and $\mathbf{W}^-$ represents the vector of variable input prices other than the raw material (e.g., labor, packaging, energy, transportation).

The cost function is derived from the general implicit production function, $F^i(Y_1^i, Y_2^i, \ldots, Y_J^i; X_1^i, X_2^i, \ldots, X_K^i; \mathbf{Z}) = 0$, where $\mathbf{Z}$ represents the vector of input quantities other than the raw material.

The first-order conditions (f.o.c.) for profit maximization under Cournot-Nash equilibrium are as follows[1]:

$$\begin{aligned} \frac{\partial \pi^i}{\partial Y_j^i} &= P_j + \frac{\partial P_j}{\partial Y_j} Y_j^i - \frac{\partial C^i}{\partial Y_j^i} = 0 \\ \frac{\partial \pi^i}{\partial X_k^i} &= -\frac{\partial C^i}{\partial X_k^i} - W_k - \frac{\partial W_k}{\partial X_k} X_k^i = 0 . \end{aligned} \tag{B.2}$$

These conditions hold for $j = 1,\ldots,J; k = 1,\ldots,K; i = 1,\ldots,N.$ Note also that

$$Y_j = \sum_i Y_j^i, \; X_k = \sum_i X_k^i .$$

The first set of equations in Eq. (B.2) shows the relationship between price and marginal cost of each firm's output production decision. Marginal revenue equals marginal cost, with marginal revenue consisting of the sum of the output price and marginal effect of the output on the output price from changes in the firm's output. The second set of equations in Eq. (B.2) shows the relationship between the raw product price from different sources and the firm's marginal input costs. If the firm can influence the price of the raw material through changes in its input purchases, the input price will change in response to a change in the firm's input purchase. In both cases of output and input decisions, these specifications show that there can be a wedge between price and marginal cost. In the case of output price, price could be above marginal cost. For input decisions, the raw material price could be below its marginal cost to the firm.

For empirical work, functional forms must be chosen for the cost function and the demand and supply functions. If the demand and raw material supply functions are linear and the cost function is quadratic, then the f.o.c. given by Eq. (B.2) can be represented as follows:

---

[1] For simplicity, we assumed the firm ignores the influence of other output quantities on own output price and other input quantities on own input price. Making the model more complete by including those cross-quantity effects only complicates the analysis without adding any new insights or different restrictions on the model.

$$P_j - b_{jj}^i Y_j^i - \sum_{l \neq j} b_{jl}^i Y_l^i - \sum_k c_{jk}^i X_k^i = 0 \qquad \text{(B.3)}$$

$$W_k + \sum_j c_{kj}^i Y_j^i + a_{kk}^i X_k^i + \sum_{m \neq k} a_{mk}^i X_m^i = 0 \ .$$

The reduced-form f.o.c. in Eq. (B.3), which are derived assuming Cournot behavior, actually depict more general behavior than Cournot. Kadiyali, Sudhir, and Rao (2001) show that under certain conditions the same behavior could result from Bertrand, leader-follower, or collusive behavior. More generally, the conjectural variations framework would also fit into this framework, provided that the Herfindahl index did not change markedly during the sample period. Therefore, the reduced-form f.o.c. in Eq. (B.3) can be taken to represent many alternative market structures.[2] *The significance of this result for this study is that the economic surplus effects account both for any market power effects and for changes in efficiencies resulting from changes in the mix of marketing arrangements.*

For estimation purposes, error terms can be attached to the equations to obtain

$$P_j = \left(b_{jj}^i Y_j^i + \sum_{l \neq j} b_{jl}^i Y_l^i + \sum_k c_{jk}^i X_k^i \right) + \varepsilon_j^i \qquad \text{(B.4a)}$$

$$W_k = -\left(\sum_j c_{kj}^i Y_j^i + a_{kk}^i X_k^i + \sum_{m \neq k} a_{mk}^i X_m^i \right) + \varepsilon_k^i \ , \qquad \text{(B.4b)}$$

where ε_j and ε_k are error terms.[3] Note that the output price and input price specifications have cross-equation restrictions. Therefore, these equations should be estimated as a system of equations with appropriate assumptions on the error terms.

In the empirical application to secondary data, we require aggregate specifications for the equations in Eq. (B.4a) and Eq. (B.4b). After summing across all firms (and dividing by the number of firms [*N*]), we obtain

[2] Note that when there is price-taking behavior, the coefficients directly represent parameters of the cost function.

[3] For sake of presentation, other variable input prices are not included in these equations. They should and could be accounted for in various ways. In the empirical application that follows, no data exist for these variables, but we attempted to control for these effects by including a trend variable and monthly binary variables in the model.

$$
\begin{aligned}
P_j &= b_{jj}Y_j + \sum_{l \neq j} b_{jl}Y_l + \sum_k c_{jk}X_k + \varepsilon_j \\
&+ \sum_l \sum_i (Y_l^i - \overline{Y}_l)[b_{jl}^i (Y_l^i / Y_l) - b_{jl}] / N \\
&+ \sum_k \sum_i (X_k^i - \overline{X}_k)[c_{jk}^i (X_k^i / X_k) - c_{jk}] / N
\end{aligned} \tag{B.5a}
$$

$$
\begin{aligned}
W_k &= -\left(\sum_j c_{kj}Y_j + a_{kk}X_k + \sum_{m \neq k} a_{mk}X_m \right) + \varepsilon_k \\
&- \sum_j \sum_i (Y_j^i - \overline{Y}_j)[c_{kj}^i (Y_j^i / Y_j) - c_{kj}] / N \\
&- \sum_m \sum_i (X_m^i - \overline{X}_m)[a_{mk}^i (X_m^i / X_m) - a_{mk}] / N ,
\end{aligned} \tag{B.5b}
$$

where the *a*'s, *b*'s, and *c*'s are average response parameters of all firms in the industry; $\varepsilon_j = \sum_i \varepsilon_j^i / N$ and $\varepsilon_k = \sum_i \varepsilon_k^i / N$. The additional terms on the right-hand sides of Eqs. (B.5a) and (B.5b) can be viewed as covariances between coefficients of individual firms and the quantities of outputs and inputs selected by the firm. If Y_l^i and b_{jl}^i are stochastic and independent, then the $\text{cov}(Y_l^i, b_{jl}^i) = 0$. Likewise, if X_k^i and c_{jk}^i are independent, then the covariance between these two variables will also be zero. In the same way, we might expect the covariances between Y_j^i and c_{kj}^i and between X_m^i and a_{mk}^i to be zero.

If the above stochastic assumptions hold, then the aggregate counterparts to Eqs. (B.4a) and (B.4b) are simply[4]

$$
P_j = b_{jj}Y_j + \sum_{l \neq j} b_{jl}Y_l + \sum_k c_{jk}X_k + \varepsilon_j \tag{B.6a}
$$

$$
W_k = -\left(\sum_j c_{kj}Y_j + a_{kk}X_k + \sum_{m \neq k} a_{mk}X_m \right) + \varepsilon_k \ . \tag{B.6b}
$$

Therefore, we can view the aggregate-level relationships in every respect as if they represented the average response of all firms in the industry.[5] Aside from the own-quantity variables, the other parameters in Eqs. (B.6a) and (B.6b) correspond to

[4] See Theil (1971, p. 572) for more discussion about the convergence approach to aggregation.

[5] For the data used below, this seems very reasonable because the carlot data on pork cuts are sales of a random sample of firms each week. The MPR data may be viewed as stochastic as well. In both instances, the validity of aggregation hinges on whether firm-level marginal costs do not vary systematically with size of the firm.

the aggregate cost function. If market power is present, then the own-quantity variables reflect the effects of both imperfect competition and curvature of the cost function.

Eqs. (B.6a) and (B.6b) involve a large number of parameters, even for a moderate-sized industry. In the pork industry, there are six primal cuts and three sources of hogs. Even with the symmetry restrictions imposed, this still represents a large number of parameters to estimate. The number of parameters to estimate can be significantly reduced by assuming the aggregate production function is separable in outputs and inputs; that is,

$$F(\mathbf{Y}) = H[G(\boldsymbol{X}), I(\mathbf{Z})] \ . \tag{B.7}$$

With the production function indicated by Eq. (B.7), the aggregate cost function corresponding to the average representative firm can be represented as

$$C = C(\mathbf{Y}, \mathbf{X}, \mathbf{W}^{-}) = C^{*}[F(\mathbf{Y}), G(\mathbf{X}), \mathbf{W}^{-}] \ . \tag{B.8}$$

When the cost function has the quadratic form as indicated in Eq. (B.8), where the functions $F(\mathbf{Y})$ and $G(\mathbf{X})$ are each quadratic linearly homogenous functions, the aggregator functions can be exactly represented by the Fisher Ideal quantity indexes (Diewert, 1976),

$$Y_{Id}(\mathbf{P}^0, \mathbf{P}^1; \mathbf{Y}^0, \mathbf{Y}^1) = [\mathbf{P}^1 \bullet \mathbf{Y}^1 \mathbf{P}^0 \bullet \mathbf{Y}^1 / \mathbf{P}^1 \bullet \mathbf{Y}^0 \mathbf{P}^0 \bullet \mathbf{Y}^0]^{1/2} \tag{B.9a}$$

$$X_{Id}(\mathbf{W}^0, \mathbf{W}^1; \mathbf{X}^0, \mathbf{X}^1) = [\mathbf{W}^1 \bullet \mathbf{X}^1 \mathbf{W}^0 \bullet \mathbf{X}^1 / \mathbf{W}^1 \bullet \mathbf{X}^0 \mathbf{W}^0 \bullet \mathbf{X}^0]^{1/2} \ , \tag{B.9b}$$

and one does not have to estimate the unknown parameters in the aggregator functions $F(\mathbf{Y})$ and $G(\mathbf{X})$.[6]

The implication of the specification indicated by Eq. (B.8) is that the estimating equations can be written with raw materials in Eq. (B.6a) replaced with the aggregator function Eq. (B.9b) and

[6] The aggregator functions for a quadratic form are square root functions of quadratic functions of the components within the aggregator functions.

the pork primals in Eq. (B.6b) replaced with the aggregator function Eq. (B.9a). The new specification becomes[7]

$$P_j = b_{jj}Y_j + \sum_{l \neq j} b_{jl}Y_l + c_j X_{Id} + \varepsilon_j \qquad \text{(B.10a)}$$

$$W_k = d_k Y_{Id} - a_{kk} X_k - \sum_{m \neq k} a_{mk} X_m + \varepsilon_k \quad . \qquad \text{(B.10b)}$$

In addition to conserving degrees of freedom, this specification of packer behavior allows us to separate the input decisions from the output decisions. That is, given total pork output (or anticipated pork demand), packers may be viewed as choosing the mix of raw materials given the prices of the inputs. Alternatively, with the quantities of the hogs to be slaughtered predetermined in the current period, the equations shown in Eq. (B.10b) represent the market prices given the quantities of hogs marketed and the expected pork demand. Likewise, prices of primal cuts in Eq. (B.10a) would be determined by relative quantities of cuts produced given the available supply of pork from hogs slaughtered. In the above specification, we would expect the matrix of parameters associated with the output variables in Eq. (B.10a) to be positive semidefinite and the matrix of parameters associated with the input quantities in Eq. (B.10b) to be negative semidefinite (equivalently, the matrix of the a_{km}'s to be positive semidefinite). We also expect $c_j < 0$ and $d_k > 0$.

The demand functions facing packers are derived demand functions for the commodities ultimately purchased by consumers. Conceptually, these demand functions take into

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[7] Note that the f.o.c. for profit maximization with the aggregate cost function Eq. (B.8) become

$$P_j + \frac{\partial P_j}{\partial Y_j} Y_j - \frac{\partial C}{\partial Y_j} Y_j = P_j + \frac{\partial P_j}{\partial Y_j} Y_j - \frac{\partial C^*}{\partial F} \frac{\partial F}{\partial Y_j} = 0 \quad .$$

$$-\frac{\partial C}{\partial X_k} - W_k - \frac{\partial W_k}{\partial X_k} X_k = -\frac{\partial C^*}{\partial G} \frac{\partial G}{\partial X_k} - W_k - \frac{\partial W_k}{\partial X_k} X_k = 0$$

Because the first set of equations depends only on the aggregator function *G* in addition to the *Y* variables, we can express these equations as shown by Eq. (B.10a). Likewise, the second set of f.o.c. only depends on the aggregator function *F* in addition to the *X*s, so these equations can be expressed in the form shown in Eq. (B.10b). The specifications shown by Eqs. (B.10a) and (B.10b) are less restrictive than that implied by the separable form of the cost function, because the model does not impose the separability restriction that $\frac{\partial C / \partial Y_j}{\partial C / \partial Y_l} = \psi(\mathbf{Y})$ and $\frac{\partial C / \partial X_k}{\partial C / \partial X_m} = \xi(X)$.

account all downstream effects of changes occurring in upstream markets. Although the systems of the demand functions approach can still be appropriate in modeling demand for these commodities, it is important to allow for appropriate modifications. In particular, these demand functions are homogenous of degree zero in income and all input prices—raw material input prices and nonraw material input prices. Therefore, in estimating such a system of demand functions without all input prices included, the homogeneity restrictions may not hold. However, the symmetry restrictions may still hold (Chavas and Cox, 1997).[8]

The approach taken here is similar to the approach of Hausman (Mortimer, 2005). In this approach, we assume a two-stage budgeting process. In the first stage, the consumer chooses between pork and all other goods. In the second stage, given expenditures on pork products, the consumer chooses among the different pork products.

Initially, the almost ideal demand system (AIDS) model was chosen. Although convergence was achieved and the own-price elasticities were found to be negative at the majority of the observations, it failed to satisfy negative semidefiniteness at any data point and produced implausible elasticities in many instances. Correction was made for estimation of first-order autocorrelation in the residuals, but that approach failed to change the results materially.[9]

A viable alternative functional form to the AIDS model is the absolute price version of the Rotterdam Model (RM). This model can be specified as follows:

$$\overline{S}_j \Delta \log Y_j = a_j + \sum_{k=1}^{n} b_{jk} \Delta \log P_j + c_j \Delta \log X \quad , \qquad \text{(B.11)}$$

where $\overline{S}_j$ is the average budget share between intervening periods (weeks in this case), and $\Delta \log X = \sum_j \overline{S}_j d \log Y_j$ is the relative change in real total expenditures on pork in the current period. The notation "Δ" denotes change and refers to change in the variable from the previous week to the current week. Symmetry holds when $b_{jk} = b_{kj}$. Also, if homogeneity holds,

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[8] See Attachment 1 of this appendix, "Specification of Derived Demand for Pork Cuts," for a discussion of these points.

[9] Estimation was conducted by Piggott.

then $\sum_k b_{jk} = 0 \forall j$. Of course, as indicated before, there is reason to believe that this restriction will not hold, so one should only impose the homogeneity restriction if it is not rejected statistically. Finally, the matrix of parameters (b_{jk}) is expected to be negative-definite. In support of the RM, Barnett and Seck (2006) have shown that the RM clearly dominates the AIDS in cases where there can be high substitutability among goods, which one would expect to be the case here. Overall, the RM seems to do a better job of approximating unknown price elasticities than the AIDS model in conditional demand functions.

Supply of hogs from each source is assumed to be predetermined in each week because decisions on number of pigs to slaughter in a given week are made previous to that week. Also, because of tight scheduling problems, there is little or no opportunity to move slaughter from 1 week to the other in response to changes in economic conditions. Therefore, supplies can be viewed as perfectly inelastic with respect to market prices within the current week (Bullock, 2003).

B.2 PORK INDUSTRY DATA

Pork data were obtained from USDA, AMS, *National Carlot Meat Trade Review: Meat, Livestock, and Slaughter Data*, 2001–2005. We aggregated the data to weekly amounts. The quantity data are presented in number of carlots (40,000-pound lots). The proportions of each cut (loin, butt, ham, picnic, belly, rib) were multiplied by average weekly U.S. pork production to obtain thousands of pounds marketed. Table B-1 summarizes the data.

Hog data are MPR data provided by USDA, AMS. The data are provided for August 10, 2001, through September 30, 2005, on a weekly basis.[10] The six types of marketing instruments are (1) negotiated purchases, (2) other market formula purchases (based on formula price other than the market for hogs, pork, or a pork product; formula may be based on one or more futures or options contracts), (3) swine or pork market formula purchases (formula price based on market for swine, pork, or a

[10] The same aggregation procedure is followed as for estimating aggregate quantities—proportions of head in each category are multiplied by the average pork production per week.

Table B-1. Summary Statistics of Weekly Pork Primal Cuts: Slaughter Values and Quantities, August 10, 2001–September 30, 2005

Variable	N	Mean	Std Dev
p_loin	217	79.9664516	10.1727399
p_butt	217	59.2835945	12.5855802
p_ham	217	50.3645161	12.2033613
p_rib	217	122.0556682	17.1121195
p_belly	217	83.9891705	14.4318368
p_picnic	217	40.8767281	11.1189015
loin_lbs	217	110.3752063	30.6538388
butt_lbs	217	58.3497952	18.3915121
ham_lbs	217	94.3521645	26.9974187
rib_lbs	217	12.5418756	6.9529211
belly_lbs	217	21.7612271	14.2663447
picnic_lbs	217	29.5053996	10.0565297

Note: Values are in $/cwt, and quantities are in 1,000 lbs.

pork product), (4) other purchase arrangements (including long-term contract agreements, fixed-price contracts, cost of production formulas), (5) packer sold (sold for slaughter to another packer), and (6) packer owned (hogs owned by packer for at least 14 days before slaughter). Price data were available only for the first through fifth instruments because packer-owned hogs were not traded. The fifth instrument, hogs owned by packers, is viewed as an intermediate input and is therefore not included in the empirical model. However, the price of packer-sold hogs is taken to be the imputed price of packer-owned hogs because this price is a measure of the opportunity cost of hogs owned by packers. For econometric analysis, all marketing instruments (instruments 2 through 4) are aggregated together. The quantity index is the Fisher Ideal index multiplied by the sample mean average of quantities for this category. The price index is obtained by dividing total value by the quantity index. Summary statistics of the three marketing arrangements used in the econometric analysis (negotiated, contracted, and packer owned) are shown in Table B-2.

Table B-2. Summary Statistics of Weekly Mandatory Hog Prices and Quantities, August 10, 2001–September 30, 2005

Variable	N	Mean	Std Dev
p_neg	217	59.4053610	12.1348986
p_con	217	60.3493519	9.7093267
p_own	217	63.1364716	11.8053015
neg_lbs	217	50.4345681	8.6589549
con_lbs	217	257.7430445	21.3350240
own_lbs	217	72.8061901	8.6881661

Note: See Table B-1.

B.3 ECONOMETRIC SPECIFICATION

The reduced-form f.o.c. of packer behavior, Eqs. (B.10a) and (B.10b), are estimated using the DSUR method (Mark, Ogaki, and Sul, 2005). DSUR is an especially appropriate method when transient dynamics and endogeneity jointly can make it difficult to estimate standard dynamic simultaneous equation models. The approach posits the existence of long-run relationships between prices and quantities in the case of the packer f.o.c. If unit roots are present in the variables, which is the case here, then establishing a cointegrating relationship among the variables of interest is necessary. From an economic point of view, the goal is to estimate the long-run or steady-state relationship. Error correction models have often been proposed as the best vehicle to achieve this goal, and they are advantageous because short-run dynamics, regardless of the source, can be controlled for in estimation. One of the problems with a strictly error-correction model is the problem of endogeneity. If the variables on the right-hand side are not strictly exogenous, traditional estimation methods may produce inconsistent results. One could use an instrumental variable approach, but selecting the best instruments becomes problematic. The method of DSUR introduced by Mark, Ogaki, and Sul (2005) extends previous methods by correcting for endogeneity while also controlling for transient dynamics and unit roots.

Endogeneity and dynamics are controlled for by introducing lag and lead variables in each equation estimated. For the packer behavioral equations, the equations to estimate become

$$
\begin{aligned}
P_{jt} &= b_{jj} Y_{jt} + \sum_{l \neq j} b_{jl} Y_{lt} + c_j X_{Idt} \\
&\sum_{l} \sum_{r} d_{jl}^{r} \Delta Y_{jt-r} + \sum_{l} \sum_{s} d_{jl}^{s} \Delta Y_{jt+s} \\
&\sum_{j} \sum_{r} e_{jk}^{r} \Delta X_{kt-r} + \sum_{j} \sum_{s} e_{jk}^{s} \Delta X_{kt+s} + \varepsilon_{jt}
\end{aligned}
\tag{B.12a}
$$

$$
\begin{aligned}
W_{kt} &= d_k Y_{Idt} - a_{kk} X_{kt} - \sum_{m \neq k} a_{mk} X_{mt} + \\
&\sum_{j} \sum_{r} f_{kj}^{r} \Delta Y_{jt-r} + \sum_{j} \sum_{s} f_{kj}^{s} \Delta Y_{jt+s} \\
&\sum_{m} \sum_{r} f_{mk}^{r} \Delta X_{kt-r} + \sum_{l} \sum_{s} f_{mk}^{s} \Delta X_{kt+s} + \varepsilon_{kt} ,
\end{aligned}
\tag{B.12b}
$$

where *r* and *s* denote lags and leads of first differences of the quantities of outputs and quantities of marketing arrangements.

The set of equations in Eqs. (B.12a) and (B.12b) were estimated by DSUR assuming $r = s = 3$.[11] To account for seasonal effects, monthly binary variables are included in the model. A linear time trend is also included in the model to account for the effects of unobserved changes in other variable input prices.

The packer behavioral equations were estimated in two sets: (1) input decisions given (expected) output of pork and (2) output prices given supplies of pork available from hogs. Following the approach of Mark, Ogaki, and Sul (2005) each model was estimated in two steps. In the first step, all the dependent and right-hand side variables were regressed on the lags and leads of the first differences of the quantities of outputs and quantities of marketing arrangements to purge the variables of endogeneity and transient dynamics. In the second step, the residuals from the first step were used in estimation by the seemingly unrelated regression (SUR) method. Mark, Ogaki, and Sul (2005) proved that this approach is equivalent to estimating the complete model in one step. In addition to including first differences in lags and leads of the various quantity variables, in the first step, an intercept, 11-monthly binary variables, and a linear time-trend variable are included to purge the error of any seasonal effects and influence of other variable input prices.

[11] Stock and Watson (1993) suggested that the order of lag and lead equals 2 for $T = 100$ and 3 for $T = 300$.

Although the above approach is useful to remove effects of endogeneity and to correct for the effect of unit roots, there is no guarantee the approach will correct for autocorrelation in the residuals. Therefore, the model was estimated assuming the error terms follow the first-order error correction processes:

$$\begin{aligned} \varepsilon_{jt} &= \delta_j \varepsilon_{jt-1} + \sum_{l \neq j} \delta_l \varepsilon_{lt-1} + v_{jt} \forall j \\ \varepsilon_{kt} &= \delta_k \varepsilon_{kt-1} + \sum_{m \neq j} \delta_m \varepsilon_{mt-1} + v_{kt} \forall k . \end{aligned} \tag{B.12c}$$

The stochastic specification of the RM was as follows:

$$\overline{S}_{jt} \Delta \log Y_{jt} = a_j + \sum_{k=1}^{n} c_{jk} \Delta \log P_{jt} + b_j \Delta \log X_t + u_{jt} , \tag{B.13a}$$

where u_{jt} is the error term. In estimation, the restriction of homogeneity ($\sum_k c_{jk} = 0$) is tested prior to imposition, while symmetry ($c_{jk} = c_{kj}$) is imposed a priori. We have also estimated the model assuming first-order autocorrelation in the error terms of the form:

$$u_{jt} = \rho_j u_{jt-1} + \sum_{k \neq j} \rho_k u_{kt-1} + e_{jt} \quad \forall j . \tag{B.13b}$$

Eqs. (B.12a), (B.12b), and (B.13a) are estimated as separate blocks of equations. All three sets of equations are estimated by the iterated seemingly unrelated regression (ITSUR) method, which is equivalent to maximum likelihood estimation, assuming the error terms are normally distributed. In the case of the RM, one equation needs to be deleted before estimation because of singularity of the variance-covariance matrix of the residuals due to the adding-up property. Although recouping all the parameter estimates of the underlying autoregressive process in Eq. (B.13b) is not possible, Berndt and Savin (1975) showed that the estimation results are invariant of the equation that is deleted.

For economic surplus analysis, we required that the Hessian matrix of second-order partial derivatives with respect to quantities of outputs of the profit function be positive semidefinite, the Hessian matrix of second-order partial derivatives with respect to quantities of inputs be negative semidefinites, and the Hessian matrix of the expenditure function associated with the demand functions with respect to output prices be negative semidefinite. In the empirical application, these restrictions are violated in some instances, so it is important to impose these restrictions before conducting the analysis. The approach taken in imposing semidefiniteness is the semiflexible functional form approach of Diewert and Wales (1988). In this approach, the Hessian matrix is restricted to have rank less than or equal to $K < N$, the number of second-order partial derivatives that can attain arbitrary values. As Diewert and Wales show, the semiflexible functional form is less flexible but requires fewer parameters and does not restrict its second-order parameters in any obvious restrictive manner. The advantage of the approach is that it can overcome degrees-of-freedom problems and computational problems that may arise in estimation stemming from multicollinearity or lack of identification of the underlying structural parameters.

The semiflexible functional form approach is implemented by imposing semidefiniteness in the packer relationships as follows:

(a) $\tilde{\mathbf{B}} = [b_{jl}] = \mathbf{SS}'$, where $\mathbf{B}$ is approximated by the matrix $\tilde{\mathbf{B}}$, which has rank less than the matrix $\mathbf{B}$.

(b) $\tilde{\mathbf{A}} = [a_{km}] = \mathbf{SS}'$, where $\mathbf{A}$ is approximated by the matrix $\tilde{\mathbf{A}}$, which has rank less than the matrix $\mathbf{A}$.

For the RM, the matrix $\tilde{\mathbf{C}} = [c_{jk}] = \mathbf{SS}'$ is specified to approximate the matrix $\mathbf{C}$, where $\tilde{\mathbf{C}}$ has rank less than the matrix $\mathbf{C}$. Barten and Geyskens (1975) showed that if the matrix $\mathbf{C}$ is negative semidefinite, then the demand elasticities will globally satisfy the integrability requirement of demand.

B.4 ECONOMETRIC RESULTS

The econometric estimation proceeded in a number of preliminary steps. The first step was to determine the time-series properties of the variables used in estimating the packer behavioral Eqs. (B.12a) and (B.12b). Augmented Dickey-Fuller (ADF) tests were conducted for all the quantity and price variables used in estimating the packer behavioral equations. Unit roots were indicated in all variables, with the possible exception of quantities of ribs, belly, and picnic cuts.

Equations in (B.12a) and (B.12b) without symmetry imposed were estimated by OLS, with first-order autocorrelation to check for stationarity in the error terms.[12] Using the critical values established by Engle and Granger (1987, Table II) for the Dickey-Fuller (DF) test,[13] the null hypothesis of a unit root in the error term was rejected at the 1% significance level for the loin, butt, ham, rib, and picnic price equations, and the null hypothesis of a unit root was rejected at the 10% level for the negotiated, contract, and ownership price equations.

The econometric estimates of the packer output price behavioral equations, Eq. (B.12a), are shown in Table B-3.[14] The subscripts for b_{jl} refer to loin, butt, ham, rib, belly, and picnic. The coefficient estimates associated with c_j refer to the index of hog quantities slaughtered. The pattern of effects of output on wholesale meat values is mixed and complex. In some instances (loin and picnic), there is a clear positive relationship between price and own-quantity; in other cases (ham, rib, and belly), there appears to be a negative relationship between price and own-quantity. With the exceptions of ham and ribs, there is a strong negative relationship between quantity of hogs slaughtered and wholesale values of pork. The packer price equations were also estimated subject to the restriction that the coefficients associated with the output quantity variables be positive semidefinite. The matrix $\tilde{\mathbf{B}} = \mathbf{SS}'$ only consists of one K column. Attempts to obtain estimates with more than one K were unsuccessful because of nonconvergence. The semidefinite constrained estimates are shown in Table B-4.

The results indicate that all wholesale cuts are complements, as one might expect. Furthermore, the quantity of hogs is negative and statistically significant except for the case of ham. Differences in the estimated c_j's indicate that changes in the quantities of hogs slaughtered have much different effects on marginal costs of production of different wholesale cuts.

[12] Correction for first-order autocorrelation seemed to be adequate. Estimation with up to fourth-order correction indicated little effect of autocorrelation beyond one period.

[13] Engle and Granger (1987) indicated that although the ADF tests are generally preferred to the DF tests, the latter are appropriate when we believe that the autocorrelation process is first order, as is the case here.

[14] For sake of presentation, only the parameter estimates of the b_{jl}'s and c_j's are shown.

Table B-3. Packer Output Price Equation Estimates, Symmetry Imposed

Parameter	Estimate	Standard Error	t Value	Pr > |t|
b_{11}	0.127172	0.0637	2.00	0.0473
b_{12}	0.046169	0.0611	0.76	0.4507
b_{13}	0.034437	0.0502	0.69	0.4932
b_{14}	0.023750	0.0826	0.29	0.7740
b_{15}	0.244832	0.0658	3.72	0.0003
b_{16}	0.151550	0.0412	3.68	0.0003
c_1	–0.310680	0.0641	–4.84	<0.0001
b_{22}	–0.086470	0.0916	–0.94	0.3463
b_{23}	–0.104500	0.0570	–1.83	0.0682
b_{24}	–0.274100	0.1051	–2.61	0.0098
b_{25}	0.267459	0.0764	3.50	0.0006
b_{26}	0.013975	0.0524	0.27	0.7899
c_2	–0.241950	0.0671	–3.60	0.0004
b_{33}	–0.250280	0.0585	–4.28	<0.0001
b_{34}	–0.195840	0.0827	–2.37	0.0188
b_{35}	0.112652	0.0654	1.72	0.0865
b_{36}	–0.009510	0.0423	–0.22	0.8222
c_3	0.110026	0.0583	1.89	0.0606
b_{44}	–0.641310	0.2164	–2.96	0.0034
b_{45}	0.347627	0.1132	3.07	0.0024
b_{46}	–0.047110	0.0846	–0.56	0.5780
c_4	–0.031660	0.0835	–0.38	0.7051
b_{55}	–0.243480	0.1208	–2.02	0.0452
b_{56}	0.257595	0.0560	4.60	<0.0001
c_5	–0.292420	0.0737	–3.97	0.0001
b_{66}	0.124327	0.0658	1.89	0.0603
c_6	–0.124120	0.0421	–2.95	0.0036

Table B-4. Packer Output Price Equation Estimates, Symmetry and Positive Semidefiniteness Imposed

Term	Estimate	Standard Error	t Value	Pr > |t|
b_{11}	0.174577	0.0544	3.21	0.0016
b_{12}	0.112251	0.0493	2.28	0.0238
b_{13}	0.101643	0.0406	2.50	0.0132
b_{14}	0.130789	0.0702	1.86	0.0640
b_{15}	0.177195	0.0566	3.13	0.0020
b_{16}	0.184043	0.0397	4.64	<0.0001
b_{22}	0.072177	0.0483	1.49	0.1370
b_{23}	0.065356	0.0352	1.86	0.0646
b_{24}	0.084096	0.0559	1.50	0.1339
b_{25}	0.113935	0.0522	2.18	0.0303
b_{26}	0.118338	0.0468	2.53	0.0123
b_{33}	0.059179	0.0339	1.74	0.0826
b_{34}	0.076149	0.0484	1.57	0.1169
b_{35}	0.103168	0.0448	2.30	0.0223
b_{36}	0.107155	0.0391	2.74	0.0067
b_{44}	0.097984	0.0885	1.11	0.2696
b_{45}	0.132751	0.0727	1.83	0.0694
b_{46}	0.137881	0.0704	1.96	0.0514
b_{55}	0.179852	0.0824	2.18	0.0303
b_{56}	0.186803	0.0498	3.75	0.0002
b_{66}	0.194023	0.0553	3.51	0.0005
c_1	–0.345060	0.0602	–5.73	<0.0001
c_2	–0.295260	0.0607	–4.87	<0.0001
c_3	–0.026610	0.0535	–0.50	0.6196
c_4	–0.109900	0.0766	–1.43	0.1529
c_5	–0.315450	0.0691	–4.56	<0.0001
c_6	–0.166590	0.0412	–4.05	<0.0001

The packer output constant input demand functions for hogs procured from different markets are shown in Tables B-5 and B-6.[15] For the semiflexible functional form estimates in Table B-6, two *K*s were used to approximate the matrix **A**. Recall that the specification Eq. (B.12b) indicates that the a_{km}'s should be positive to obtain downward-sloping demand functions, which is the case in every instance. The results clearly indicate that all inputs are substitutes and that the quantity of pork produced and sold has a strong and positive effect on demand for hogs. Moreover, there is little difference between the results when negative semidefiniteness is imposed and when it is not imposed.

Table B-5. Packer Output Constant Inverse Input Demand Functions, Symmetry Imposed

Parameter	Estimate	Standard Error	t Value	Pr > |t|
a_{11}	0.252669	0.0503	5.03	<0.0001
a_{12}	0.195627	0.0367	5.33	<0.0001
a_{13}	0.149206	0.0514	2.90	0.0041
a_{22}	0.138016	0.0279	4.94	<0.0001
a_{23}	0.168122	0.0370	4.54	<0.0001
a_{33}	0.026425	0.0550	0.48	0.6311
d_1	0.100432	0.0400	2.51	0.0127
d_2	0.069339	0.0305	2.27	0.0242
d_3	0.078254	0.0406	1.93	0.0554

The results for the demand functions for the six wholesale pork cuts are shown in Tables B-7 and B-8. In estimation, one of the equations had to be dropped because of the adding-up restriction, so the equation for picnic cuts was dropped. As indicated above, the results are invariant to which equation is deleted.

[15] The subscripts 1, 2, and 3 refer to negotiated, contract, and owned pigs.

Table B-6. Packer Output Constant Inverse Input Demand Functions, Symmetry and Semidefiniteness Imposed

Term	Estimate	Standard Error	t Value	Pr > |t|
a_{11}	0.285041	0.0509	5.60	<0.0001
a_{12}	0.171702	0.0358	4.80	<0.0001
a_{13}	0.197988	0.0502	3.94	0.0001
a_{22}	0.121516	0.0271	4.49	<0.0001
a_{23}	0.133725	0.0350	3.82	0.0002
a_{33}	0.149085	0.0477	3.12	0.0020
d_1	0.096735	0.0398	2.43	0.0160
d_2	0.065050	0.0302	2.15	0.0324
d_3	0.080079	0.0403	1.99	0.0484

The homogeneity restriction was tested and not rejected and therefore imposed in estimation. It was unnecessary to use a reduced set of *K*s for the **S** matrix in imposing negative semidefiniteness, so the fully restricted estimates are shown in Table B-8. As the table shows, there is very little difference between the two sets of estimates, suggesting that negative semidefiniteness very nearly holds without imposing the restriction. Most of the cross-price effects are positive, and many are statistically significant, indicating substitute relationships between the various wholesale products.

Using the parameter estimates from Table B-4, Table B-9 presents the elasticities for output prices with respect to quantities of outputs and quantities of inputs.[16] Using the parameter estimates from Table B-6, Table B-10 presents the elasticities for the three hog prices with respect to quantities of outputs and quantities of inputs. For the most part, these elasticities seem reasonable. Output prices with respect to output quantities are all relatively inelastic, as one might

[16] The elasticities are evaluated at the sample means. For the input quantities (respectively, output quantities in input demand functions), the derivatives of the index with respect to components of the index can be shown to equal $\partial X_{Id} / \partial X_k = S_k^x / X_k$, where S_k^x is the cost share of the *k*th factor in total hog procurement costs.

Table B-7. Demand Functions for Wholesale Pork Cuts, Symmetry Imposed

Parameter	Estimate	Standard Error	t Value	Pr > |t|
b_{11}	–0.831170	0.1275	–6.52	<0.0001
b_{12}	0.258454	0.0708	3.65	0.0003
b_{13}	0.289427	0.0695	4.16	<0.0001
b_{14}	0.141797	0.0591	2.40	0.0174
b_{15}	0.153251	0.0591	2.59	0.0102
b_{16}	–0.011760	0.0384	–0.31	0.7596
b_{22}	–0.376610	0.0626	–6.01	<0.0001
b_{23}	0.035848	0.0462	0.78	0.4390
b_{24}	–0.023070	0.0414	–0.56	0.5778
b_{25}	0.064963	0.0392	1.66	0.0991
b_{26}	0.040413	0.0267	1.51	0.1321
b_{33}	–0.373270	0.0677	–5.51	<0.0001
b_{34}	0.026085	0.0412	0.63	0.5270
b_{35}	0.008302	0.0412	0.20	0.8403
b_{36}	0.013604	0.0261	0.52	0.6032
b_{44}	–0.141680	0.0592	–2.39	0.0177
b_{45}	0.032045	0.0371	0.86	0.3889
b_{46}	–0.035180	0.0307	–1.14	0.2537
b_{55}	–0.272970	0.0493	–5.53	<0.0001
b_{56}	0.014408	0.0245	0.59	0.5571
b_{66}	–0.021490	0.0352	–0.61	0.5420
c_1	0.586584	0.0537	10.91	<0.0001
c_2	0.138045	0.0371	3.72	0.0003
c_3	0.025510	0.0430	0.59	0.5539
c_4	0.141406	0.0270	5.24	<0.0001
c_5	0.134505	0.0312	4.31	<0.0001
c_6	–0.026050	0.0160	–1.63	0.1045

Table B-8. Demand Functions for Wholesale Pork Cuts, Symmetry and Negative Semidefiniteness Imposed

Term	Estimate	Standard Error	t Value	Pr > |t|
b_{11}	–0.831250	0.1272	–6.54	<0.0001
b_{12}	0.258599	0.0706	3.66	0.0003
b_{13}	0.289421	0.0694	4.17	<0.0001
b_{14}	0.141938	0.0590	2.41	0.0170
b_{15}	0.153425	0.0589	2.60	0.0099
b_{16}	–0.012130	0.0383	–0.32	0.7515
b_{22}	–0.376670	0.0625	–6.03	<.0001
b_{23}	0.035751	0.0461	0.78	0.4390
b_{24}	–0.023100	0.0413	–0.56	0.5762
b_{25}	0.064889	0.0391	1.66	0.0986
b_{26}	0.040537	0.0267	1.52	0.1299
b_{33}	–0.373230	0.0675	–5.53	<0.0001
b_{34}	0.025976	0.0411	0.63	0.5276
b_{35}	0.008201	0.0411	0.20	0.8419
b_{36}	0.013879	0.0261	0.53	0.5950
b_{44}	–0.141770	0.0591	–2.40	0.0174
b_{45}	0.032009	0.0370	0.86	0.3882
b_{46}	–0.035050	0.0307	–1.14	0.2542
b_{55}	–0.273110	0.0492	–5.55	<0.0001
b_{56}	0.014582	0.0244	0.60	0.5513
b_{66}	–0.021810	0.0351	–0.62	0.5349
c_1	0.586511	0.0536	10.94	<0.0001
c_2	0.138029	0.0371	3.73	0.0003
c_3	0.025546	0.0429	0.60	0.5523
c_4	0.141426	0.0269	5.25	<0.0001
c_5	0.134508	0.0311	4.32	<0.0001
c_6	–0.026020	0.0159	–1.63	0.1040

Table B-9. Elasticities of Wholesale Pork Prices with Respect to Wholesale Pork Quantities and Hog Quantities

Price / Quantity	Loin	Butt	Ham	Rib	Belly	Picnic
Loin	0.240963	0.081907	0.119929	0.020513	0.048220	0.067907
Butt	0.208991	0.071040	0.104016	0.017791	0.041822	0.058897
Ham	0.222754	0.075718	0.110866	0.018963	0.044576	0.062775
Rib	0.118273	0.040203	0.058865	0.010068	0.023668	0.033331
Belly	0.232863	0.079154	0.115897	0.019823	0.046599	0.065624
Picnic	0.496953	0.168923	0.247336	0.042305	0.099447	0.140048

Price / Quantity	Negotiated	Contract	Packer Owned
Loin	–0.21151615	–1.106380	–0.325447
Butt	–0.24413320	–1.276988	–0.375633
Ham	–0.02589864	–0.135468	–0.039849
Rib	–0.04413636	–0.230864	–0.067910
Belly	–0.18410432	–0.962995	–0.283270
Picnic	–0.19976967	–1.044936	–0.307374

Table B-10. Elasticities of Hog Prices with Respect to Wholesale Pork Quantities and Hog Quantities

Price / Quantity	Loin	Butt	Ham	Rib	Belly	Picnic
Negotiated	0.25576368	0.100375	0.137823	0.044771	0.053287	0.034957
Contract	0.03365456	0.013208	0.018135	0.005891	0.007012	0.004600
Owned	0.14666750	0.057560	0.079035	0.025674	0.030557	0.020046

Price / Quantity	Negotiated	Contract	Packer Owned
Negotiated	–0.2419967	–0.744966	–0.242651
Contract	–0.1434929	–0.518977	–0.161328
Owned	–0.1581564	–0.545909	–0.154206

expect. Also, all three inputs are net substitutes, as one would anticipate.

Table B-11a shows compensated unconditional demand elasticities for pork cuts. Unconditional demand elasticities that take into account the impact of price changes on the first-stage allocation of total expenditures between pork and other goods are required. The formula used to calculate these elasticities is Barten (1977):

$$e_{ij} = e_{ij}^{p} + e_{i}^{p} e_{pp} s_{j}^{p} \ ,$$

where the unconditional elasticity, e_{ij}, equals the conditional elasticity, e_{ij}^{p}, plus the expenditure elasticity from the second stage for good *i*, e_{i}^{p}, multiplied by the own-price elasticity of demand for pork from the first stage, e_{pp}, all multiplied by the expenditure share of the *j*th good relative to expenditures on pork, s_{j}^{p}. These unconditional elasticities are computed at the sample means of the shares, assuming the own-price elasticity of demand for all pork is –0.29.[17] The compensated elasticities (both price and expenditure elasticities) are calculated from the parameter estimates in Table B-8. Note that with the exception of picnic cuts, the own-price elasticities are all elastic. This indicates quite high substitutability on the demand side between different cuts.

Table B-11a. Compensated Unconditional Demand Elasticities for Wholesale Pork Cuts

Quantity / Price	Loin	Butt	Ham	Rib	Belly	Picnic
Loin	–2.207947	0.567127	0.617744	0.318146	0.340639	–0.053020
Butt	1.513241	–2.392904	0.168306	–0.162192	0.384045	0.239256
Ham	1.302845	0.157238	–1.705279	0.115771	0.034436	0.061259
Rib	1.753207	–0.415594	0.237441	–2.026365	0.399380	–0.522921
Belly	1.617834	0.689938	–0.004497	0.343803	–3.252382	0.145944
Picnic	–0.162426	0.748739	0.278712	–0.619005	0.273021	–0.383587

[17] From the agricultural economics literature, the own-price elasticity of retail demand for pork is estimated to be about –0.7 (Huang, 1993). A lower-bound estimate of the wholesale demand elasticity can be obtained by multiplying the wholesale share of retail dollar by the retail demand elasticity. The average wholesale share value is estimated to be 0.41, so (.41)(–0.7) = –0.29.

Uncompensated elasticities are shown in Table B-11b. These elasticities are computed using the general Slutsky equation

$$e_{ij}^{u} = e_{ij} - s_j e_i \quad ,$$

where e_{ij}^{u} is the uncompensated unconditional elasticity between goods *i* and *j*, e_{ij} is the compensated unconditional elasticity, s_j is the share of the good in total consumer expenditures, and e_i is the unconditional expenditure elasticity of the *i*th good.[18]

Table B-11b. Uncompensated Unconditional Demand Elasticities for Wholesale Pork Cuts

Quantity / Price	Loin	Butt	Ham	Rib	Belly	Picnic
Loin	–2.215337	0.564227	0.613762	0.316852	0.339099	–0.054030
Butt	1.511502	–2.395292	0.167530	–0.163115	0.383439	0.239256
Ham	1.302523	0.157133	–1.705403	0.115690	0.034436	0.061259
Rib	1.751426	–0.417714	0.236050	–2.026365	0.399380	–0.522921
Belly	1.616139	0.688826	–0.004497	0.343803	–3.252382	0.145944
Picnic	–0.162099	0.748739	0.278712	–0.619005	0.273021	–0.383587

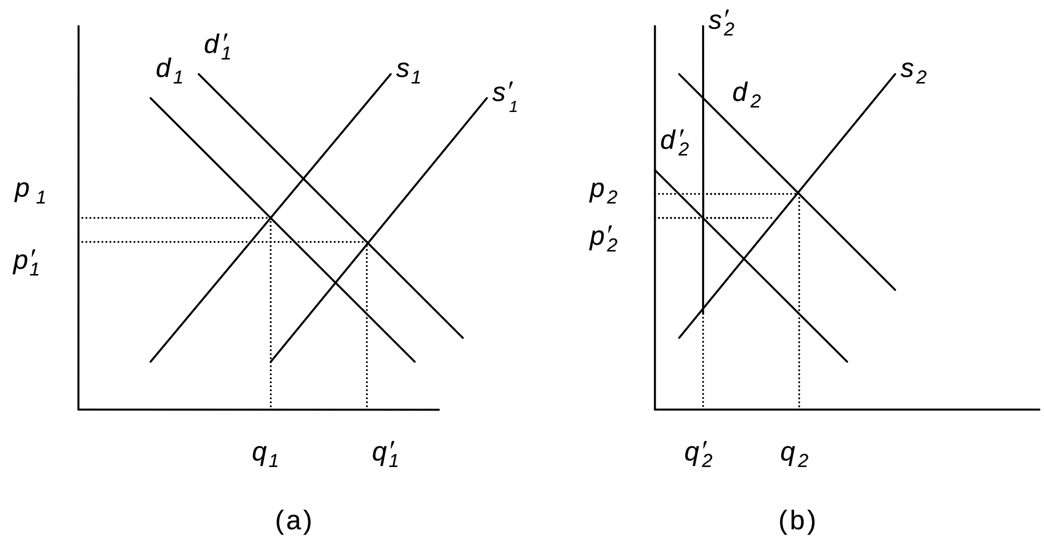
B.5 IMPACT OF CHANGES IN MARKETING ARRANGEMENTS ON THE HOG AND PORK INDUSTRIES

The estimated elasticities for packer behavior and demand will be used, together with supply elasticities for hogs, to simulate different possible restrictions on the mix of marketing arrangements. This section describes the economic processes at work that produce changes in the negotiated market and changes in the AMA supplies markets (which refers to hogs sold under contract and packer ownership in this appendix).

For the sake of presentation, assume there are two markets: (1) the negotiated or spot market and (2) the AMA supplies market. As shown in Figure B-1, a decrease in AMA supplies

[18] Edgerton (1997) showed that this elasticity can be calculated as $e_i = e_p e_i^p$, where e_p is the first-stage expenditure elasticity of pork (assumed to be 0.7 based on a study by Huang [1993]), and e_i^p is the conditional expenditure elasticity defined above.

Figure B-1. Effect on Negotiated Sales and AMA Supplies from a Restriction Reducing Availability of Hogs in AMA Supplies Market



because of restriction (panel b) causes the supply curve, s_2, to fall and become kinked, as shown by s_2'. Because of reduced availability of supplies from that source, packers bid up the price of hogs on the spot market causing demand to increase from d_1 to d_1' (panel a). In response to the higher price on the spot market, producers will shift out of the AMA supplies markets and increase supply of hogs to the spot market, causing supply to increase in that market. At the same time, an increased availability of hogs from the spot market causes packers to reduce demand for hogs from AMA supplies, causing demand for hogs from AMA markets to decrease.

It is important to recognize that the supply shifts in both markets come about because of the restriction that total supply must equal the sum of supplies to both markets. Even if the supplies in both markets are independent of one another (i.e., do not depend directly on price on the other outlet), if supply in one market decreases at a given price (which is the case for AMA supplies), then supply in the other market must increase by that same amount at its original price. This is because the supply reduction is not voluntary but would come about through some type of restriction. Producers are willing to supply the original quantity at the going price in the AMA supplies market so they must be willing to supply the same quantity at that price (net of any transfer costs) in the negotiated market. Additional adjustments along the supply curves occur as the demand curves shift in response to changes in quantities marketed.

The above description assumes that (1) the different AMAs are substitutes in demand and (2) the increase in supply in the spot market exceeds the increase in demand resulting from restricting sales in the AMA supplies market. As shown below in the simulations, both of these assumptions are validated, although for other applications the assumptions may not be valid.

The economic effects of restricting sales for AMA supplies consist of effects on producers selling in the spot market, effects on producers selling in the AMA supplies markets, effects on consumers buying pork products, and effects on packers' net revenues. To compute the economic surplus effects, we needed to first develop formulas to compute equilibrium changes in the quantities and prices of the six pork cuts and the three hog AMAs. Second, given these formulas for computing changes in quantities and prices, we needed to develop formulas for calculating economic surplus effects on producers, consumers, and packers.

The model of the pork and hog industries can be expressed as an equilibrium displacement model by writing the equations describing the market in log differential form. In matrix notation, displacement in equilibrium of the nine markets can be represented as

$$
\begin{aligned}
\text{dlog}\,\mathbf{Y} &= \mathbf{E}^{*}\text{dlog}\,\mathbf{P} \\
\text{dlog}\,\mathbf{P} &= \mathbf{B}^{*}\,\text{dlog}\,\mathbf{Y} + \mathbf{C}^{*}\text{dlog}\,\mathbf{X} \\
\text{dlog}\,\mathbf{W} &= \mathbf{D}^{*}\,\text{dlog}\,\mathbf{Y} - \mathbf{A}^{*}\text{dlog}\,\mathbf{X} \\
\text{dlog}\,\mathbf{X} &= \mathbf{F}^{*}\text{dlog}\,\mathbf{W} + \text{dlog}\,\mathbf{s}\,,
\end{aligned}
\tag{B.14}
$$

where $\mathbf{Y}$ is the 6x1 vector of quantities of pork cuts, $\mathbf{P}$ is the 6x1 vector of prices of pork cuts, $\mathbf{X}$ is the 3x1 vector of quantities of hog AMAs, $\mathbf{W}$ is the 3x1 vector of prices of hog AMAs, $\text{dlog}\,\mathbf{s}$ is a 3x1 vector of relative changes in supplies of hogs due to a given policy change, $\mathbf{E}^{*}$ is the 6x6 matrix of elasticities of demand for pork cuts (Table B-11b), $\mathbf{B}^{*}$ is the 6x6 matrix of elasticities of pork prices with respect to pork quantities (Table B-9), $\mathbf{C}^*$ is the 6x3 matrix of elasticities of pork prices with respect to hog quantities (Table B-9), $\mathbf{D}^*$ is the 3x6 matrix of elasticities of hog prices with respect to pork quantities (Table B-10), $-\mathbf{A}^*$ is the 3x3 matrix of flexibilities of hog prices with respect to hog quantities (Table B-10), and $\mathbf{F}^*$ is a 3x3 matrix of price elasticities of supplies of hogs. The matrix $\mathbf{F}^*$ is assumed to be diagonal. Supply elasticities are assumed to apply over two lengths of run: short run (time for adjustment of herd size to occur, approximately 1 year) and long run (assumed to represent a time period of approximately 10 years). The short-run elasticities were obtained from Zheng, Vukina, and Shin (2006). Their model, which uses Agricultural Resource Management Survey (ARMS) data to estimate supply response for cash market and production contract markets, was used to simulate elasticities by increasing price on each market and observing the outcome. Using this procedure, they obtained an estimate of the supply elasticity on the cash or negotiated market of 3.02 and an estimate for the contract market of 0.46. Throughout the analysis, we assume that the supply elasticity of hogs owned by packers is the same as that for the contract market.

The reduced-form solution to Eq. (B.14) can be characterized as follows:

$$\begin{bmatrix} \text{dlog}\,\mathbf{P} \\ \text{dlog}\,\mathbf{W} \end{bmatrix} = \begin{bmatrix} \mathbf{I}_J - \mathbf{B}^*\mathbf{E}^* & \mathbf{0} \\ -\mathbf{D}^*\mathbf{E}^* & \mathbf{I}_K \end{bmatrix}^{-1} \begin{bmatrix} \mathbf{C}^* \\ \mathbf{A}^* \end{bmatrix} \text{dlog}\,\mathbf{X} = \begin{bmatrix} \boldsymbol{\pi}_p \\ \boldsymbol{\pi}_w \end{bmatrix} \text{dlog}\,\mathbf{X} \quad \text{(B.15)}$$

and

$$\text{dlog}\,\mathbf{X} = \mathbf{F}^*\,\text{dlog}\,\mathbf{W} + \text{dlog}\,\mathbf{s}\ . \quad \text{(B.16)}$$

The solution for the inverse industry derived demand functions is obtained from Eq. (B.15) as

$$\text{dlog}\,\mathbf{W} = \boldsymbol{\pi}_w\ \text{dlog}\,\mathbf{X}\ . \quad \text{(B.17)}$$

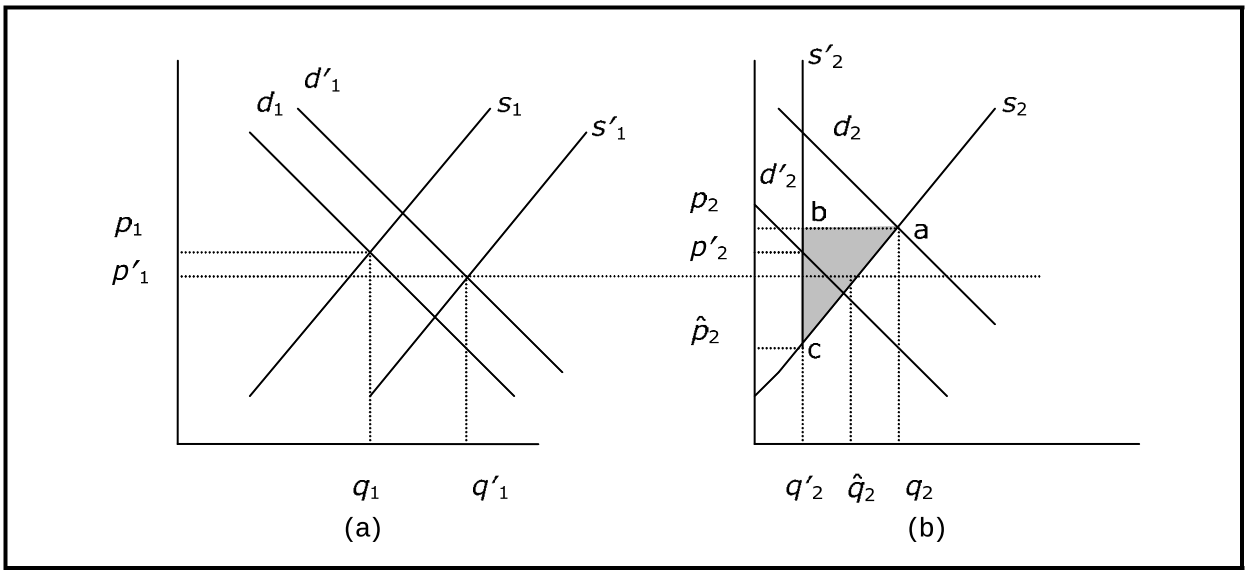
Substituting the input supply functions from Eq. (B.16) into Eq. (B.17) yields the relative changes in input prices from relative shifts in the input supply functions:

$$\text{dlog}\,\mathbf{W} = (\mathbf{I}_k - \boldsymbol{\pi}_w\mathbf{F}^*)^{-1}\boldsymbol{\pi}_w\ \text{dlog}\,\mathbf{s}\ . \quad \text{(B.18)}$$

The solution for relative changes in input quantities is obtained by substituting Eq. (B.18) into Eq. (B.17). Given the solutions to relative changes in input quantities, the first set of solutions in Eq. (B.15), $\text{dlog}\,\mathbf{P} = \boldsymbol{\pi_p}\,\text{dlog}\,\mathbf{X}$, can be used to estimate relative changes in the wholesale prices of pork. Finally, the demand functions, $\text{dlog}\,\mathbf{Y} = \mathbf{E^*}\,\text{dlog}\,\mathbf{P}$, can be used to calculate relative changes in equilibrium quantities of pork.

Economic surplus effects from changes in the AMAs can be calculated as follows. For producers, the effects on producers selling on the spot market consist of the losses sustained from the reduced price. In Figure B-2, losses to these producers make up the area above the supply curve s_1 between prices p_1 and p_1'. For producers under contract, their losses are represented by the two areas $(p_2' - p_2)q_2'$ and the area of the triangle abc. This loss, however, is offset somewhat by the gain they receive by selling the quantity $\hat{q}_2 - q_2'$ they would wish to sell in the spot market at price p_1'.

Figure B-2. Economic Effects on Producers from a Restriction Reducing Availability of Hogs in AMA Supplies Market



The formula for changes in producer's surplus in terms of the notation of the model is as follows:[19]

[19] The values for $\hat{W}_2$ and $\hat{X}_2$ are estimated as

$\hat{W}_2 = W_2[1 + (\Delta X_2 \,/\, X_2)(1 \,/\, \varepsilon_2)]$ and $\hat{X}_2 = X_2 + \varepsilon_2(W_1'' - W_2)(X_2 \,/\, W_2)$.

$$\begin{aligned}\Delta PS &= \Delta W_1 X_1 + (\varepsilon_1 / 2)(X_1 / W_1)(W_1' - W_1)^2 \\ &+ \Delta W_2 X_2' + (1/2)(\hat{W}_2 - W_2)(X_2 - X_2') \\ &+ (1/2)(W_1' - \hat{W}_2)(\hat{X}_2 - X_2')\ .\end{aligned} \tag{B.19a}$$

Change in consumer's surplus is evaluated using the sequential method developed by Just, Hueth, and Schmitz (1982):

$$\Delta CS = -\sum_{j=1}^{n} \int_{P_j}^{P_j'} Y_j [\hat{P}_j (P_j), U^0] dP_j\ , \tag{B.19b}$$

where $Y_j(\bullet)$ is the Hicksian demand function for the *j*th pork product. The notation $\hat{P}_j(P_j)$ indicates that the integration is sequential, with the Hicksian demand function conditional on the previous price change. For the present application, we assume that the areas above the demand curves between the prices can be approximated by the sum of rectangles and triangles. For the first good, the Hicksian demand level is conditioned on initial prices of the *n–1* other goods; for the second good, the Hicksian demand is conditioned on the new price for good 1 and *n–2* prices for the other goods; and for the *k*th good, the Hicksian demand is conditioned on the new prices for the *k–1* goods already evaluated plus the *n–k* goods not evaluated. The elasticities should be Hicksian elasticities, which are shown in Table B-11a. Although the Marshallian elasticities (Table B-11b) are used to compute the new equilibrium quantities and prices, the Hicksian elasticities are used for the economic surplus analysis.[20]

Changes in processor's net revenue can be calculated as follows:[21]

$$\begin{aligned}\Delta NetRev &= 1/2(\boldsymbol{Y}_{\boldsymbol{new}}' \boldsymbol{B} \boldsymbol{Y}_{\boldsymbol{new}} + \boldsymbol{X}_{\boldsymbol{new}}' \boldsymbol{A} \boldsymbol{X}_{\boldsymbol{new}} \\ &- \boldsymbol{Y}_{\boldsymbol{old}}' \boldsymbol{B} \boldsymbol{Y}_{\boldsymbol{old}} - \boldsymbol{X}_{\boldsymbol{old}}' \boldsymbol{A} \boldsymbol{X}_{\boldsymbol{old}}) + \Delta W_3 X_{3new} \\ &+ (1/2)(\hat{W}_3 - W_{3old})(X_3 - X_{3new}) \\ &+ (1/2)(W_{1new} - \hat{W}_3)(\hat{X}_3 - X_3')\end{aligned}\ , \tag{B.19c}$$

where the subscripts "new" and "old" refer to the new equilibrium quantities and original equilibrium quantities,

---

[20] As a practical matter, it would not make that much difference if the uncompensated elasticities were used because of the small income effects (Tables B-11a and B-11b).

[21] The formulas used to compute $\hat{W}_3$ and $\hat{X}_3$ are the same as those shown in footnote 19, with the obvious change in notation from subscript 2 to subscript 3.

respectively. The first part of the formula is obtained by substituting the f.o.c. back into the processor's (quadratic) profit function and noting that the optimal profit function reduces simply to $1/2(\boldsymbol{Y'BY} + \boldsymbol{X'AX})$.[22] The last part of the formula is the economic surplus effect from forcing packer owned producers to sell hogs on the spot market.

Table B-12 presents the reduced-form, inverse industry derived demand flexibilities for the alternative sources of hog procurement. Consistent with the output constant flexibilities (Table B-10), the total effects show strong substitution between the different AMAs and the spot market. This pattern of substitution is consistent with the commonly observed phenomena that increased quantities or shares of contract and packer-owned hogs have a depressing effect on the spot price.

Table B-12. Reduced-Form, Inverse Industry Derived Demand Flexibilities for Hogs from Alternative Market Sources

Price / Quantity	Negotiated	Contract	Packer Owned
Negotiated	–0.26698155	–0.875654	–0.281093
Contract	–0.14678056	–0.536174	–0.166386
Packer owned	–0.17248395	–0.620852	–0.176251

We performed three types of simulations:

- (a) reducing both contract and packer-owned hogs by 25%
- (b) limiting the spot/cash market to 25%
- (c) banning packer-owned hogs.

The matrices of supply shifters in the three cases become

[22] To see this, note that in matrix notation the profit equation can be written $\Pi = \boldsymbol{Y'P} - \boldsymbol{X'W} - \boldsymbol{Y'b} - 0.5\boldsymbol{Y'BY} - \boldsymbol{X'a} - 0.5\boldsymbol{X'AX} - \boldsymbol{Y'CX_{FI}} + \boldsymbol{X'DY_{FI}}$.

The first-order conditions for profit maximization are $\begin{array}{l}\boldsymbol{P} = \boldsymbol{b} + \boldsymbol{BY} + \boldsymbol{CX_{FI}} \\ \boldsymbol{W} = -\boldsymbol{a} - \boldsymbol{AX} + \boldsymbol{DY_{FI}}\end{array}$, where the intercept vectors $\boldsymbol{a}, \boldsymbol{b}$ represent the combination of market power and cost effects. Substituting the first-order conditions into the profit equation and rearranging terms leads to the expression in the text for optimal profit.

(a)

$$\Delta \log \boldsymbol{s} \cong \begin{bmatrix} -(k_2/k_1)(\Delta X_2/X_2)-(k_3/k_1)(\Delta X_3/X_3) \\ -0.25 \\ -0.25 \end{bmatrix} \cong$$

$$\begin{bmatrix} -(0.6732491/0.128711)(-0.25)-(0.1980399/0.128711)(-0.25) \\ -0.25 \\ -0.25 \end{bmatrix}$$

(b)

$$\Delta \log \boldsymbol{s} \cong \begin{bmatrix} \Delta X_1 \ / \ X_1 \\ -(k_2 \ / \ k_1)(\Delta X_2 \ / \ X_2) \\ -(k_3 \ / \ k_1)(\Delta X_3 \ / \ X_3) \end{bmatrix} \cong$$

$$\begin{bmatrix} (0.25/0.128711)-1 \\ -(1/2)[(0.25/0.128711)-1] \\ -(1/2)[(0.25/0.128711)-1] \end{bmatrix}$$

(c)

$$\Delta \log \boldsymbol{s} \cong \begin{bmatrix} -(k_3/k_1)(\Delta X_3/X_3) \\ 0 \\ -1.00 \end{bmatrix} \cong$$

$$\begin{bmatrix} -(0.1980399/0.128711)(-1.0) \\ 0 \\ -1.0 \end{bmatrix}.$$

Scenario (a)

Table B-13 presents the impact of restricting both contract and packer-owned hogs by 25% on quantities and prices of hogs and pork.

Table B-14 shows the changes in consumer’s surplus, changes in processor’s net revenue, and changes in producer’s surplus from policy Scenario (a).

Scenario (b)

Table B-15 shows the impact of restricting both contract and packer-owned hogs on quantities and prices of hogs and pork to increase the spot market share to 25%.

Table B-16 provides the changes in consumer’s surplus, changes in processor’s net revenue, and changes in producer’s surplus from policy Scenario (b).

Table B-13. Percentage Changes in Wholesale Pork Prices and Hog Prices from Scenario (a)

Variable	Percentage Changes in Prices		Percentage Changes in Quantities	
Loin	P1	5.071995	Y1	–6.254235
Butt	P2	6.047142	Y2	–4.321752
Ham	P3	0.129534	Y3	7.824395
Rib	P4	0.811994	Y4	4.340150
Belly	P5	4.280122	Y5	–0.690170
Picnic	P6	4.038218	Y6	2.858603
Negotiated	W1	–8.993384	X1	142.073600
Contract	W2	–3.287139	X2	–25
Packer owned	W3	–4.566955	X3	–25

Table B-14. Effects on Consumer's Surplus, Processor's Net Revenue, and Producer's Surplus from Policy Scenario (a)

Effect	Percentage Changes
Changes in consumer's surplus (% of total revenue of pork)	–3.918210
Changes in processor's net revenue (% of total revenue of pork)	3.220613
Changes in producer's surplus (% of total revenue of hog production)	–18.498550

Table B-15. Percentage Changes in Wholesale Pork Prices and Hog Prices from Scenario (b)

Variable	Percentage Changes in Prices		Percentage Changes in Quantities	
Loin	P1	2.824217	Y1	–3.482518
Butt	P2	3.367203	Y2	–2.406462
Ham	P3	0.072128	Y3	4.356823
Rib	P4	0.452139	Y4	2.416707
Belly	P5	2.383281	Y5	–0.384305
Picnic	P6	2.248583	Y6	1.591743
Negotiated	W1	–5.007746	X1	79.110200
Contract	W2	–1.830363	X2	–13.920640
Packer owned	W3	–2.542997	X3	–13.920640

Table B-16. Effects on Consumer's Surplus, Processor's Net Revenue, and Producer's Surplus from Policy Scenario (b)

Effect	Percentage Changes
Changes in consumer's surplus (% of total revenue of pork)	–2.131444
Changes in processor's net revenue (% of total revenue of pork)	1.711562
Changes in producer's surplus (% of total revenue of hog production)	–8.569028

Table B-18 shows the changes in consumer's surplus, changes in processor's net revenue, and changes in producer's surplus from policy Scenario (c).

Scenario (c)

Table B-17 provides the impact of banning packer-owned hogs on quantities and prices of hogs and pork.

Table B-17. Percentage Changes in Wholesale Pork Prices and Hog Prices from Scenario (c)

Variable	Percentage Changes in Prices		Percentage Changes in Quantities	
Loin	P1	4.844295	Y1	–5.902172
Butt	P2	5.770456	Y2	–4.082730
Ham	P3	0.137115	Y3	7.453754
Rib	P4	0.781763	Y4	4.149452
Belly	P5	4.090397	Y5	–0.650994
Picnic	P6	3.877224	Y6	2.717540
Negotiated	W1	–6.643450	X1	133.800800
Contract	W2	–2.407050	X2	–1.107242
Packer owned	W3	–4.765950	X3	–100

B.5.1 Long-Run Effects of Restricting AMAs

Effects on prices, quantities, and economic surplus measures are also calculated for a 10-year adjustment period. These long-run estimates show more of the effects passed on to consumers.

Table B-18. Effects on Consumer's Surplus, Processor's Net Revenue, and Producer's Surplus from Policy Scenario (c)

Effect	Percentage Changes
Changes in consumer's surplus (% of total revenue of pork)	–3.737820
Changes in processor's net revenue (% of total revenue of pork)	0.704409
Changes in producer's surplus (% of total revenue of hog production)	–11.778780

Attachment 4 in this appendix develops the long-run supply elasticities for the three markets, which are 7.8, 2.4, and 2.4 for the spot, contract, and packer owned markets, respectively. The effects on prices; quantities; and surplus of consumers, processors, and producers using the disaggregated equilibrium displacement model are indicated below.

Scenario (a)

Table B-19 shows the long-run (10-year adjustment period) impact of restricting both contract and packer-owned hogs by 25% on quantities and prices of hogs and pork.

Table B-19. Percentage Changes in Wholesale Pork Prices and Hog Prices from Scenario (a) (10-year adjustment period)

Variable	Percentage Changes in Prices		Percentage Changes in Quantities	
Loin	P1	7.671774	Y1	–9.459999
Butt	P2	9.146756	Y2	–6.536973
Ham	P3	0.195929	Y3	11.834980
Rib	P4	1.228201	Y4	6.564803
Belly	P5	6.474005	Y5	–1.043934
Picnic	P6	6.108108	Y6	4.323851
Negotiated	W1	–5.266870	X1	128.152000
Contract	W2	–1.242450	X2	–25
Packer owned	W3	–2.160140	X3	–25

Table B-20 presents the long-run changes in consumer's surplus, changes in processor's net revenue, and changes in producer's surplus from policy Scenario (a).

Scenario (b)

Table B-21 shows the long-run impact of restricting both contract and packer-owned hogs on quantities and prices of hogs and pork to increase the spot market share to 25%.

Table B-20. Effects on Consumer's Surplus, Processor's Net Revenue, and Producer's Surplus from Policy Scenario (a) (10-Year Adjustment Period)

Effect	Percentage Changes
Changes in consumer's surplus (% of total revenue of pork)	–6.084669
Changes in processor's net revenue (% of total revenue of pork)	1.128958
Changes in producer's surplus (% of total revenue of hog production)	–10.350590

Table B-21. Percentage Changes in Wholesale Pork Prices and Hog Prices from Scenario (b) (10-Year Adjustment Period)

Variable	Percentage Changes in Prices		Percentage Changes in Quantities	
Loin	P1	4.271840	Y1	–5.267569
Butt	P2	5.093148	Y2	–3.639954
Ham	P3	0.109099	Y3	6.590022
Rib	P4	0.683894	Y4	3.655450
Belly	P5	3.604892	Y5	–0.581289
Picnic	P6	3.401151	Y6	2.407631
Negotiated	W1	–2.932727	X1	71.358330
Contract	W2	–0.691827	X2	–13.920640
Packer owned	W3	–1.202820	X3	–13.920640

Table B-22 provides the long-run changes in consumer's surplus, changes in processor's net revenue, and changes in producer's surplus from policy Scenario (b).

Scenario (c)

Table B-23 shows the long-run impact of banning packer-owned hogs on quantities and prices of hogs and pork.

Table B-22. Effects on Consumer's Surplus, Processor's Net Revenue, and Producer's Surplus from Policy Scenario (b) (10-Year Adjustment Period)

Effect	Percentage Changes
Changes in consumer's surplus (% of total revenue of pork)	–3.272983
Changes in processor's net revenue (% of total revenue of pork)	0.594490
Changes in producer's surplus (% of total revenue of hog production)	–5.347453

Table B-23. Percentage Changes in Wholesale Pork Prices and Hog Prices from Scenario (c) (10-Year Adjustment Period)

Variable	Percentage Changes in Prices		Percentage Changes in Quantities	
Loin	P1	7.164770	Y1	–8.729382
Butt	P2	8.534572	Y2	–6.038406
Ham	P3	0.202795	Y3	11.024190
Rib	P4	1.156237	Y4	6.137088
Belly	P5	6.049745	Y5	–0.962828
Picnic	P6	5.734460	Y6	4.019274
Negotiated	W1	–3.696744	X1	125.029400
Contract	W2	–0.749186	X2	–1.798047
Packer owned	W3	–2.824136	X3	–100

Table B-24 presents the changes in consumer's surplus, changes in processor's net revenue, and changes in producer's surplus from policy Scenario (c).

Table B-24. Effects on Consumer's Surplus, Processor's Net Revenue, and Producer's Surplus from Policy Scenario (c) (10-Year Adjustment Period)

Effect	Percentage Changes
Changes in consumer's surplus (% of total revenue of pork)	–5.660309
Changes in processor's net revenue (% of total revenue of pork)	–0.829551
Changes in producer's surplus (% of total revenue of hog production)	–6.155498

Attachment 1: Specification of Derived Demand for Pork Cuts

The theory of derived demand allows us to develop estimated demand relationships for pork cuts at the wholesale level that can be used to conduct economic surplus analysis much in the same way as the theory of consumer demand. Let Y_r , P_r , and E_r denote vectors of retail quantities, retail prices, and retail expenditures on pork. The system of consumer demand relationships can be expressed as follows:

$$Y_r = D_r(P_r, E_r) \quad . \tag{1}$$

The aggregate relationships between retail and wholesale prices (i.e., the inverse retail supply relations) can be expressed as follows:

$$P_r = S_r(P_w, C_r, Y_r) \quad , \tag{2}$$

where P_w is the vector of wholesale prices, and C_r is the vector of exogenous supply shifters (e.g., wage rates, energy prices). Input demand functions for the wholesale pork cuts by retailers are

$$Y_w = D_w(P_w, P_r, C_r) \quad . \tag{3}$$

The system of derived demand functions is obtained by solving the system of equations (1) and (2) for retail prices as a function of wholesale prices, exogenous supply shifters, and retail expenditures on pork,

$$P_r = P_r(P_w, C_r, E_r) \quad , \tag{4}$$

and then substituting the retail price functions from Eq. (4) into the wholesale input demand functions in Eq. (3):

$$Y_w = D_w[P_w, P_r(P_w, C_r, E_r), C_r] = \overline{D}_w(P_w, C_r, E_r) \quad . \tag{5}$$

Heiner (1982, 1984) and Braulke (1984) showed that these demand functions will possess the usual properties of symmetry and homogeneity (among all input prices) if the consumer demand functions are symmetric functions. This will not be true in general, as pointed out by Chavas and Cox (1997); however, if the retail demand functions are Hicksian demand functions, then these functions will be symmetric.

Another issue concerns the use of wholesale expenditure rather than retail expenditure as an explanatory variable. Note that real retail expenditures in log differential form can be written as

$$d \log \bar{E}_r = d \log E_r - \sum s_r d \log P_r \quad . \tag{6}$$

Likewise, real wholesale expenditures in log differential form is written as

$$d \log \bar{E}_w = d \log E_w - \sum s_w d \log P_w \quad . \tag{7}$$

The two will be equal if

$$\sum s_r d \log Y_r = \sum s_w d \log Y_w \quad . \tag{8}$$

In the somewhat plausible case where $d \log Y_r = d \log Y_w =$ d log Y for each pork cut, Eq. (8) reduces to

$$\sum (s_r - s_w) d \log Y = 0 \quad . \tag{9}$$

Thus, the relative change in real retail pork expenditures, Eq. (6), will equal the relative change in real wholesale pork expenditure, Eq. (7), if and only if the retail expenditure share of each cut equals its wholesale expenditure share. On the face of it, this seems entirely plausible, so it is imminently reasonable to reformulate the system of derived demand functions as follows:

$$Y_w = \bar{D}_w (P_w, C_r, \bar{E}_w) \quad . \tag{10}$$

This set of derived demand functions should be symmetric and homogenous of degree zero in wholesale pork prices and other input prices.

Attachment 2: Sources of Changes in Processing Costs

Using monthly farm–wholesale price spread for pork published by USDA over the time period that MPR was in effect, we estimated a relationship for the farm–wholesale price spread. The purpose of the exercise was to measure the effect of quantity of pork produced, effect of AMA supplies, and effect of market power on the price spread. In theory, the price spread between the farm and wholesale levels should reflect the marginal cost of producing wholesale pork. However, the price spread can also reflect market power and changes in market power as the proportion of hogs under contract and/or owned by companies increases (Azzam, 1998).

Our model follows the framework developed by Schroeter (1988). If the firm can exercise market power in both the output market (wholesale pork) and the market for the agricultural raw material input (slaughter hogs), then marginal revenue from producing another pound of pork can be expressed as

$$MR = P(1+\theta) \ ,$$

where P is wholesale price and θ / P is the marginal effect of the quantity produced on the pork price, which reflects the degree of market power in the output market. The marginal cost of procuring another pound of pork is $W_1(1+\phi)$, where W_1 is the hog price (per-unit wholesale quantity [i.e., carcass value]) and ϕ / W_1 is the marginal effect of quantity procured on the hog price, which reflects the degree of market power in the input market. The marginal cost of producing pork, consisting of the sum of procurement and production costs, equals

$$W_1(1+\phi) + \frac{\partial C}{\partial Y} \ ,$$

where $\frac{\partial C}{\partial Y}$ is the marginal production cost. Therefore, the general form of the price equation to estimate is[23]

[23] The assumption is made that there is a fixed transformation between the farm and wholesale levels. Other studies (Wohlgenant, 2001) have shown that this assumption will lead to overestimation of the degree of market power if there are variable, rather than fixed, proportions.

$$P(1+\theta) = W_1(1+\phi) + \frac{\partial C}{\partial Y} \quad . \tag{1}$$

Solving for output price and dividing by input price yields the expression

$$\frac{P}{W_1} = \frac{(1+\phi)}{(1+\theta)} + W_1^{-1}\frac{1}{(1+\theta)}\frac{\partial C}{\partial Y} \quad . \tag{2}$$

We assume the cost function is quadratic with the following form:[24]

$$C = F + W_1^{-1}(\boldsymbol{w'Aw})Y + (\boldsymbol{a'w})Y^2 \quad , \tag{3}$$

where F is fixed costs and w is the vector of processing input prices (e.g., labor, energy). The two most important processing inputs are labor and energy and time-series data on a monthly basis are readily available for these inputs. Therefore, these two input prices are used to specify production costs so Eq. (3) can be written as

$$C = F + W_1^{-1}(a_{22}W_2^2 + a_{33}W_3^2 + 2a_{23}W_2W_3)Y + (a_2W_2 + a_3W_3)Y^2 \quad . \tag{4}$$

Because of multicollinearity, we chose to aggregate labor (W_2) and energy (W_3) into one index using the Fisher Ideal index. Diewert (1976) has shown that this index is exact for a quadratic function, which is the case here, so little is lost by using this specification. Therefore, the cost function with an aggregate input price index is

$$C = F + W_1^{-1}(\alpha W_{FI}^2)Y + \beta W_{FI} Y^2 \quad , \tag{5}$$

where the subscript "*FI*" refers to the Fisher Ideal index. In addition to the above modifications, we also assume that both parameters in the cost function depend on the proportion of hogs procured through AMA supplies, *amashare*. Thus, the cost function is represented as

$$C = F + W_1^{-1}(\alpha_0 + \alpha_1 amashare)W_{FI}^2 Y + (\beta_0 + \beta_1 amashare)W_{FI} Y^2 \quad . \tag{6}$$

[24] This specification is different than other specifications in that all fixed and variable costs have been separated. Because the firm will not incur variable costs when output is zero, functions of variable input prices must interact with output, as indicated in this specification.

Finally, to account for the fact that market power, particularly in the input market, can depend on the proportion of hogs either under contract or packer owned, we make the parameter ϕ a function of $amashare$. If the relationship is linear, $\phi = \phi_0 + \phi_1 amashare$, Eq. (2) can be expressed as

$$\frac{P}{W_1} = \frac{(1+\phi_0 + \phi_1 amashare)}{(1+\theta)} + W_1^{-1}\frac{1}{(1+\theta)}\frac{\partial C}{\partial Y} \quad .$$

Differentiating total costs with respect to output and substituting for marginal cost yields

$$\frac{P}{W_1} = \frac{(1+\phi_0 + \phi_1 amashare)}{(1+\theta)} + \frac{1}{(1+\theta)}(\alpha_0 + \alpha_1 amashare)\left(\frac{W_{FI}}{W_1}\right)^2 + (\beta_0 + \beta_1 amashare)\left(\frac{W_{FI}}{W_1}\right)Y$$

or more simply

$$\left(\frac{P}{W_1}\right)_t = b_0 + b_1 amashare_t + (c_0 + c_1 amashare_t)\left(\frac{W_{FIt}}{W_{1t}}\right)^2 + (d_0 + d_1 amashare_t)\left(\frac{W_{FIt}}{W_{1t}}\right)Y_t + u_t \quad , \qquad (7)$$

where u_t is the error term.

Eq. (7) can be used to estimate separately the influence of market power and production costs on the farm–wholesale price spread. The markup/markdown value is estimated as the sum of the first two terms in Eq. (7). If markup power is present, then we would expect these two terms (evaluated at some data point, for example, the sample mean) to be significantly different from one and larger than one numerically. The coefficients associated with output in the marginal production cost portion of the equation (the last set of terms) indicate whether there are increasing, constant, or decreasing returns to scale. Also, it is possible to differentiate between the economies/diseconomies of scale depending on the source of input purchases. Finally, the equation allows us to estimate the net effect of AMA supplies on market power and marginal production costs.

The model, Eq. (7), was estimated with monthly data from August 2001 through September 2005, the period in which MPR was in effect. Data for wholesale and farm prices are USDA price spread data for pork, output is the quantity of pork produced in each month in the United States, and W_{2t} is an index of processing costs consisting of costs of slaughtering and energy prices.

In estimating Eq. (7) with time-series data, it is important to note that unit roots are present in the series, so it is important to include leads and lags of the right-hand variables in estimation (Phillips and Loretan, 1991). First-order differences on leads and lags were included in the model, but only first-order differences (as a group) were found significant and were retained. The estimated equation is shown in Table 1.[25] As indicated, AMA supplies have a positive impact on market power but a negative impact on marginal costs. At the sample mean, a one-unit change in output causes marginal costs to increase by only 7.36302×10^{-5}(elasticity at sample means equals 0.04). This suggests that the average firm in the industry is operating near constant returns to scale. The average markup/markdown is 1.108104 (coefficient on *amashare* multiplied by the mean value of *amashare*). The standard error of this coefficient estimate is 0.035196. For the null hypothesis of no market power (coefficient equal to one) the t-value is 3.07146. Therefore, we strongly reject price-taking behavior, although the degree of market power is modest.

The estimated covariances of the parameter estimates were used with the parameter estimates of the price spread equation to estimate the effect of AMA supplies on market power, AMA supplies on marginal costs, and net effect on the price ratio. In terms of elasticities, a 1% increase in AMA supplies leads to a 0.734617% increase in market power, with a standard error of 0.020228, holding marginal costs constant. A 1% increase in AMA supplies leads to a –4.99137% change in marginal costs, with a standard error of –1.67052, holding the degree of market power constant. The net effect of market power and efficiency gains from increased AMA supplies is therefore –1.47107%, with a standard error of –0.4021 for each 1% increase in AMA supplies. Thus, the benefits from increased AMA supplies outweigh increases in market power through decreased costs in procuring and processing pork.

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[25] The intercept was also found to be insignificant and was deleted from the model.

Table 1. Estimates of Farm–Wholesale Price Spread for Pork, August 2001–September 2005

Variable	Wholesale–Farm Price Ratio
$amashare_t$	1.278235 (0.0406)
$\left(\frac{W_{FIt}}{W_{1t}}\right)^2$	–21,806.8 (14,888.8)
$amashare_t \left(\frac{W_{FIt}}{W_{1t}}\right)^2$	27,004.8 (17,138.9)
$\left(\frac{W_{FIt}}{W_{1t}}\right) Y_t$	0.348274 (0.1153)
$amashare_t \left(\frac{W_{FIt}}{W_{1t}}\right) Y_t$	–0.39560 (0.1324)
$\Delta\left(\frac{W_{FIt}}{W_{1t}}\right)^2$	19,220.84 (8,887.1)
$\Delta\left[amashare_t \left(\frac{W_{FIt}}{W_{1t}}\right)^2\right]$	–22,217.7 (10,266.9)
$\Delta\left(\frac{W_{FIt}}{W_{1t}}\right) Y_t$	–0.23965 (–0.0708)
$\Delta\left[amashare_t \left(\frac{W_{FIt}}{W_{1t}}\right)^2 Y_t\right]$	0.273775 (0.0814)
R^2	0.96680
$\hat{p}$	0.622802 (0.1345)

Note: Values in parentheses are estimated standard error; $\hat{\rho}$ is the estimate of the first-order autocorrelation parameter.

Attachment 3: Monthly Demand for Pork and Market-Level Effects from Restricting AMA Supplies

We also estimated monthly wholesale demand for pork. The model estimated is a linear specification of per capita pork consumption as the dependent variable; independent variables are the deflated wholesale price of pork, deflated retail price of beef, deflated retail price of poultry (weighted average of chicken and turkey prices), and per capita deflated disposable personal income. In addition, first differences in lags and leads of the right-hand side variables are included in the model to account for the effect of unit roots in prices and income variables.[26] These results are shown in Table 1. These results are reasonable and have the expected signs except for the income variable, although it is statistically insignificant. The own-price elasticity of demand at the wholesale level is calculated to be –0.38, which is in the range of estimates obtained from other studies.

The estimated parameters of the price spread and the demand for pork were used to assess the validity of the economic surplus calculations from the 17-equation model. For this purpose, we also need the elasticity of supply for hogs. We used the weighted average of short-run elasticities for the spot and contract markets of 3.02 and 0.46, respectively, to obtain an aggregate short-run estimate of 0.79. The comparative statics formula for the total elasticity of farm price with respect to a 1% change in AMA supplies is

$$E_{famash} = \frac{\eta e_{wamash}}{(\varepsilon - e\eta)} ,$$

where η is the own-price elasticity of wholesale demand for pork ($\eta = -0.38$), e_{wamash} is the elasticity of wholesale price with respect to AMA supplies ($e_{wamash} = -1.47$), ε is the elasticity of farm supply ($\varepsilon = 0.79$), and e is the elasticity of price transmission of wholesale price with respect to farm price ($e = 0.86$). Using the above formula, the effect of a 25%

[26] First differences in leads were included to account for simultaneity, which appears to be present. There was no indication that seasonality was important for this sample period. The F-test for the null hypothesis that the monthly binary variables equals zero was 1.79. The critical value for the F-statistic at the 5% level is 2.22.

Table 1. Estimates of Monthly Wholesale Demand for Pork

Variable	Per Capita Pork Consumption
Constant	–2.65727 (5.6319)
Deflated wholesale pork price	–0.03523 (0.0151)
Deflated retail beef price	0.01416 (0.00841)
Deflated retail poultry price	0.111327 (0.0436)
Deflated per capita disposable personal income	–0.15254 (0.4373)
First-difference deflated wholesale pork price	–0.04335 (0.0225)
First-difference deflated retail beef price	–0.01386 (0.0137)
First-difference deflated retail poultry price	–0.08263 (0.0507)
First-difference deflated per capita disposable personal income	–0.08978 (0.4142)
First-difference (lead) deflated wholesale pork price	–0.46848 (0.0546)
First-difference (lead) deflated retail beef price	0.030095 (0.0125)
First-difference (lead) deflated retail poultry price	–0.02901 (0.0525)
First-difference (lead) deflated per capita disposable personal income	0.030956 (0.4147)
R^2	0.7787
D.W.	2.0216

D.W. is the Durbin-Watson statistic.

reduction in AMA supplies is the value of the formula multiplied by –25 and equals –12.6%. That is, a 25% reduction in all contracts and packer-owned hogs is predicted to decrease the spot price of hogs by 12.5%. How does this prediction compare with the disaggregated model? For the disaggregated model, this simulation predicts the spot price would decline 9%, which is close to the prediction from the aggregate model. Thus, it is reasonable to conclude that the disaggregate model does indeed produce reasonable results, if in fact we accept the aggregate model as a reasonable description of the pork industry.

Attachment 4: Long-Run Impacts of Changes in AMAs

One important way in which the long-run analysis differs from the short-run analysis is that producers would be free to move from one supply source to another. Economic theory would predict that, aside from transaction and transfer costs, prices on the different outlets should be equal. Thus, we might consider the average prices on the three outlets as reflecting in some sense intrinsic differences between returns on the three markets. These restrictions and an estimate of aggregate supply elasticity for the long run (i.e., 10-year adjustment period) would characterize the supply structure of the model and could be used with the demand-side parameters from the packer model and wholesale demand structure for pork to estimate the long-run economic surplus effects for the three scenarios.

However, in a regulatory environment, producers are not free to move from one market to the other. In particular, while producers can sell in the spot market, they would be forced to reduce supplies in the other markets. Thus, we would not necessarily expect proportionate changes in prices on the three market outlets, even in the long run.

An estimate of supply response of hogs over a 10-year period was obtained from an econometric model of the hog industry using state-level annual data from USDA, ARMS from 1994 to 2001. By pooling cross-section time-series data, we were able to enlarge the sample and account for heterogeneity in production across the country. The particular model estimated was a dynamic model. The structural model gives end-of-the-year inventory of farrowing sows as a linear function of beginning-of-the-year inventory and the present discounted value of quasi rents from farrowing sows. Market hog production is then determined by multiplying the number of sows farrowing by the number of pigs per litter and average weight per market hog. Empirically, only sows farrowing was found to be price responsive so that the percentage change in number of sows farrowing over time in response to a price change is equivalent to the percentage change in quantity of market hogs sold in response to a price change. The model estimated had the general form (Wohlgenant, 2005),

$$b_{t+1} = \lambda_1 b_t + \lambda_1 \beta\omega \sum_{j=0}^{\infty} (\lambda_1 \beta)^j Em_{t+1+j} \quad , \qquad (1)$$

where b_{t+1} is the end-of-the-year inventory of farrowing sows, Em_{t+1+j} is expected quasi rents (i.e., hog price minus feed costs per pound market hog) in year $t+1+j$, and the other terms in the equation are parameters to estimate. The expected quasi rents were related to observed prices of hogs, corn, and soybean meal by assuming producers form quasirational expectations. This modeling approach says that producers look to the past history of the price variable in question and form forecasts based on the best univariate time-series model. Nerlove and Bessler (2001) argue that this model of expectations is preferable to the alternatives available in the literature. Using this approach, we found that the optimal price predictors for both hog prices and feed prices (weighted average of corn and soybean meal prices) indicated that producers only need to look at last year's price when forming price expectations. With these specifications for price expectations and the supply model indicated above, we identified and estimated the parameters of the supply model. The estimated supply model is

$$b_{it+1} = const + 0.7735 b_{it} + 1.035 \sum_{j=0}^{\infty} (0.7367)^j Ep_{it+1+j} \quad , \qquad (2)$$

where the subscript "i" refers to a particular state. The advantage of this model is that expectations are separated from adjustment costs so that supply elasticities can be calculated for different scenarios for how producers respond to interventions. In the present application, it seems reasonable that producers would view restrictions on AMA supplies as permanent. Therefore, it is reasonable to model price effects as though the price changes would be the same in all future periods. The supply equation, with all future prices set equal to one another, is

$$b_{i+1} = const + 0.7735 b_i + \frac{1.035}{(1 - 0.7367)} p_i^* = const + 0.7335 b_i + 3.931\, p_i^* \quad , \qquad (3)$$

where p_i^* represents the steady-state, or long-run expected price of state i. For a 10-year adjustment period, the price elasticity of supply can then be represented by solving the above dynamic equation for 10 years and multiplying by the ratio of the steady-state price to inventory level:

$$\varepsilon_i^{lr} = \sum_{j=0}^{10} (0.7735)^j \frac{\partial b_{i+1}}{\partial p_i^*} \frac{p_i^*}{b_{i+1}} \quad . \tag{4}$$

On average, for all hog-producing states, the elasticity at the sample means was estimated to be 4.2.

To estimate the effects of restricting AMA supplies on the hog market with the disaggregate model, it is necessary to obtain long-run elasticities (i.e., elasticities over a 10-year adjustment period) for each of the three markets: spot, contract, and packer owned. The short-run elasticities were assumed to be 3.02, 0.46, and 0.46 for the three markets, respectively. If we assume that each of these markets adjusts at the same rate over time, then we can obtain long-run elasticities for these three markets using the following relationships:

$$\varepsilon = k_1\varepsilon_1 + k_2\varepsilon_2 + k_3\varepsilon_3 \tag{5}$$

$$\begin{aligned} \varepsilon_1 &= \frac{\varepsilon}{k_1 + k_2(\varepsilon_2 / \varepsilon_1) + k_3(\varepsilon_3 / \varepsilon_1)} \\ \varepsilon_2 &= \frac{\varepsilon}{k_1(\varepsilon_1 / \varepsilon_2) + k_2 + k_3(\varepsilon_3 / \varepsilon_2)} \\ \varepsilon_3 &= \frac{\varepsilon}{k_1(\varepsilon_1 / \varepsilon_3) + k_2(\varepsilon_2 / \varepsilon_3) + k_3} \quad . \end{aligned} \tag{6}$$

Each of the relationships in Eq. (6) is obtained by successively solving Eq. (5) for each of the elasticities of supply. If we assume that the relationship between the elasticities for each market is the same in the long run as in the short run, then we can use that information with the market shares to calculate long-run elasticities for each market. The mean cost shares are $k_1 = 0.13, k_2 = 0.67, \text{ and } k_3 = 0.20$. Thus, the long-run elasticities for the spot, contract, and packer owned markets are

$$\begin{aligned} \varepsilon_1 &= 7.8 \\ \varepsilon_2 &= 2.4 \\ \varepsilon_3 &= 2.4 \quad . \end{aligned}$$

Appendix C: ARMS Data Set

In this appendix, we describe the ARMS data set used in conducting the analysis in Section 5. We obtained the data set from the *Agricultural Resource Management Survey Phase III, Hogs Production Practices and Costs and Returns Report, Version 4, for 2004*[1] (hereafter, ARMS III V4, 2004). ARMS Phase III data are collected at the farm level to obtain information about farm financial statements, production practices, and farm operators' household characteristics. Commodity-specific information is collected on a rotating basis. The special hogs survey is done every 6 years: 1992, 1998, and 2004. The data from different years do not form a panel; rather they represent independent cross sections. ARMS III V4, 2004 was collected from a series of interviews with 1,414 farm operators from 19 states.[2]

The ARMS III V4, 2004 survey responses consist of all types of hogs sold/marketed/removed during 2004. Because our major concern is with market hogs, defined as hogs sold directly for slaughter, we deleted the records for farmers who do not sell market hogs. This step reduced the sample size to 906. Market hog transactions are captured in three different channels: cash/open market sales, marketing contracts, and production contracts. Among 906 farmers who sell market hogs, a great majority used only one channel: 532 farmers used cash sales,

[1] ARMS has been conducted by USDA's Economic Research Service (ERS) and National Agricultural Statistics Service (NASS) since 1975. More information and survey questionnaires can be found at http://www.ers.usda.gov/data/arms/globaldocumentation.htm.

[2] These states are AR, CO, GA, IL, IN, IA, KS, KY, MI, MN, MO, NE, NC, OH, OK, PA, SD, VA, and WY.

328 used production contracts, 21 used marketing contracts, 20 used a combination of marketing contracts and cash sales, and 5 used production contracts and cash sales. None of the respondents used all three channels at the same time. Because very few farmers use marketing contracts and marketing contracts and cash sales have many similarities, we combined them into one category, hereafter referred to as the cash/marketing channel.[3]

In Section P of ARMS, farm operators are asked to report the number of head of market hogs sold on the open market or under a marketing contract and the total dollar amount received for these sales. Using these responses, we constructed the quantities (q^1) and average prices (p^1) of market hogs sold through the cash/marketing channel. In the same section, farmers are asked to report the number of head of market hogs removed under a production contract. However, the final per-unit fee received under production contracts was reported in Section D, where the survey uses a different method of classifying hogs. Instead of market hogs, the survey uses commodity codes for the various types of hogs. For our analysis, we used *farrow to finish* (807), *grower to finish* (808), and *finisher* (809) hogs because all these contracts lead to the production of market hogs. Another problem is that for some observations the grower compensation fees are recorded on a per-animal space basis instead of on a per-head basis. In this case, we converted per-pig space fees into per-head fees using the available information in Section P of ARMS such that the quantities (q^2) and fees (p^2) for market hogs removed under production contracts are reported in the same units as prices and quantities in the cash/marketing channel.

We also extracted a number of variables describing farmers' socioeconomic characteristics. After deleting several outliers and accounting for missing observations, we ended up with 738 observations. Among these 738 farmers, 457 farmers use cash/marketing arrangements, 279 farmers use production

[3] The relatively small representation of marketing contracts does not seem to be in line with other publicly available sources of market hogs transactions data such as MPR. Personal communication with ERS and NASS personnel revealed that this phenomenon results because ARMS targets only farmers, whereas marketing contracts are largely used by integrators (not included in the survey) who contract the production of live hogs with farmers but use marketing contracts to sell live hogs to packers.

contracts, and only 2 farmers reported using both. We deleted these two observations because we believe that the simultaneous use of production contracts and other marketing arrangements may actually be prohibited by the majority of integrators or packers, so these two observations may be flawed.[4] The final sample consists of 736 farmers.

The variable names, descriptions, and summary statistics are reported in Table C-1. Two important features of the data set stand out. First, farmers who use cash/marketing arrangements are smaller and on average sell 4,098 hogs per year. Contract producers are larger and on average produce 8,680 hogs per year. Second, the average price recorded for cash/marketing arrangements is $119.75 per hog, while the average grow-out fee for production contracts is only about $13.41 per hog. This large spread reflects the differences in provision of inputs between the two different types of marketing arrangements and naturally leads to similar differences in production costs between the two AMAs.

Each observation in the ARMS survey has a different weight, or expansion factor. The weights reflect each observation's probability of selection and can be used to prepare population estimates from the survey results. These weights are designed to expand certain variables such that they match the total industry numbers. For example, in the hog survey case, these expansion factors are calculated to correctly expand the inventory of all hogs and pigs on December 31, 2004, to match the number reported by NASS. The population estimate from ARMS is 57,851,816, and the total number of hogs and pigs on December 1, 2004, reported by NASS is 60,501,000.[5] Using these weights, we expanded the number of market hogs sold or removed in ARMS 2004 to obtain the population estimate of 82,012,081. This number can be compared with the estimates from several other sources. The number of market hogs sold in 19 states in 2004 reported in the National Pork Board Checkoff system is 91,537,136, the number of hogs sold in the MPR is 92,554,641, and the number of hogs slaughtered reported by NASS is 103,573,000.

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[4] This is most definitely the case in the poultry industry where production contracts explicitly prevent contract operators from keeping other birds on the farm.

[5] See Table 7–25 in *Agricultural Statistics*, United States Department of Agriculture, 2005.

Table C-1. Summary Statistics for the ARMS Data, 2004

Variable	Definition	Mean	Std. Dev.
cons	Constant	1	NA
farmtype	1 if hog operation is the main business	0.6277	0.4837
farmsize	Log of the acreage of the farm	4.6468	1.9650
east	1 if in NC, VA, and GA	0.2092	0.4070
midwest	1 if in Western Cornbelt	0.6821	0.4660
offincome	Log of off-farm income	3.5732	5.2006
age	Age divided by 10	5.0601	1.0623
educ	1 if at least has some college	0.5285	0.4995
nfamily	Number of family members	3.3166	1.7353
nfasset	Log of value of nonfarm assets	10.0015	3.9855
q^1	Number of hogs for cash/marketing farmer (10,000 head)	0.4098	1.4917
q^2	Number of hogs for production farmer (10,000 head)	0.8680	0.9330
p^1	Price per hog for cash/marketing farmer ($)	119.7453	21.5121
p^2	Price per hog for production farmer ($)	13.4087	6.4846

Note: Number of observations for q^1 and p^1 is 457, number of observations for q^2 and p^2 is 279, and number of observations for other variables is 736.

NA = Not applicable

To determine how well the expansion weights predict the number of hogs by states, we examined the three largest hog-producing states in the country: Iowa, North Carolina, and Minnesota. As Table C-2 indicates, after eliminating the outliers and the observations with missing values, the shares of expanded total hog sales in these three states are reasonably close to the National Pork Board Checkoff data. This comparison assures us that the sample used to estimate the farmers' supply of live hogs is not likely to suffer from sample selection bias.

Table C-2. Comparison of ARMS and National Pork Board Checkoff Data: Number of Hogs in Key States

	ARMS		
State	**Expanded Total Before Eliminating Outliers (%)**	**Expanded Total After Eliminating Outliers (%)**	**National Pork Board Checkoff System (%)**
Iowa	32.95	27.36	30.10
Minnesota	14.09	15.90	13.33
North Carolina	16.67	19.92	15.90

Appendix D: Estimation of Factor Demand Elasticities

To conduct the model simulations described in Section 5.3, we needed to estimate the industry inverse factor demand equations for live hogs through different channels (Eq. [5.21]) and the downstream consumer inverse demand (Eq. [5.22]). We obtained our data on the farmers' supply of hogs from ARMS 2004. Therefore, it would be most desirable to obtain factor demand elasticity estimates using the annual data. However, annual hog transactions data for different marketing arrangements are not available. Thus, we estimated the factor demand elasticities for different channels by aggregating the original *USDA/AMS Mandatory Price Reports* (MPR) daily data into monthly averages. Quantities are expressed as the monthly sums of slaughtered hogs, and prices are simple monthly averages of daily prices in dollars per head. The time period covered by the data is August 6, 2001, through February 22, 2006.

MPR records the transactions of *National Daily Direct Hog Prior Day—Slaughtered Swine* through six marketing arrangements:

- **Negotiated Purchase (MA1):** Cash or spot market purchase of hogs by a packer from a producer.
- **Other Market Formula Purchase (MA2):** Pricing mechanism is a formula price based on any market other than the market for hogs, pork, or pork products.
- **Swine / Hog Market Formula Purchase (MA3):** Pricing mechanism is a formula price based on a market for hogs, pork, or pork products.
- **Other Purchase Arrangements (MA4):** Other purchase arrangements include long-term contract

agreements; fixed price contracts; cost of production formulas; and formula purchases with a floor, window, or ceiling price.

- **Packer Owned (MA5):** Hogs that a packer owns for at least 14 days before slaughter.
- **Packer Sold (MA6):** Hogs that are owned by a packer and sold for slaughter to another packer.

Because the above channels do not match the definition of the alternative marketing channels in the ARMS data set, we combined marketing arrangements in the MPR to match the farmers' side data from ARMS. However, the exact correspondence is not possible to achieve. The reason for this is that ARMS data underrepresent the number of hogs coming from marketing contracts, and the MPR data underrepresent the number of hogs coming from production contracts. This is because ARMS surveys producers/farmers who predominantly use either cash markets or production contracts and rarely use marketing contracts. Marketing contracts are predominantly used by integrators who have production contracts with farmers and sell their finished hogs to packers using marketing contracts. The hogs produced under production contracts and sold to packers using marketing contracts do not appear under MA5 because this category only includes hogs owned by packers (both production contracts with independent producers or packer-owned farms). Instead, they appear under one of the marketing contracts categories (MA2–MA4).

Therefore, we grouped the marketing arrangements so that MA1 was kept by itself and MA2, MA3, MA4, and MA5 were grouped together into one category. Because the packer-owned hogs category (MA5) does not report prices (because these transactions are internal to the company), we used packer-sold (MA6) prices and paired them together with the packer-owned (MA5) quantities. Hogs recorded under packer sold (MA6) might come from all different channels (some of which could have been also bought on the spot market); thus, we excluded them from either of the two groupings. Because MA6 amounts to only 2.11% of the total hogs slaughtered in 2004, the potential error appears to be quite small. When creating the quantities and prices for the second channel (MA2+MA3+MA4+MA5), we took the sum of quantities from each channel and computed the weighted average of the prices using the quantities as weights. Finally, the correspondence with the supply side of the model is established by matching MA1 with the joint cash and marketing contracts arrangements (d = 1) and (MA2+MA3+MA4+MA5) with the production contracts arrangements (d = 2).[1]

To estimate the system of two factor inverse demand equations and one downstream consumer inverse demand equation, we needed to address the following two issues: (1) accounting for the endogeneity of the prices and quantities and (2) identifying the demand functions rather than supply functions. Carefully chosen instrumental variables resolve these two issues. We use live hog supply shifters in all three equations. Thus, the candidates for instrumental variables are variables that affect the live hog production costs including price of corn (P_{corn}), price of soybean meal (P_{sbm}), price indices of natural gas (P_{ngas}), price index for gasoline (P_{gas}), and price of feeder pigs ($P_{feedpig}$).[2] These variables can be also viewed as supply shifters for pork because they affect packers' demand for live hogs, which is closely related to the supply of pork.

We obtained the data series for the instrumental variables from publicly available sources. The data on feeder pig prices were obtained from the MPR (http://mpr.datamart.ams.usda.gov). Prices of corn and soybean meal were obtained from the Commodity Research Bureau (http://www.crbtrader.com/). The gasoline price index was obtained from the Bureau of Labor Statistics, U.S. Department of Labor (http://www.bls.gov/).

The 2SLS estimation results are summarized in Table D-1. In conducting the estimation, we imposed the restriction of the equal cross elasticities of the two channels in the inverse factor demand equations. We also tried different combinations of five instrumental variables. The combinations of instruments {P_{corn}, $P_{feedpig}$, P_{gas}} yield the smallest mean squared error, the smallest variance of individual parameter estimates, and the best goodness of fit. All the parameter estimates have the correct signs, though some of them are not significant.

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[1] The other possibility would be to match (MA1+MA2+MA3+MA4) with d = 1 and MA5 with d = 2. However, the error committed in this matching is, in our opinion, larger, and the estimation of the factor demands produces unreasonable results.

[2] The price of feeder pigs would be an endogenous variable if the system of equations consisted of both live hog supply and demand because most farmers who supply live hogs also supply feeder pigs. However, our current model consists of only factor demand equations; hence, feeder pig price is a valid instrument.

Table D-1. Estimation Results for Factor Demands and Pork Demand

Variable	Estimate	t-stat	Variable	Estimate	t-stat	Variable	Estimate	t-stat
	$\overline{p}^{cash}$			$\overline{p}^{production}$			$\overline{p}^{pork}$	
α_0	36.923	3.73	β_0	16.168	1.36	γ_0	22.558	1.21
α_1	–1.477	–3.29	β_1	–0.874	–2.56	γ_1	–0.927	–2.26
α_2	–0.874	–2.56	β_2	–0.091	–0.16	γ_2	–0.464	–0.47
α_3	0.449	1.31	β_3	0.502	1.97	γ_3	0.333	1.36
R^2	0.584		R^2	0.575		R^2	0.25	

Note: $\overline{p}^{cash}$ is average prices packers pay for live hogs under cash/marketing contract arrangements, $\overline{p}^{production}$ is the average price for live hogs under production contracts, and $\overline{p}^{pork}$ is the average price of pork in the downstream market (see Eq. [5.23]).

January 2007

GIPSA Livestock and Meat Marketing Study

Contract No. 53-32KW-4-028

Volume 5: Lamb and Lamb Meat Industries

Final Report

Prepared for

Grain Inspection, Packers and Stockyard Administration
U.S. Department of Agriculture
Washington, DC 20250

Prepared by

RTI International
Health, Social, and Economics Research
Research Triangle Park, NC 27709

RTI Project Number 0209230

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Abstract

Over time, the variety, complexity, and use of alternative marketing arrangements (AMAs) have increased in the livestock and meat industries. Marketing arrangements refer to the methods by which livestock and meat are transferred through successive stages of production and marketing. Increased use of AMAs raises a number of questions about their effects on economic efficiency and on the distribution of the benefits and costs of livestock and meat production and consumption between producers and consumers. This volume of the final report focuses on AMAs used in the lamb and lamb meat industry and addresses the following parts of the Grain Inspection, Packers and Stockyard Administration (GIPSA) Livestock and Meat Marketing Study:

- Part C. Determine extent of use, analyze price differences, and analyze short-run market price effects of AMAs.
- Part D. Measure and compare costs and benefits associated with spot marketing arrangements and AMAs.
- Part E. Analyze the implications of AMAs for the livestock and meat marketing system.

This final report follows the publication of an interim report for the study that used qualitative sources of information to identify and classify AMAs and describe their terms, availability, and reasons for use. The portion of the study contained in this volume of the final report is based on quantitative analyses using transactions data, Mandatory Price Reporting (MPR) data, other publicly available data, and the results of the industry survey and industry interviews.

This volume of the final report presents the results of analyses of the effects of AMAs on the markets for lambs and lamb products. Economic and statistical models were developed and estimated to examine the effects of AMAs on lamb prices, procurement costs, quality, price risk, and consumers and

producers. Results of analyses of the estimated effects of hypothetical restrictions on AMAs also are presented.

The principal contributors to this volume of the final report are the following:

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Executive Summary

As part of the congressionally mandated Livestock and Meat Marketing Study, this volume of the final report presents the results of analyses of the effects of alternative marketing arrangements (AMAs) on the lamb and lamb meat industries. This final report focuses on determining the extent of use of AMAs, analyzing price differences and price effects associated with AMAs, measuring the costs and benefits associated with using AMAs, and assessing the broad range of implications of AMAs. The analyses in this volume were conducted using the results of industry interviews, the industry survey, and analysis of Mandatory Price Reporting (MPR) data and other publicly available data sources. Transactions data from lamb packers were used to validate MPR data used in the analyses.

In this report, AMAs refer to all possible alternatives to cash or spot market. AMAs include arrangements such as forward contracts, marketing agreements, procurement or marketing contracts, packer ownership, custom feeding, and custom slaughter. Cash or spot market transactions refer to transactions that occur immediately, or "on the spot." These include auction barn sales; video or electronic auction sales; sales through order buyers, dealers, and brokers; and direct trades.

Primary conclusions for this final report, as they relate to the lamb and lamb meat industries, are as follows:

- **Lamb packers procure fed lambs primarily through formula pricing arrangements and auctions.** According to MPR data, lamb packers procure 42.2% of fed lambs through formula pricing arrangements and 39.4% through auctions. Negotiated sales account for 12.0% of fed lamb procurement, and packer ownership represents 4.9%. Contracted procurement represents only 0.8% of lamb procurement, while imports represent only 0.7%. These data are similar to those obtained from the lamb packer survey.

- **The means and standard deviations of fed lamb prices from MPR data for formula pricing and cash arrangements were similar during the sample period.** The price series were highly correlated with an estimated correlation coefficient of 0.970. A reduced-form model of the difference between normalized formula pricing and cash fed lamb prices indicated that lamb inventories, lamb carcass price risk, and seasonality were the primary determinants of variations in the difference.
- **Changes in procurement methods for lamb would impose costs on the lamb marketing system by reducing efficiencies, but may also provide some benefits by altering potential market power effects.** If formula pricing procurement is restricted, lamb acquisition costs would rise. However, some of this increase in costs may be offset by a reduction in potential oligopsony power. Ultimately, a combination of these effects yields net changes in lamb prices, quantities, and producer surplus.
- **Given that lamb markets are relatively thin, the primary effect of MPR may have been to reduce price risk rather than to influence price levels.** The implementation of MPR in 2001 increased slaughter lamb price by only 0.129%.
- **AMAs were found to have statistically significant although economically small effects on lamb prices.** A 10% increase in formula pricing lamb procurement would increase the slaughter lamb price by an estimated 2.54%; this effect is likely due to risk reductions. A 10% increase in cash lamb procurement increases slaughter prices by an estimated 2.68%. A 10% increase in packer ownership reduces slaughter lamb prices by an estimated 0.23%.
- **Increases in formula pricing and cash procurement methods reduce lamb procurement costs, while increases in packer ownership increase procurement costs.** The effects of formula pricing and cash procurement methods on procurement costs for lambs were similar and not statistically different from one another.
- **Technological change has likely increased lamb quality over time.** However, there does not appear to be any statistically significant difference in the quality of

lambs procured through formula pricing and cash procurement methods.

- **Price risk shifting from lamb producers to lamb packers and breakers has not occurred as a result of AMAs.** No statistical difference was found between the variances of prices for each type of AMA.
- **Restrictions on the use of AMAs cause almost every sector in the lamb industry to lose producer surplus, even if potential market power (if it exists) is reduced or eliminated.** Reductions in the use of AMAs have both positive and negative effects on the lamb industry. Reductions in potential market power (a positive effect) do not offset the increases in processing costs and reductions in lamb quality (negative effects).
- **Restrictions on the use of AMAs would likely reduce the competitiveness of the lamb industry.** Although lamb is not a strong substitute for beef and pork, restrictions on the use of AMAs would place it at a competitive disadvantage to these other meats. More importantly, however, it appears that imported lamb is a strong substitute for domestic lamb. Hence, the loss of competitiveness in response to restrictions on the use of AMAs is much more pronounced with respect to lamb imports.
- **AMAs may have multiple effects on accessing the lamb market.** Ease of entry may be affected by the availability of AMAs, because financing of production operations often depends on the assurance of market access and price risk management. However, for small producers, it may be more difficult to secure AMAs because it is more costly for packers to negotiate with many small producers relative to fewer large producers. Hence, if AMAs reduce the viability of public auctions, small producers may find that their market access is limited.
- **Restrictions on the use of AMAs may increase concentration of various segments of the lamb industry, but the effect of increased concentration on market power is unknown.** There are no clear effects of the changes in the use of AMAs on concentration in the lamb industry. Concentration in the lamb packing industry has remained relatively flat, even though the use of AMAs has increased. However, increased use of AMAs may reduce the viability of auctions and could lead to increased concentration in the lamb feeding sector. In addition, if restrictions on AMAs

reduce the competitiveness of domestic lamb meat relative to lamb imports, then concentration in the lamb packing and processing industry is likely to increase in response to declining domestic demand.

The analyses presented in this volume are based on the best available data, using methodologies developed to address the study requirements under the time constraints of the study. Some analyses were limited based on availability of transactions and profit and loss (P&L) statement data. However, secondary data were used, as available, to conduct the analyses.

1 Introduction and Background

AMAs include all possible alternatives to use of cash or spot markets for conducting transactions.

As part of the congressionally mandated Livestock and Meat Marketing Study, this volume of the final report presents the results of analyses of the effects of AMAs in lamb and lamb meat industries. The types of questions posed by the Livestock and Meat Marketing Study include the following: What types of marketing arrangements are used? What is the extent of their use? Why do firms enter into the various arrangements? What are the terms and characteristics of these arrangements? What are the effects and implications of the arrangements on participants and on the livestock and meat marketing system?

The overall study comprises five parts based on the performance work statement in the contract with the Grain Inspection, Packers and Stockyard Administration (GIPSA). An interim report released in August 2005 addressed the first two parts, Parts A and B, of the study (Muth et al., 2005). It described marketing arrangements used in the livestock and meat industries and defined key terminology.[1] Results presented in the interim report were preliminary because they were based on assessments of the livestock and meat industries using published data, review of the relevant literature, and industry interviews.

This final report describes the results of quantitative analyses addressing Parts C, D, and E of the study as follows:

- Part C. Determine extent of use, analyze price differences, and analyze short-run market price effects of AMAs.

[1] A glossary of terms used in the study is included in a separate document.

The interim report released in August 2005 addressed the first two parts of the study. This final report focuses on the final three parts of the study (Parts C, D, and E).

- Part D. Measure and compare costs and benefits associated with spot and AMAs.
- Part E. Analyze the implications of AMAs for the livestock and meat marketing system.

The analyses presented in this volume address these final three parts of the study using information from industry interviews,[2] data from the industry surveys (described in Volume 2), transactions data and profit and loss statements from packers and processors, and a variety of publicly available data. Analyses conducted for the Livestock and Meat Marketing Study are limited to economic factors associated with spot and AMAs and do not analyze policy options or make policy recommendations.

1.1 OVERVIEW OF THE LAMB AND LAMB MEAT INDUSTRIES

In this section, we describe the stages of lamb production and location of operations as background information for analyses described in later sections of this volume.[3]

1.1.1 Stages of Lamb Production

The specific stages of slaughter lamb production include feeder lamb production, backgrounding, feeding, packing, and processing or breaking.[4] In some cases, all of these stages are distinct production stages. However, production, backgrounding, and feeding are often combined at the livestock production stage, and packing and breaking are often combined at the meat production stage.

This biological cycle results in the majority of lambing occurring in the spring.

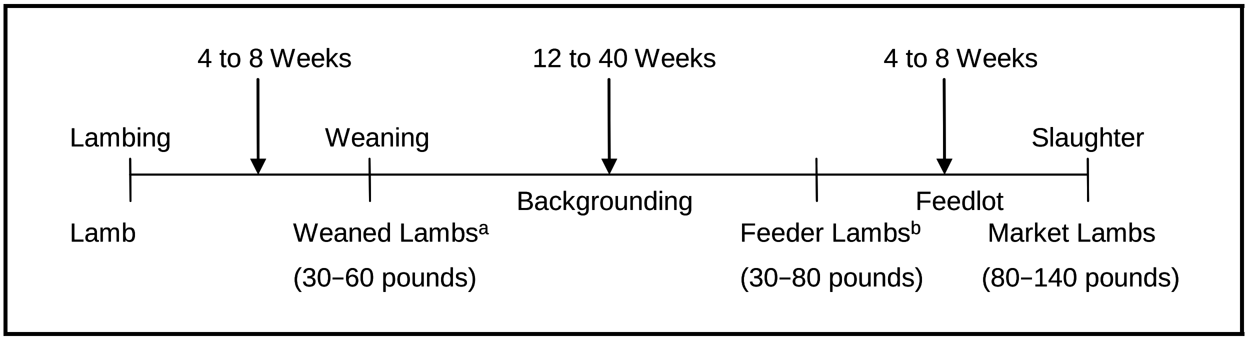
Most sheep can only be bred during specific times of the year. The breeding season tends to be induced by the shorter days of fall (Kott, 2004). This biological cycle results in the majority of lambs born in the spring. Newborn lambs will remain with ewes for 4 to 8 weeks before they are weaned (Figure 1-1). During the nursing period, lambs will gradually increase their intake of

[2] A description of the process for conducting the interviews and the complete findings from the interviews are provided in the interim report (Muth et al., 2005).

[3] A more complete overview of the lamb and lamb meat industries is provided in the interim report (Muth et al., 2005).

[4] Breaking refers to cutting carcasses into primal, subprimal, and other meat cuts. Although the term “breaking” has been used in the past for all meat species, it is now usually only used in the lamb industry.

Figure 1-1. Lamb Production Timeline
Lamb production time varies depending on the type of meat desired.



[a] Lambs sold for slaughter after weaning are referred to as milkfat lambs.
[b] Some feeder lambs are sold for slaughter after being backgrounded and are referred to as market lambs.

forages. After weaning, lambs can be sent directly to a feedlot, or they may be backgrounded. Lambs that go directly to feedlots are targeted to specific markets that desire young lambs. Backgrounding refers to providing lambs forages while they increase frame size and body mass. At this stage, lambs are referred to as feeder lambs. Feeder lambs are then placed in feedlots where they are fed a grain-based diet to bring them to slaughter weight and increase intramuscular marbling. Some lambs never enter a feedlot and are strictly grass fed; however, grain-fed lamb dominates U.S. production. The weight of finished market lambs varies, but the average liveweight is 135 pounds.

The production stages have remained relatively unchanged over time, but an increase in vertical integration within the industry has prompted several stages to be performed by a single entity or producer-owned cooperative.

Finished lambs are sent to a packer where they are slaughtered and the pelts and offal are separated from the fresh meat. Lamb carcasses are inspected by the U.S. Department of Agriculture/Food Safety Inspection Service (USDA/FSIS) or a state government inspection service. They are also usually quality graded by USDA/Agricultural Marketing Service (AMS).[5] Packers either sell carcasses to breakers or sell fabricated cuts. Breakers facilitate the distribution of lamb to consumers. Breakers exist in the industry because of geographical distances that separate packers from consumers and because of the relatively low volumes of lamb that are required by retail outlets. Increasingly, packers perform much of the initial breaking and boxing of cuts.

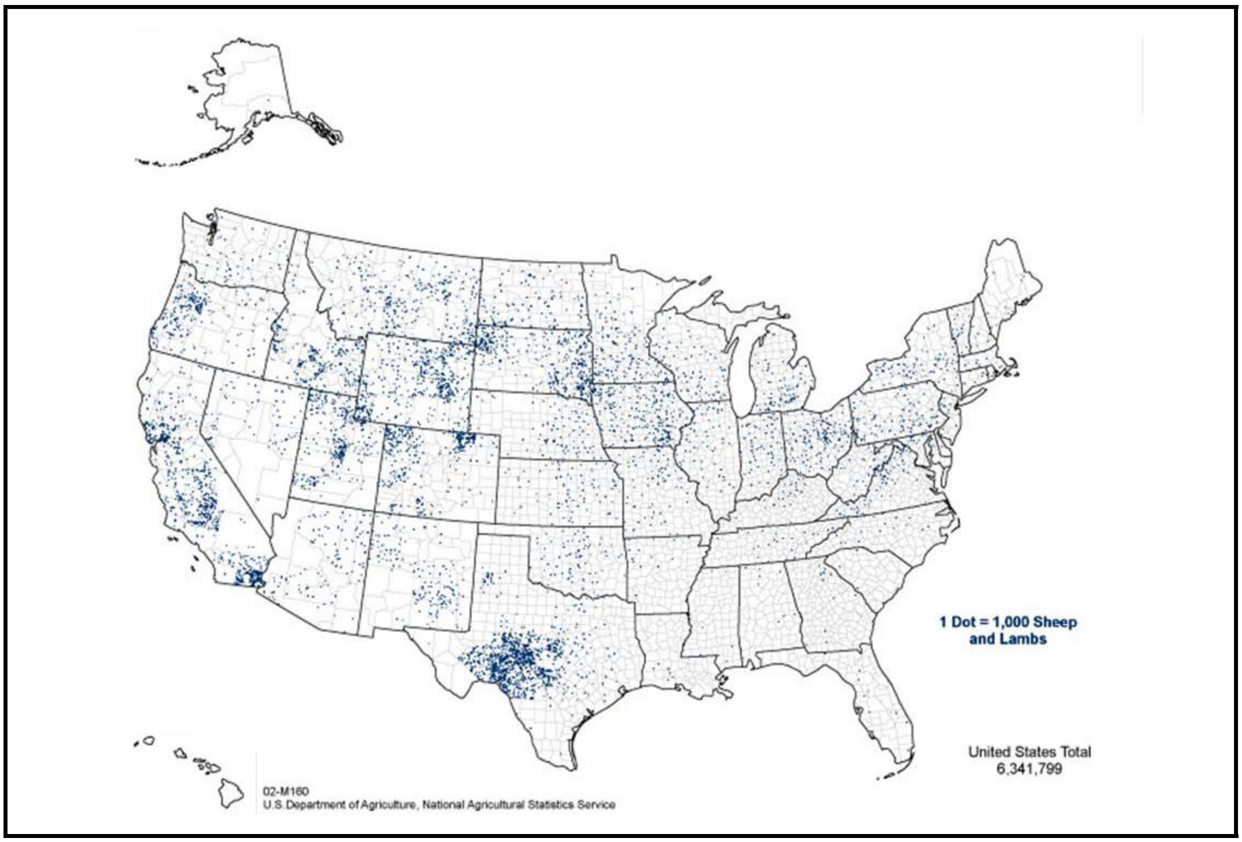
[5] The quality grades differ between lamb and beef, with lamb using Prime, Choice, Good, and Utility grades and beef using Prime, Choice, Select, and Standard (Other) grades.

The production stages have remained relatively unchanged over time, but an increase in vertical integration within the industry has prompted several stages to be performed by a single entity or producer-owned cooperative. Some producers not only sell feeder lambs to feedlots but also sell finished lambs to packers, carcasses to breakers, and meat products to retailers and food service providers.

1.1.2 Locations of Sheep and Lamb Operations

Lamb production occurs in all 50 states (Figure 1-2); however, flock sizes vary significantly by geographic location. Small flocks are located throughout the country, and many are part of diversified or hobby farms. Large flocks are typically located in the western part of the country, where large tracts of land are available for grazing. In 2002, 88% of sheep farms had fewer than 100 head, but these small farms represented only 22% of total sheep inventories.

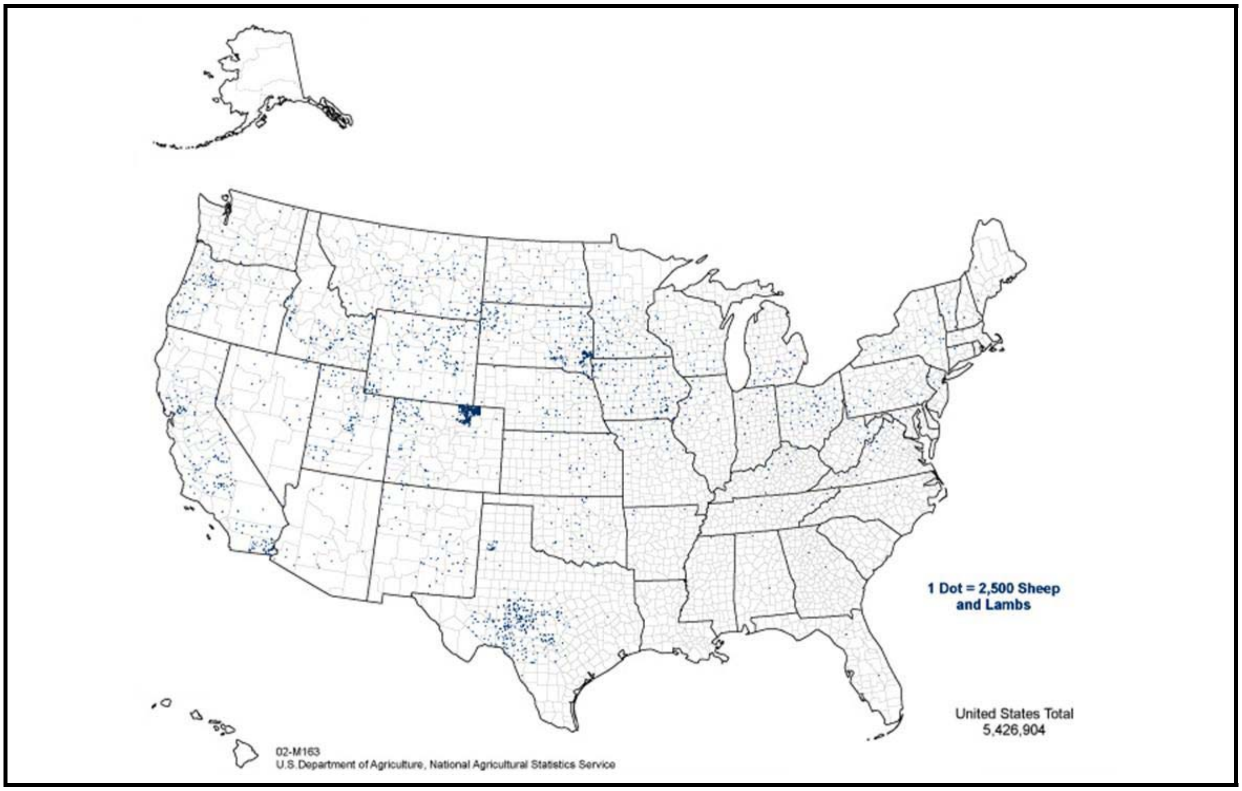
Figure 1-2. U.S. Inventory of Sheep and Lambs, 2002
Sheep are raised throughout the country.



Source: U.S. Department of Agriculture, National Agricultural Statistics Service. 2004b. “2002 Census of Agriculture.” Washington, DC: USDA. <http://www.nass.usda.gov/research/atlas02/>.

The number of producers and sheep inventories has declined steadily in the United States since 1884, when there were 51 million sheep in the country (USDA/Economic Research Service [ERS], 2004c). In 2002, there were 6.68 million sheep (USDA/National Agricultural Statistics Service [NASS], 2002) raised on slightly more than 64,000 operations (USDA/NASS, 2003). Figure 1-3 shows that the largest concentration of lamb sales is in the Plains States where several large feedlots are located.

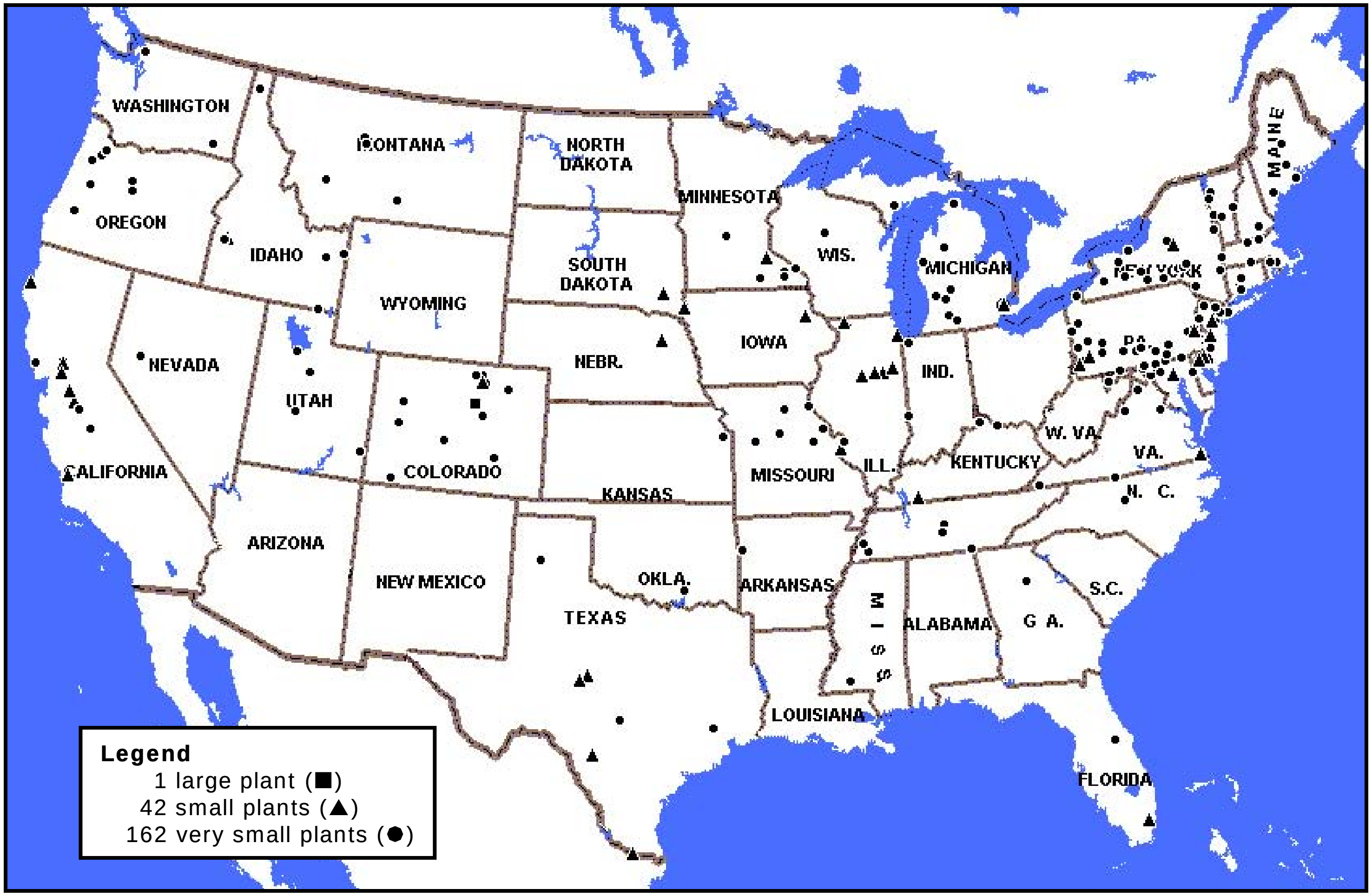
Figure 1-3. Number of Sheep and Lambs Sold, 2002
Few regions specialize in large-scale sheep or lamb production, but sales are concentrated in California, Texas, and Colorado.



Source: U.S. Department of Agriculture, National Agricultural Statistics Service. 2004b. “2002 Census of Agriculture.” Washington, DC: USDA. <http://www.nass.usda.gov/research/atlas02/>.

As with lamb producers, lamb packers are located throughout the country (Figure 1-4). However, most facilities are located strategically near lamb feeders, consumers, or both. The only large lamb packer (defined as a plant with 500 or more employees) is located close to large feedlots. Several small plants (defined as plants with 10 to 499 employees) and very small plants (defined as plants with fewer than 10 employees) are located in the Northeast, where consumption of lamb tends to be higher. Several plants are also located on the West coast.

Figure 1-4. Location of Federally Inspected Lamb Slaughter Plants[a]



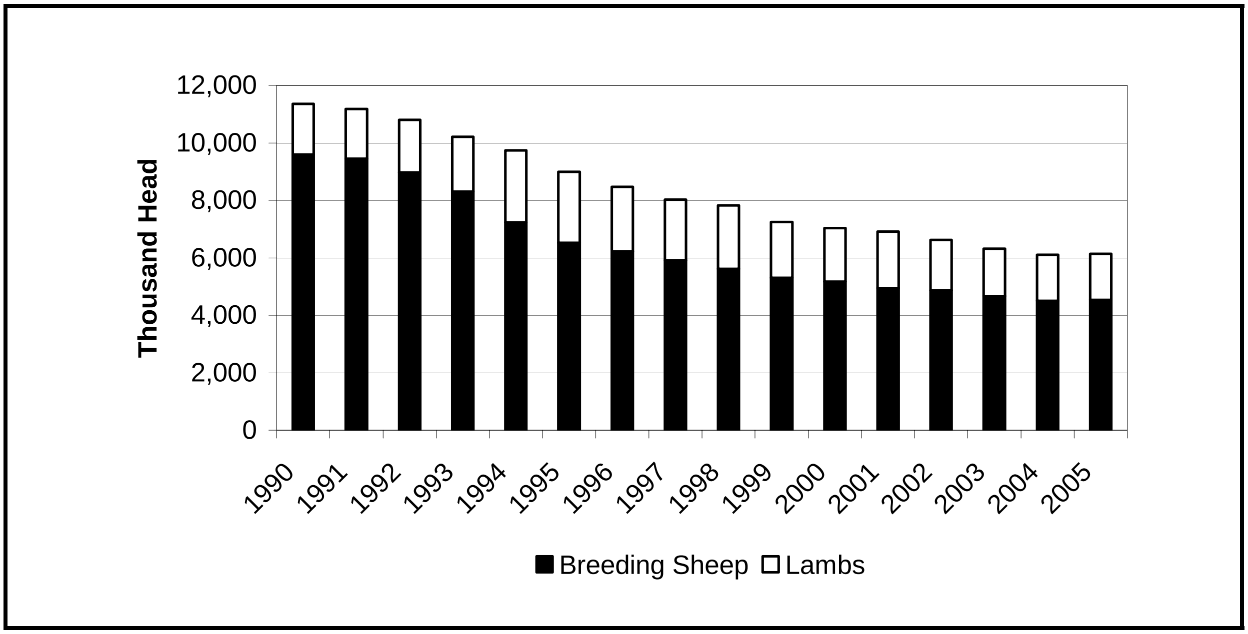
[a] Plants that slaughtered at least 50 head of lambs in FY2004 (October 1, 2003 through September 30, 2004) are included. Of 205 plants, 1 is classified by FSIS as large, with 500 or more employees; 42 are classified as small, with 10 to 499 employees; and 162 are classified as very small, with fewer than 10 employees or less than $2.5 million in annual sales. One plant in Hawaii is not shown.

Source: RTI International. 2005. Enhanced Facilities Database. Prepared for the U.S. Department of Agriculture, Food Safety and Inspection Service. Research Triangle Park, NC: RTI.

1.1.3 Trends in Sheep and Lamb Operations

Sheep inventories have continued to decline in recent years. Figure 1-5 presents total sheep inventories and the size of the breeding herd. Between 1990 and 2005, the total inventory of sheep declined 46%, breeding sheep declined 53%, and lamb inventories declined 9%. Lamb inventories are subject to several environmental conditions including drought and predators. However, the smaller decrease in progeny inventories indicates that breeding herd efficiency is increasing. Selective crossbreeding and intensive breeding programs have allowed producers to alter estrus cycles and attempt to increase the frequency of multiple births.

Figure 1-5. U.S. Inventory of Sheep and Lambs, December 1, 1990–2005
Sheep and lamb inventory categories include breeding sheep (ewes, rams, and new crop lambs) and lambs.



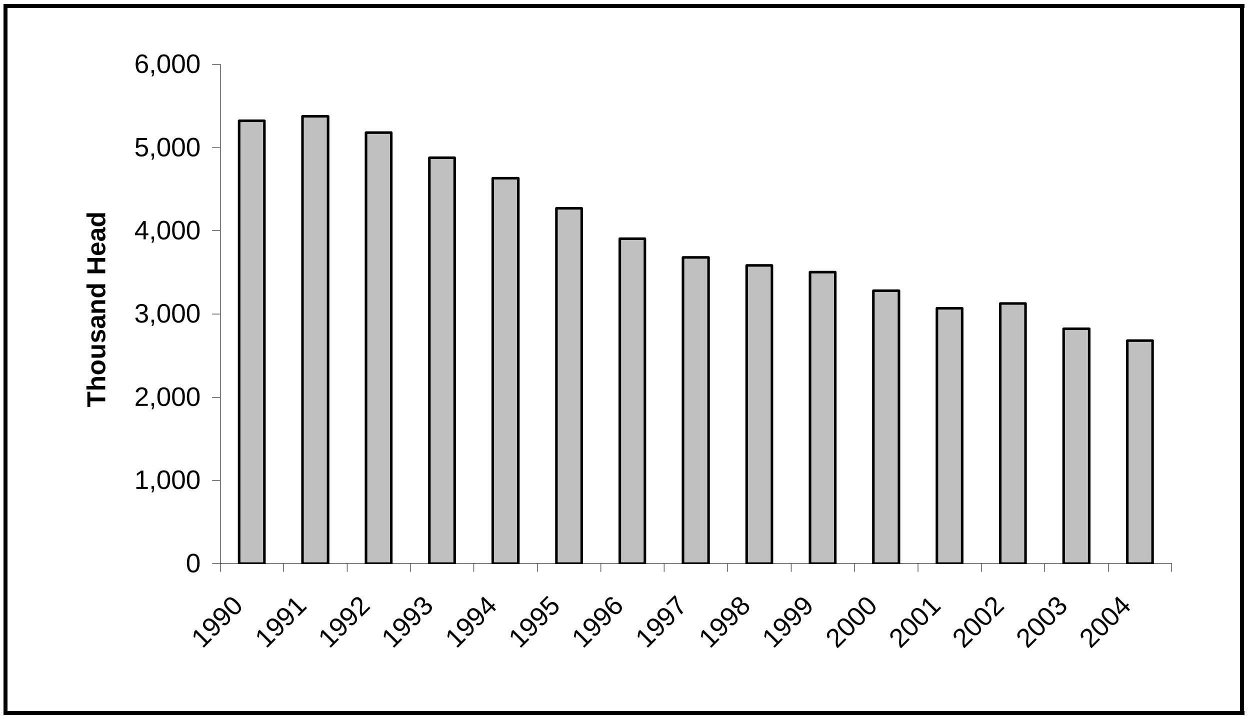
Sources: U.S. Department of Agriculture, National Agricultural Statistics Service. 2005. "Agricultural Statistics." ISBN 0-16-036158-3. Washington, DC: USDA.

U.S. Department of Agriculture, National Agricultural Statistics Service. 1995-1996. "Agricultural Statistics." ISBN 0-16-036158-3. Washington, DC: USDA.

> The number of lambs slaughtered in the United States has declined dramatically over the past decade.

Federally inspected lamb slaughter volumes have decreased more rapidly than total commercial slaughter. The number of lambs slaughtered commercially decreased by 50% from 1990 to 2004 (Figure 1-6). During the same period, the percentage of lambs slaughtered at federally inspected facilities decreased from 97% in 1990 to 94% in 2002.

Figure 1-6. U.S. Commercial Lamb and Yearling Slaughter, 1990–2004
Commercial lamb and yearling slaughter includes animals slaughtered at federally inspected and nonfederally inspected plants but does not include animals slaughtered on the farm.



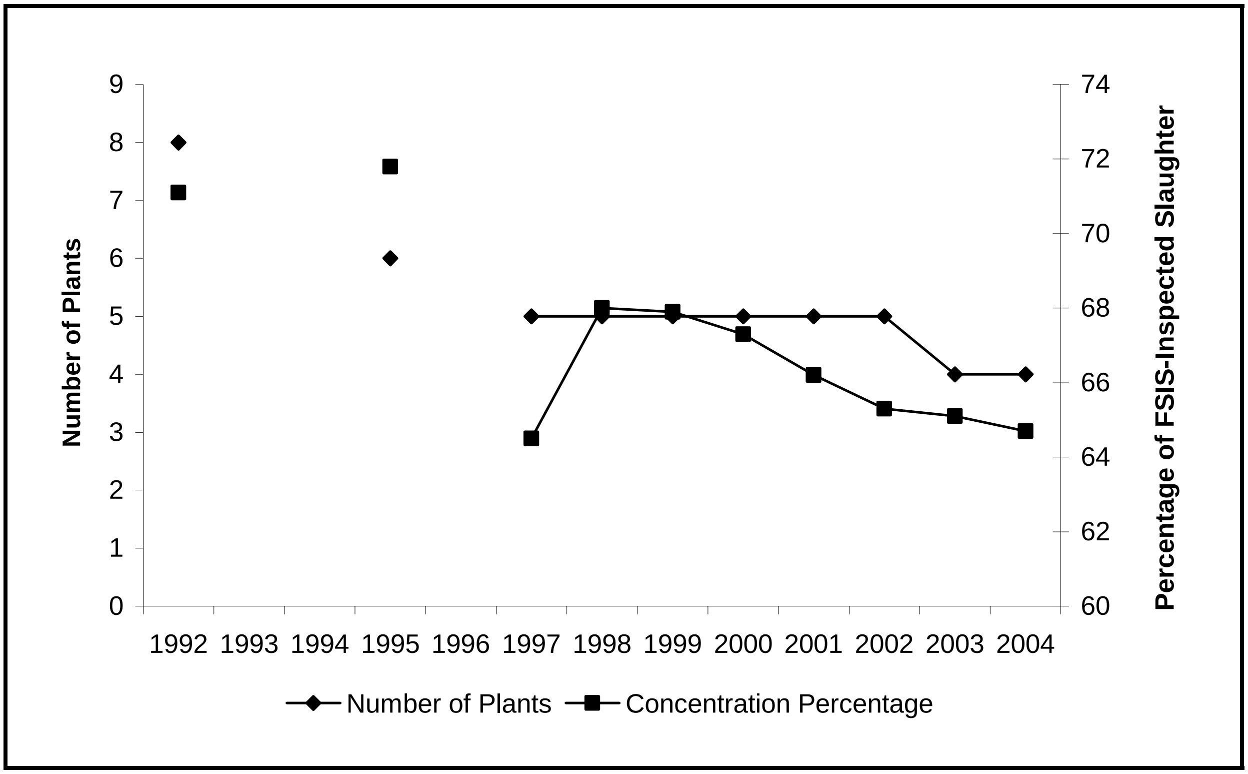
Source: U.S. Department of Agriculture, Economic Research Service, Market & Trade Economics Division. 2006. *Red Meat Yearbook*. Stock #94006. Washington, DC: USDA. <http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1354>.

The amount of meat produced per animal slaughtered has steadily increased. Between 1990 and 2003, the average liveweight of federally inspected slaughter lambs and sheep increased from 126 pounds to 135 pounds. During the same period, average lamb carcass weights increased from 64 to 68 pounds. About 70% of the carcass weight is saleable cuts, with fat and bones making up 30% (Boland, Bosse, and Brester, 2005).

Unlike lamb production, the lamb-packing phase is highly concentrated. From 1992 to 2004, the four largest slaughtering companies processed, on average, 67% of all U.S. lambs under federal inspection (Figure 1-7). The total number of plants operated by these companies decreased by 50% since 1992. During fiscal year 2002, 220 federally inspected plants slaughtered 50 or more lambs.

Figure 1-7. U.S. Sheep and Lamb Packer Four-Firm Concentration Ratio (CR4), Selected Years, 1992–2004

The CR4s show the percentage of all sheep and lambs slaughtered at plants owned by the four largest firms during the respective year. The total number of plants operated by those firms is also included. Percentages are based on total federally inspected slaughter numbers.



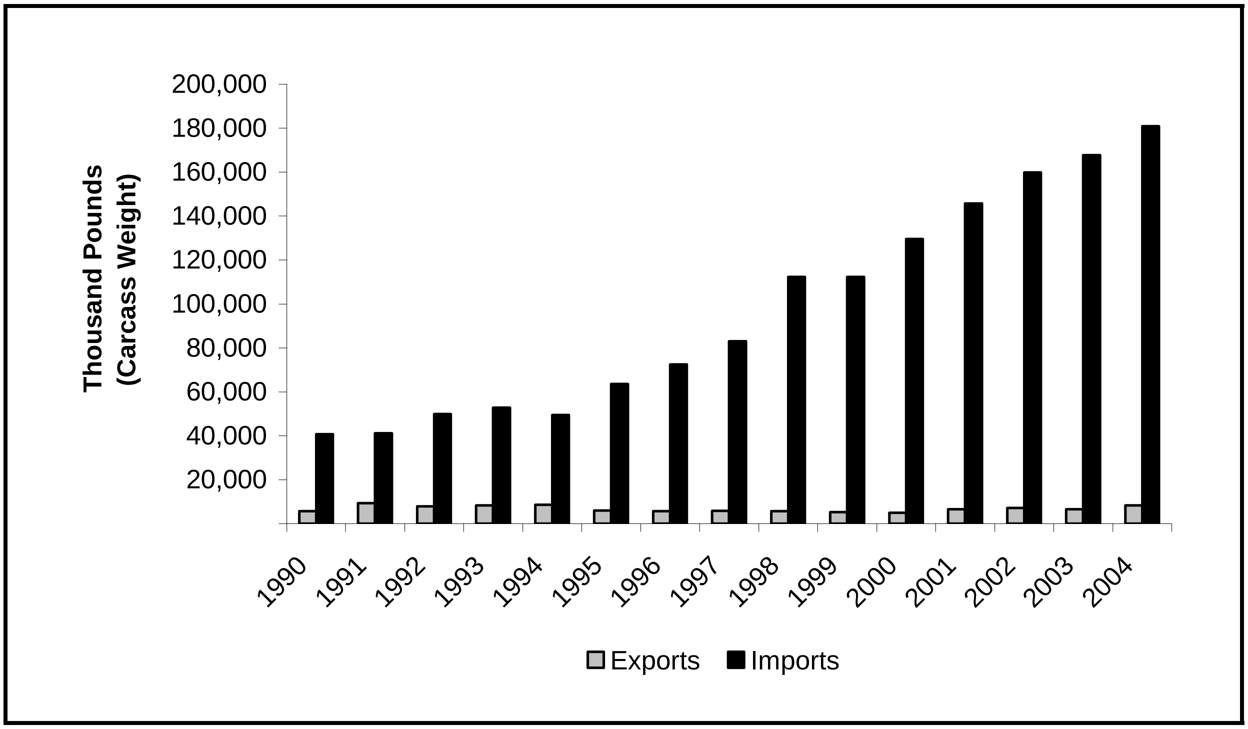
Source: U.S. Department of Agriculture, Grain Inspection, Packers and Stockyards Administration. 2006. *Packers and Stockyards Statistical Report*. SR-06-1. Washington, DC: GIPSA.

1.1.4 Imports and Exports of Lamb Meat

A substantial portion of the lamb consumed in the United States is imported.

The large decreases in U.S. production have been partially offset by increased imports of lamb meat (Figure 1-8). In 2003, lamb imports were approximately 46% of U.S. lamb consumption, and lamb exports were approximately 3% of U.S. lamb production (USDA/ERS, 2004b). Australia and New Zealand supply the majority of imported lamb to the United States. These countries account for 40% of U.S. consumption (Jones, 2004b). Traditionally, lamb exports have not been a large outlet for U.S. lamb production. Exports typically consist of mutton or lower-valued cuts that are not desired by domestic consumers. In 2002, more than 75% of U.S. lamb and mutton exports went to Mexico. Japan is the other main importer of U.S. lamb and purchased 7.2% of U.S. exports in 2002 (Jones, 2004b).

Figure 1-8. Total U.S. Lamb and Mutton Imports and Exports, 1990–2004
The United States is a net importer of lamb and mutton. Australia and New Zealand are the primary sources of imported lamb and mutton.



Source: U.S. Department of Agriculture, Economic Research Service, Market & Trade Economics Division. 2006. *Red Meat Yearbook*. Stock #94006. Washington, DC: USDA. <http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1354>.

Very few live sheep are imported or exported by the United States. Most of the existing trade occurs within North America, and the United States has generally been a net exporter of live animals. Live exports are usually culled breeding stock shipped to Mexico.

1.2 OVERVIEW OF MARKETING ARRANGEMENTS IN THE LAMB AND LAMB MEAT INDUSTRIES

In this report, cash or spot market transactions refer to transactions that occur immediately or “on the spot.” These include auction barn sales; video or electronic auction sales; sales through order buyers, dealers, and brokers; and direct trades. The terms “cash market” and “spot market” are used interchangeably. “Alternative marketing arrangements” refer to all possible alternatives to the cash or spot market. In the lamb industry, these include arrangements such as forward contracts, marketing agreements, procurement or marketing contracts, packer owned, custom feeding, and custom slaughter. For AMAs at the producer level, livestock may be owned by the individual(s) that owns the farm or facility, or they may be owned by a different party.

Figure 1-9 illustrates the types of marketing arrangements used for sale of feeder lambs by producers to feedlots and for sale of fed lambs by producers or feedlots to lamb packers. The key dimensions of marketing arrangements at each stage include the **ownership method** for the animal or product while it is at the establishment (e.g., sole ownership, shared ownership, or owned by another entity) and the **pricing method** used. If formula pricing is used, a **formula base price** must also be specified. The **valuation method** for carcasses might be on a per-head basis or liveweight or carcass weight basis. Carcass weight valuation might be based on a grid that offers premiums or discounts based on weight range and carcass quality grade. If animals or products are shipped from one establishment to another owned by the same company, an **internal transfer pricing method** must also be specified.

Figure 1-10 illustrates the types of marketing arrangements used for sales or transfers of all types of meat products (including lamb) by packers. In addition to ownership method, pricing method, formula base, valuation method, and internal transfer pricing methods, **other pricing practices** might also be a key dimension of marketing arrangements for packer sales. Other pricing practices used for meat products might include two-part pricing, volume discounts, exclusive dealings, and bundling.

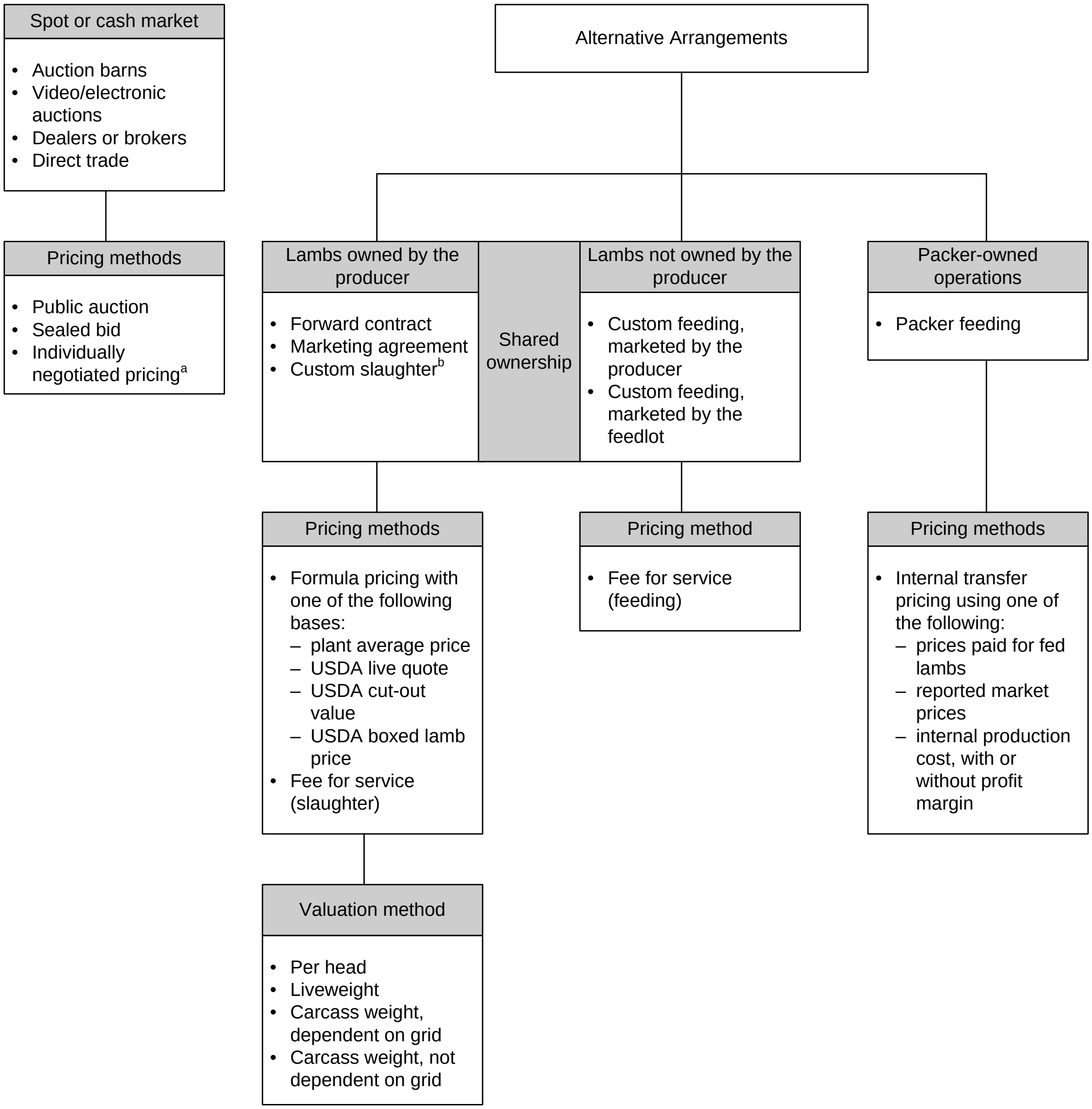
Whether lamb packers sell carcasses, cuts, or processed products, the types of sales transactions they use are similar. They generally have informal relationships with their buyers in which they anticipate some level of weekly orders. In some cases, they may have established marketing agreements with breakers or with distributors that purchase product for retail grocery and food service sales.

1.3 DATA ISSUES FOR THE EMPIRICAL ANALYSES OF THE LAMB INDUSTRY

The statistical analyses presented in this volume have intensive data requirements. It was anticipated that transactions data obtained from lamb packers and processors would be the primary source of data for evaluating the impact of AMAs on

Figure 1-9. Marketing Arrangements for Sale or Transfer of Feeder and Fed Lambs, by Lamb Producers

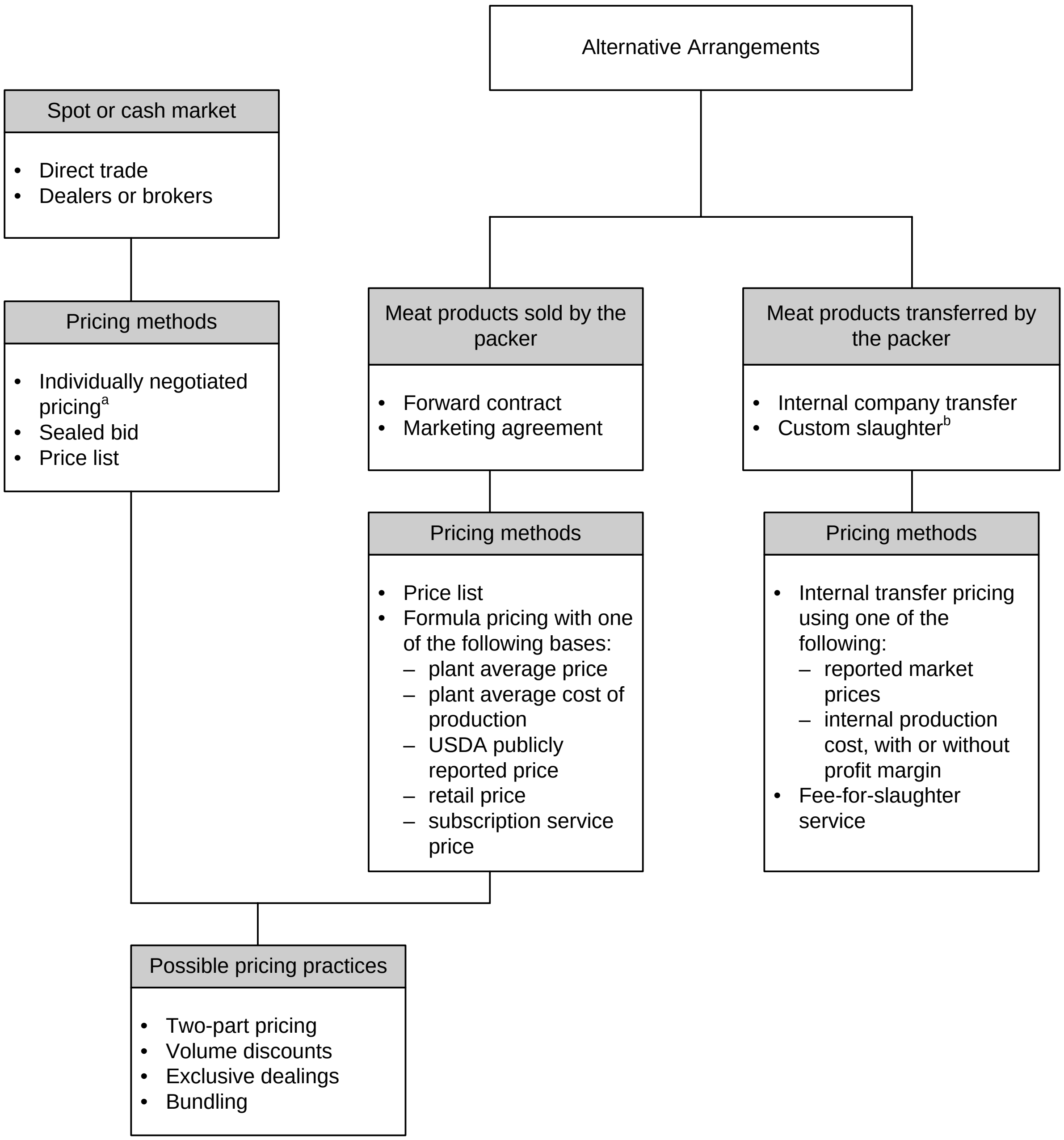
Different types of pricing methods are associated with each type of marketing arrangement used in the industry.



[a] Individually negotiated pricing is often benchmarked against reported prices.

[b] Custom slaughter may be coordinated by a cooperative that schedules slaughter of lambs for its producer-members.

Figure 1-10. Marketing Arrangements for Sale or Transfer of Meat Products from Packers
Meat products are sold or transferred to breakers, processors, wholesalers, exporters, food service operators, or grocery retailers.



[a] Individually negotiated pricing is often benchmarked against reported prices.

[b] Custom slaughter may be coordinated by a cooperative for its producer-members.

the lamb industry. However, little electronic transactions data were received from lamb packing plants that perform slaughtering and processing functions. Some data from a few packing plants were reported for the October 2002 to March 2005 period.

Because the transactions data received from lamb packers were very limited and had many deficiencies, the analyses presented in this volume are based primarily on other data sources.

In general, the transactions data contained information on total weight, total costs, gross prices, and net prices for live lambs, lamb carcasses, boxed (cut-out) lamb, wholesale lamb cuts, and lamb by-products. Each plant used different product description codes for wholesale lamb cuts, which reduced our ability to formulate homogeneous product categories among the plants. Furthermore, the data did not provide information regarding pricing, purchasing, and sales methods. No information was provided regarding the quality of live lamb purchases or product sales.

Because of these data problems, all of the statistical and econometric analyses presented in this volume use mandatory price reporting (MPR) data. Although the time periods differed for some of the variables, the longest consistent period for which at least some of the data were reported was October 2001 through May 2005. The MPR data were supplemented with data provided by the American Sheep Industry Association (ASIA) (2003–2004) and Tom McDonnell, ASIA Director of Natural Resources and Policy (McDonnell, 2005–2006).

1.4 DESCRIPTION OF THE LAMB TRANSACTIONS DATA

Some electronic transactions data were available for partial comparisons with MPR data. Four different data sets obtained from a few plants contained some observations on the following types of transactions: packer lamb purchases, packer product sales, breaker product purchases, and breaker product sales. The obtained data are described below.

- The fed lamb purchase data from packing plants included weekly information on total live weight, total carcass weight, and total lamb costs. Weekly data were aggregated into monthly data. These data allowed for the calculation of per-unit live and carcass prices. No data were reported on the quality of either live lamb or lamb carcasses.

- The sales data from packing plants included information on weekly total weight and gross prices of lamb carcasses, lamb cuts (loin, rib, shoulder, breast, leg, and chops), and lamb by-products (head, liver, intestines, kidney).
- The carcass purchase data from lamb breakers included information on total weight and total costs of carcasses, primals, subprimals, wholesale cuts, and by-products (loin, rack, and liver) purchases.
- The sales data from lamb breakers included weekly total weight and gross (list) prices for lamb product sales. No information, however, was provided in terms of sales method or on disaggregated lamb cuts.

Weekly data for lamb packers and breakers were aggregated to monthly data, and per-unit prices were calculated from the total weight and gross lamb price data for conducting comparisons of the data discussed in Section 1.5.

1.5 COMPARISON OF LAMB MPR DATA TO TRANSACTIONS DATA

We compared the limited transactions data received with MPR data and found that price and weight variables were closely related.

Although the transactions data could not be used for statistical analyses, it is informative to compare these data with relevant MPR data where possible. If the limited amount of transactions data compare favorably with the MPR data, then inferences obtained from statistical analyses of the MPR data should be similar to those obtained from a comprehensive set of transactions data.

Enough usable observations from the transactions data regarding fed lamb, lamb carcasses, boxed lamb values, and weights were available to compare with corresponding MPR observations. Wholesale lamb cut prices for legs, shoulders, and breasts could also be compared with corresponding MPR data. We describe these comparisons below.

1.5.1 Comparison of Live Lamb Prices

Live monthly nominal lamb prices were obtained from MPR data. Weekly live nominal lamb prices from lamb packing plants were averaged and aggregated on a monthly basis for comparison to the MPR data. Plotting both prices for the October 2002 through March 2005 period shows that the transactions data on live lamb prices were consistently larger than the MPR live lamb prices.[6] A two-sample test of the differences in the means of the two price series rejects the null hypothesis of no differences in the means at the α = 0.5 level. In addition, the F-test of the null hypothesis of no differences in the variances of the two price series is also rejected at the $\alpha = 0.05$ level. The result that the means and variances of the two price series are statistically different could reflect differences in weight and/or quality of lamb purchases by these plants relative to the industry as a whole.

Although the variances of the two prices series are statistically different, the correlation coefficient (0.924) between the MPR and transactions fed lamb prices indicates that the two price series are highly correlated. In addition, an ordinary least squares (OLS) regression of MPR lamb prices onto transactions lamb prices resulted in an estimated parameter coefficient close to one. This indicates that a $1/cwt increase in lamb prices in the transactions data is associated with a similar increase in the MPR lamb prices.

1.5.2 Comparison of Carcass Lamb Prices

The relationship between nominal monthly transactions lamb carcass prices and MPR carcass prices is relatively strong. Weekly carcass prices from lamb packing plants were averaged and aggregated on a monthly basis for comparison with the MPR data. Plotting the two price series for the October 2002 through March 2005 period shows that the two prices series are nearly identical.[7] A two-sample t-test of the differences in the means of the two prices series cannot reject the null hypothesis of no differences in the means at the $\alpha = 0.05$ level. Similarly, an F-test of the null hypothesis of no differences in the variances of the two price series cannot be rejected at the $\alpha = 0.05$ level.

The correlation coefficient (0.947) between the MPR and transactions carcass prices indicates that the two price series are highly correlated. In addition, an OLS regression of MPR carcass prices onto transactions carcass prices resulted in an estimated parameter coefficient close to one. This indicates that a $1/cwt increase in carcass prices in the transactions data is associated with a similar increase in the MPR lamb carcass prices. In addition, the estimated coefficient is not statistically

[6] To protect confidentiality, the graph is not included in this report.
[7] To protect confidentiality, the graph is not included in this report.

different from 1.0, which indicates that the carcass price transactions data are a good predictor of MPR carcass prices.

1.5.3 Comparison of Cut-Out and Wholesale Cut Lamb Prices

The transactions cut-out price data contained a significant number of missing observations that made comparison with the MPR wholesale cut lamb prices tenuous. Because of these problems, the only possible comparison involves estimating correlation coefficients for boxed cut-out values, shoulder cuts, breast cuts, and leg cuts. These correlation coefficients range from 0.375 to 0.641. Thus, the price relationship between the transactions cut-out price data and MPR wholesale cut price data is relatively weak.

1.5.4 Summary of Comparisons

The statistical analyses conducted for this study require the use of data that are consistently reported. The transactions data that were obtained from packing plants suffered from numerous deficiencies. However, the price and weight data for fed lambs and carcasses were closely related to similar variables obtained from MPR data. Given that a consistent series of MPR data were available and that most of the statistical analyses involve the fed lamb and wholesale lamb markets, MPR data were used throughout the remainder of this study.

1.6 ORGANIZATION OF THE LAMB AND LAMB MEAT STUDY VOLUME

In the remaining sections of this volume, we present results of the study for the lamb and lamb meat industries. Section 2 provides results on volume differences, price differences, and market price effects associated with AMAs. Section 3 provides results on procurement cost differences associated with AMAs. Section 4 provides results on quality differences, and Section 5 provides results on risk shifting associated with AMAs. Section 6 provides results on the measurement of economic effects associated with restricting AMAs by simulating hypothetical scenarios. Finally, Section 7 describes the implications of AMAs, including the incentives associated with changing the use of AMAs and the expected effects of possible changes in use of AMAs over time.

Note that each section of this volume addresses the requirements of the study as defined in the performance work statement for the contract. Section 2 addresses Part C; Sections 3, 4, and 5 address Part D; and Sections 6 and 7 address Part E. In addition to these sections, Appendix A provides additional technical details on the modeling approach presented in Section 6.

2 Volume Differences, Price Differences, and Short-Run Spot Market Price Effects Associated with Alternative Marketing Arrangements

This section uses survey responses and MPR data to describe the extent of use of AMAs. MPR legislation required market participants to report price, volume, and terms of trade for domestic and foreign live animal and meat transactions. Monthly MPR data are available for the lamb industry from August 2001 to June 2005. We consider differences between formula and cash prices in the live lamb market and estimated an econometric model to determine if systematic factors account for differences among these prices. We also considered the stability of parameter estimates over time. Formula prices refer to prices reported for live lambs procured through both formula and forward contract pricing arrangements as reported in MPR data. Cash prices refer to prices reported for live lambs that are procured through both negotiations and auction markets.

2.1 EXTENT OF USE OF ALTERNATIVE MARKETING ARRANGEMENTS

To examine the number of lambs traded under different AMAs, we compared responses from the lamb producer survey on sales of fed lambs to MPR data. However, in making these comparisons, differences in terminology and definitions occurred.

Purchase and sales information collected for this study (i.e., survey and transaction data collection) contained three categories that allow for the marketing arrangement to be clearly defined. These categories are purchase method, pricing method, and valuation method. The purchase method classifies the marketing arrangement as either a cash or alternative marketing arrangement. Examples of cash marketing arrangements include auctions and direct trade. Marketing agreements and forward contracts are examples of AMAs. The pricing method provides additional information about transactions by specifying how the price was determined (e.g., individual negotiations and formula pricing). The valuation method further defines the transaction type by indicating how the price was applied (e.g., per head, per pound liveweight, or per pound carcass weight) and whether the price was subject to premiums or discounts.

The structure of MPR for the lamb industry uses some of the same terminology and collects some of the same data as the survey and transaction data collection. However, MPR data commingles purchase method and pricing methods to define marketing arrangements. For example, based on MPR definitions, “formula marketing arrangement means the advance commitment of lambs for slaughter by any means other than through a negotiated purchase or a forward contract, using a method for calculating price in which the price is determined at a future date,” and “forward contact means an agreement for the purchase of lambs, executed in advance of slaughter, under which the base price is established by reference to publicly available prices” (USDA/AMS, 2000, p. 75519). Including pricing methods within the definition of the purchase method decreases the clarity of the data and makes direct comparisons with the survey results difficult.

2.1.1 Survey Responses

As discussed in Volume 2 of this report, 302 lamb producers responded to the industry survey (267 small and 35 large). From the weighted industry survey results, lamb producer sales arrangements to packers were as follows:

- **Sales methods to packers.** An estimated 80% of producers in Eastern states used only the cash or spot market to sell lambs in the past year, compared with 76% of producers in Western states.[1] Western producers made more use of AMAs such as forward contracts, marketing agreements, packer ownership, internal transfers, and custom feeding and slaughtering (19% of head sold for Western producers and 11% for Eastern producers). For Western producers, the AMAs used most frequently were forward contracts (5.3% of head) and marketing agreements (3.9% of head).
- **Pricing methods.** Western producers used multiple pricing methods in the past year. The most common were individually negotiated pricing (54.6%), public auction (47.1%), and formula pricing (10.3%). In contrast, Eastern producers used primarily public auction (71.8%) and individually negotiated pricing (46.4%). An additional 6.2% of Eastern producers used formula pricing.
- **Valuation methods.** The most frequently used valuation method was liveweight, regardless of regional location. However, Western producers used carcass weight valuation (with and without a grid) more frequently than Eastern producers (32% and 11.3% of producers, respectively). Nearly twice as many Eastern producers (31.2%) used per-head valuation compared with Western producers (16.9%) in the past year.

The volumes of purchases by type of marketing arrangement from the survey responses differ somewhat from the MPR data discussed below. This difference is likely because MPR data are only collected from plants that slaughter or process at least 75,000 head annually, while the survey responses are from a range of sizes of lamb producers selling to packers. The largest packers are more likely to use AMAs.

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[1] The following states were classified as Western states: Alaska, Arkansas, Arizona, California, Colorado, Hawaii, Idaho, Kansas, Louisiana, Minnesota, Missouri, Montana, North Dakota, Nebraska, New Mexico, Nevada, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. All other states were classified as Eastern states.

2.1.2 Mandatory Price Reporting

Table 2-1 presents monthly numbers of federally inspected fed lamb slaughtered in the United States and the number of head procured by various marketing arrangements. The procurement methods consist of packer ownership, formula pricing, forward contracts, negotiated sales, imports, and auctions as follows:

- **Packer-owned lambs** may be owned and finished by a packing firm or owned by a packing firm and custom finished by another entity. In both cases, lambs in this category are internally priced by packing firms.
- **Formula-priced lambs** are those procured by packing firms in which final lamb prices are determined by a combination of a fixed (base) price with adjustments made on a prespecified formula. The most common adjustments are those associated with varying quality. However, formula (base) prices are often based on nearby spot prices.
- **Forward contracting** fed lambs for slaughter includes both formal and informal agreements between a lamb producer and a packer. Contracts often establish terms of transactions with respect to both quantity and price. In general, these arrangements tend to be of a shorter duration than formula-pricing arrangements, and they tend to establish a price in advance of lamb delivery.
- **Negotiated lamb sales** represent private treaty arrangements between lamb producers and packing firms. These direct purchases are often based on spot market prices established by formal auctions.
- **Auction sales** represent fed lambs procured at formal auction locations in which prices are discovered through open bidding by packing firms or their representatives.

A small number of lambs have occasionally been imported from Canada and Mexico. However, we do not know the methods used to procure these lambs.

Table 2-1 summarizes the volume of lambs slaughtered and the relative importance of each procurement method based on MPR data. Monthly, federally inspected lamb slaughter averaged 235,399 head during the 2001 to 2005 period. Note that the MPR data used to create Table 2-1 do not report the size or location of market participants.

Table 2-1. Monthly Federally Inspected Lamb Slaughter and Lamb Procurement by Method as Reported under MPR, August 2001–June 2005, Head

Year	Month	Federally Inspected Slaughter	Packer Owned	Formula	Contract	Negotiated	Imports	Auction
2001	August	216,728	16,575	82,675	1,335	3,300	0	112,843
2001	September	290,234	17,355	153,032	1,656	23,500	2,727	91,964
2001	October	237,658	10,080	131,783	2,538	25,100	2,311	65,846
2001	November	248,416	5,520	137,188	2,518	34,100	3,297	65,793
2001	December	317,120	8,382	192,573	2,235	31,600	0	82,330
2002	January	209,709	7,881	111,196	0	27,600	0	63,032
2002	February	171,400	9,360	124,666	7,762	28,700	677	235
2002	March	297,723	24,319	162,531	11,897	28,900	4,950	65,126
2002	April	299,334	17,957	161,376	5,592	25,900	5,446	83,063
2002	May	244,013	13,047	102,700	2,879	19,800	4,424	101,163
2002	June	211,275	5,444	104,731	4,894	18,700	7,513	69,993
2002	July	259,447	2,881	107,690	7,693	40,600	1,881	98,702
2002	August	219,915	3,409	92,344	12,235	24,800	811	86,316
2002	September	308,518	12,708	126,200	6,968	32,000	1,130	129,512
2002	October	245,562	10,813	107,656	3,649	28,900	3,591	90,953
2002	November	248,350	8,629	96,802	4,581	26,200	5,025	107,113
2002	December	297,567	10,049	116,884	2,300	38,900	7,665	121,769
2003	January	201,513	6,820	74,582	321	35,700	6,879	77,211
2003	February	202,915	2,104	70,510	798	50,200	7,770	71,533
2003	March	291,227	6,786	103,972	0	55,100	6,510	118,859
2003	April	264,112	8,777	97,153	1,436	30,300	5,842	120,604
2003	May	191,948	3,895	64,785	0	23,100	4,126	96,042
2003	June	253,884	8,329	83,362	1,717	55,000	679	104,797
2003	July	191,886	7,229	65,413	0	35,000	0	84,244
2003	August	213,624	7,312	78,789	0	30,100	0	97,423
2003	September	273,311	12,972	110,668	0	36,000	0	113,671
2003	October	216,708	11,887	90,258	0	20,300	0	94,263
2003	November	231,500	11,769	93,782	2,800	21,200	0	101,949
2003	December	262,701	13,704	103,219	2,538	27,100	0	116,140

(continued)

Table 2-1. Monthly Federally Inspected Lamb Slaughter and Lamb Procurement by Method as Reported under MPR, August 2001–June 2005, Head (continued)

Year	Month	Federally Inspected Slaughter	Packer Owned	Formula	Contract	Negotiated	Imports	Auction
2004	January	188,400	10,052	74,278	5,497	20,600	0	77,973
2004	February	196,837	8,248	75,252	4,380	15,200	0	93,757
2004	March	303,337	21,491	127,749	0	28,100	0	125,997
2004	April	235,379	20,077	82,158	267	22,800	0	110,077
2004	May	220,418	22,905	72,355	0	21,100	0	104,058
2004	June	188,835	8,667	64,109	0	24,900	0	91,159
2004	July	186,680	7,171	65,231	0	30,900	0	83,378
2004	August	250,673	9,675	101,730	0	35,400	0	103,868
2004	September	206,855	14,376	83,672	0	24,850	0	83,957
2004	October	215,484	13,357	84,389	0	21,000	0	96,738
2004	November	262,977	20,242	104,495	0	13,300	0	124,940
2004	December	204,184	16,498	89,116	0	18,700	0	79,870
2005	January	224,433	14,607	100,201	0	25,400	0	84,225
2005	February	204,981	7,019	94,005	0	24,500	0	79,457
2005	March	241,562	11,022	108,199	0	26,900	0	95,441
2005	April	189,425	14,722	83,613	0	17,500	0	73,590
2005	May	242,057	28,222	80,712	0	28,100	0	105,023
2005	June	182,918	16,652	69,321	0	23,300	0	73,645
	Average	235,399	11,723	100,194	2,138	27,665	1,771	91,907

Note: MPR data are based on AMA procurement volumes, which must sum to federally inspected slaughter totals. MPR federally inspected slaughter data do not necessarily equal total federally inspected slaughter volumes because only the largest firms are required to provide MPR data.

Table 2-2 presents the percentage of monthly federally inspected lamb slaughter by procurement method based on MPR data. Lamb packers procure fed lambs primarily through formula pricing arrangements (42.2%) and auctions (39.4%).

These two methods account for 81.6% of lamb procurement during the sample period. Negotiated sales account for about 12% of lamb procurement, and packer ownership averaged 4.9%. Forward contracting and live lamb imports were quite minor; together they account for only 1.5% of lamb procurement. Since March 2004, almost no lambs were procured using either of these two methods.

Table 2-2. Monthly Percentages of Lamb Procurement by Marketing Method as Reported under MPR, August 2001–June 2005, Percent

Year	Month	Packer Owned	Formula	Contract	Negotiated	Imports	Auction	Total
2001	August	2.8	41.0	1.0	7.6	0.0	47.5	100.0
2001	September	6.8	52.4	0.0	7.8	1.2	31.8	100.0
2001	October	4.2	55.4	1.1	10.6	1.3	27.5	100.0
2001	November	2.7	57.1	0.9	12.6	1.1	25.6	100.0
2001	December	2.2	59.7	0.7	10.5	0.0	26.9	100.0
2002	January	3.7	53.2	0.0	13.2	0.0	29.9	100.0
2002	February	4.0	52.9	3.2	12.3	0.3	27.3	100.0
2002	March	7.9	53.2	3.9	9.7	1.7	23.5	100.0
2002	April	5.6	55.9	1.5	8.4	1.7	26.9	100.0
2002	May	5.5	54.7	1.2	8.3	2.1	28.2	100.0
2002	June	1.3	47.3	2.7	8.9	3.0	36.8	100.0
2002	July	1.3	40.1	3.1	17.3	0.6	37.7	100.0
2002	August	2.0	42.5	5.5	10.8	0.4	38.8	100.0
2002	September	4.2	39.9	1.5	10.7	0.3	43.4	100.0
2002	October	4.4	43.9	1.5	11.8	1.5	37.0	100.0
2002	November	3.4	39.3	1.7	11.7	2.2	41.7	100.0
2002	December	3.7	38.9	0.6	12.1	2.4	42.2	100.0
2003	January	3.3	36.4	0.2	20.0	3.5	36.6	100.0
2003	February	0.7	36.3	0.3	23.2	3.4	36.1	100.0
2003	March	2.6	34.8	0.0	17.8	2.2	42.6	100.0
2003	April	3.3	36.6	0.6	11.4	2.2	45.8	100.0
2003	May	1.9	32.4	0.0	13.2	2.0	50.4	100.0
2003	June	3.8	34.2	0.8	22.6	0.0	38.7	100.0
2003	July	3.8	34.1	0.0	18.1	0.0	43.9	100.0
2003	August	3.5	36.9	0.0	14.4	0.0	45.2	100.0
2003	September	5.0	41.4	0.0	12.5	0.0	41.1	100.0
2003	October	5.6	40.9	0.2	9.1	0.0	44.2	100.0
2003	November	4.8	41.8	0.9	9.9	0.0	42.5	100.0
2003	December	5.3	38.2	1.3	10.2	0.0	45.0	100.0

(continued)

Table 2-2. Monthly Percentages of Lamb Procurement by Marketing Method as Reported under MPR, August 2001–June 2005, Percent (continued)

Year	Month	Packer Owned	Formula	Contract	Negotiated	Imports	Auction	Total
2004	January	5.3	39.3	2.7	10.6	0.0	42.0	100.0
2004	February	4.3	39.4	1.8	8.8	0.0	45.7	100.0
2004	March	7.4	41.6	0.0	8.6	0.0	42.4	100.0
2004	April	9.2	35.4	0.1	9.2	0.0	46.0	100.0
2004	May	10.5	31.8	0.0	10.1	0.0	47.6	100.0
2004	June	4.6	33.9	0.0	13.2	0.0	48.2	100.0
2004	July	3.9	35.6	0.0	16.0	0.0	44.5	100.0
2004	August	3.8	41.3	0.0	14.4	0.0	40.6	100.0
2004	September	6.9	40.5	0.0	11.9	0.0	40.7	100.0
2004	October	6.4	40.2	0.0	8.4	0.0	45.0	100.0
2004	November	7.8	38.6	0.0	5.8	0.0	47.8	100.0
2004	December	8.1	43.4	0.0	10.4	0.0	38.0	100.0
2005	January	6.7	44.7	0.0	11.5	0.0	37.2	100.0
2005	February	3.5	46.0	0.0	11.8	0.0	38.7	100.0
2005	March	4.7	44.8	0.0	11.1	0.0	39.4	100.0
2005	April	7.9	44.0	0.0	9.1	0.0	38.6	100.0
2005	May	11.8	33.4	0.0	11.7	0.0	43.1	100.0
2005	June	9.1	37.9	0.0	12.6	0.0	40.4	100.0
	Average	4.9	42.2	0.8	12.0	0.7	39.4	100.0

Formula and auction procurement methods demonstrate opposite trends over the sample period. The MPR data indicate that packers reduced their use of formula procurement and increased their use of auction procurement in an almost equivalent fashion. For example, formula-procured lambs declined about 0.28 of a percentage point each month, and auction-procured lambs increased about 0.29 of a percentage point each month during the MPR period. These changes were statistically significant based on simple regressions of procurement percentages onto a monthly time trend variable.

A similar regression using packer ownership percentages as the dependent variable revealed that packer ownership declined about 0.07 of a percentage point each month. However, there was not a statistically significant trend associated with negotiated sales.

There are at least three possible explanations for these opposite trends. First, a variety of market factors (e.g., consolidation, changing demands, logistical issues) may have caused this to occur. That is, the relative benefits versus costs of using AMAs may have been altered during the sample period by market forces. Second, packers may use proprietary information when designing contractual arrangements, and once this information became more transparent through additional reporting, packers may have lost their individual competitive advantages in lamb procurement through the use of AMAs. Hence, on the margin, they increased procurement through auctions and reduced procurement through formulas. Third, packers may have been manipulating prices through the use of AMAs, and the increased price transparency caused them to change their practices and return to using auctions.

Our research efforts are unable to distinguish among these possible alternatives. However, the survey data indicated that packers were not likely to radically alter their procurement methods in the future. Therefore, packers may have been adjusting their procurement methods toward an equilibrium during the sample period.

2.2 TESTS OF PRICE DIFFERENCES ASSOCIATED WITH ALTERNATIVE MARKETING ARRANGEMENTS

AMAs have evolved over time for a number of reasons. Whether these arrangements have caused systematic differences among prices is an empirical question. We conduct statistical tests for differences among the prices of two different market lamb categories: formula prices and cash prices (defined as prices reported for live lambs procured through both free-on-board [FOB] feedlot negotiations and auctions).[2] Each monthly price series is obtained from MPR data on a dollars/cwt liveweight basis and are deflated by the consumer price index (CPI) (1982 – 84 = 100). Because formula prices were not reported in the MPR data during 2001, a common sample period beginning in January 2002 and ending in June 2005 is used for

[2] Because of the limited amount of contracting, MPR contract price data were not available and could not be included in the analysis.

all tests. Table 2-3 presents the deflated data. Cursory observation of the data indicates that average real lamb prices for each series are similar. The variation in lamb prices (as indicated by standard deviations) also appears similar.

Figure 2-1 illustrates the relationship between the two price series. The prices have trended upward and are highly correlated. The estimated correlation coefficient between the formula and cash price series is 0.970.

Each price series was regressed onto a monthly time trend variable. The results indicate that real slaughter cash lamb prices increased an average of $0.433/cwt each month, and real formula prices increased an average of $0.435/cwt each month.

Unit root and cointegration tests were used to examine the time-series properties of the two price series. These tests are used to determine the stationarity of the data. If the data are found to be nonstationary and not cointegrated, then subsequent regression results could yield spurious results and incorrect inferences. The augmented Dickey-Fuller (ADF) unit root test failed to reject the null hypothesis of a unit root (or nonstationarity) at the $\alpha = 0.05$ level for both slaughter price series (Pindyck and Rubinfeld, 1998). The ADF tests indicated the price series were integrated of order one. The Trace Test statistic of the Johansen Cointegration Test indicated a cointegrated relationship among the two price series at the $\alpha = 0.05$ level (Greene, 2003).

Table 2-4 presents the results of sample t- and F-tests on the difference in mean values and variances of the two slaughter lamb price series. Two-sample t-tests of the null hypotheses of no difference in mean values could not be rejected at the $\alpha = 0.05$ level for the paired comparison. Similarly, an F-test and a Bartlett test both failed to reject the null hypothesis of no differences in the variances of the two price series at the $\alpha = 0.05$ level. Based on the results of these tests, the price series are not statistically different from each other. Data obtained from the American Sheep Industry Association indicate that slight differences exist in average live slaughter weights of fed lambs procured via formula methods (formulas and forward contracts) and cash methods (negotiations and auctions). These differences are illustrated in Figure 2-2. Live slaughter weights for lambs procured by formula pricing

Table 2-3. Monthly Real Prices of Fed Lamb by Procurement Method, January 2002–June 2005, Dollars/Cwt, Liveweight

Year	Month	Cash Procurement ($)	Formula Procurement ($)
2002	January	34.66	33.44
2002	February	36.28	35.61
2002	March	35.92	35.15
2002	April	34.03	34.51
2002	May	34.63	33.60
2002	June	41.67	41.63
2002	July	44.61	45.63
2002	August	42.34	42.99
2002	September	40.91	43.45
2002	October	43.35	44.73
2002	November	45.70	46.65
2002	December	47.38	47.56
2003	January	47.60	48.19
2003	February	49.69	48.84
2003	March	52.59	50.37
2003	April	51.70	51.65
2003	May	55.74	54.41
2003	June	54.08	55.13
2003	July	48.34	49.06
2003	August	46.09	46.86
2003	September	47.98	48.88
2003	October	48.70	48.92
2003	November	48.94	48.86
2003	December	48.06	48.84
2004	January	51.16	47.95
2004	February	53.94	51.68
2004	March	53.41	53.96
2004	April	51.92	50.34
2004	May	53.78	49.58
2004	June	54.40	54.12
2004	July	52.22	54.50
2004	August	48.91	51.64
2004	September	47.49	51.06
2004	October	46.06	48.81
2004	November	48.43	48.19
2004	December	50.97	50.84
2005	January	56.01	55.19
2005	February	57.58	57.08
2005	March	55.53	56.10
2005	April	54.77	53.45
2005	May	55.94	56.54
2005	June	59.78	58.32
Average		48.41	48.44
Standard Deviation		6.60	6.46
Maximum		59.78	58.32
Minimum		34.03	33.44

Figure 2-1. Real Formula and Cash Fed Lamb Prices, January 2002–June 2005

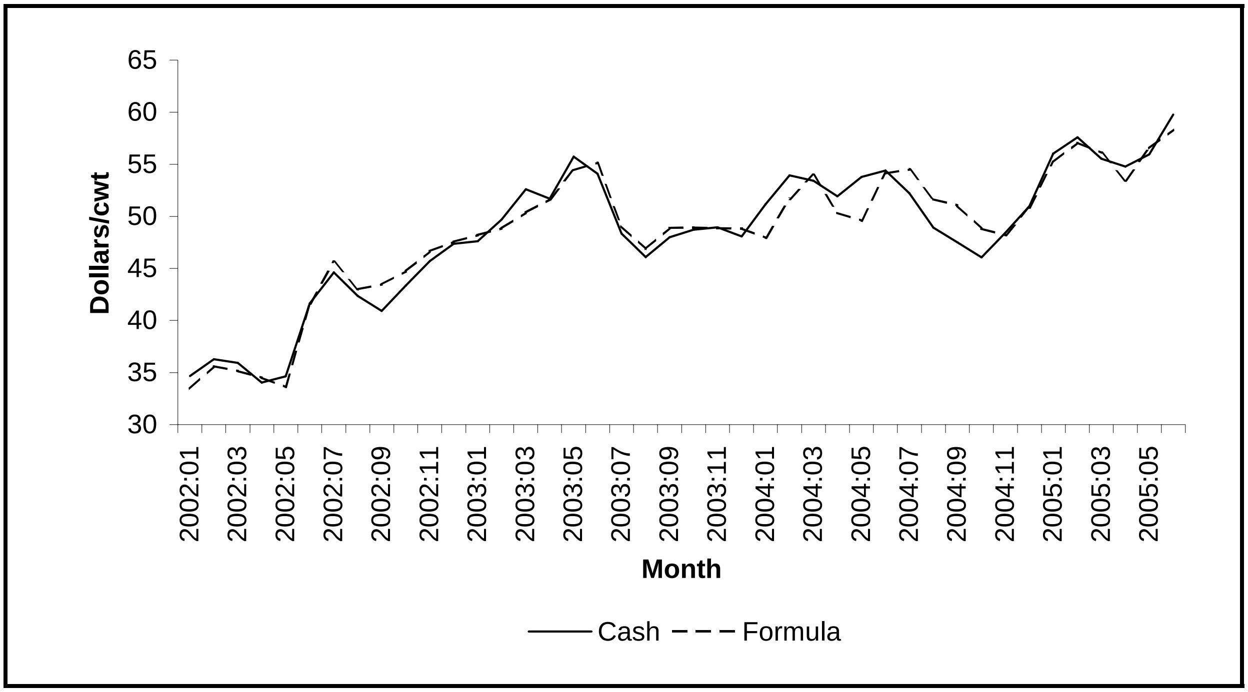
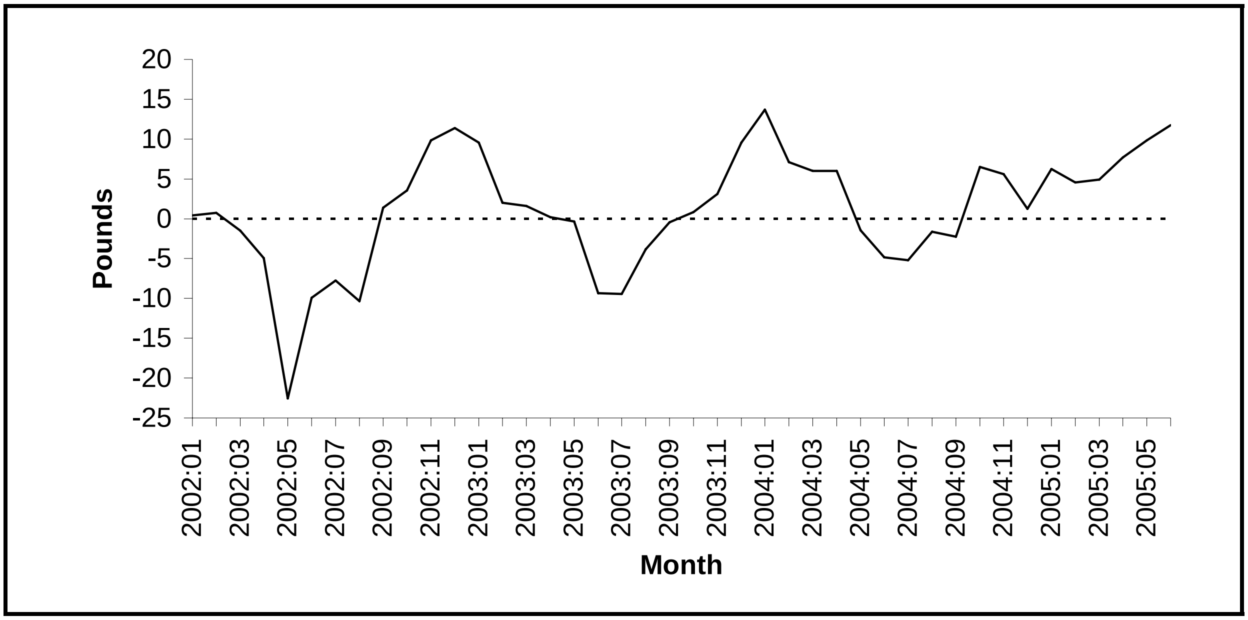


Table 2-4. Statistical Tests of the Equality of Means and Variances of Real Prices of Fed Lamb by Procurement Method, January 2002–June 2005

Statistics	Test	Price	Test Statistics For Formula Versus Cash Procurement
Mean	t-test	Real Prices	0.017
Variance	F-test	Real Prices	1.044
	Bartlett test	Real Prices	0.019
Mean	t-test	Real Normalized Prices	0.279
Variance	F-test	Real Normalized Prices	1.179
	Bartlett test	Real Normalized Prices	0.273

Note: The two sample t-test has 82 degrees of freedom (42 sample observations multiplied by 2 samples less 2 mean parameter estimates) and a critical value of 1.96 at the α = 0.05 level.

Figure 2-2. Difference between Formula and Cash Average Live Slaughter Weights of Fed Lamb, January 2002–June 2005



methods averaged 139.16 pounds, while those procured by cash methods averaged 137.97 pounds. The average liveweight variables possess unit roots and are cointegrated at the α = 0.05 level. The standard deviation of the differences is 7.32 pounds, which is 6.2 times the value of the mean difference (1.18 pounds). The differences between the two variables also trend upward (Figure 2-2). A linear regression of the differences onto a monthly trend variable indicates that the difference increased an average of 0.26 pounds per month.

Per-unit (hundredweight) prices of fed lambs are often a function of liveweight. Differences in liveweights could exist among lambs procured under various marketing arrangements throughout a month. Consequently, we normalized each real price series by average liveweight. Monthly formula prices were divided by monthly average liveweight of slaughter lambs procured through formula and forward contracting mechanisms. Monthly cash lamb prices were each divided by monthly average liveweight of slaughter lambs procured through negotiations and auctions. The mean values for normalized real formula-priced lambs and cash lambs were $0.348/pound and $0.351/pound, respectively. The standard deviation for each series was $0.043 and $0.047, respectively.

Table 2-4 presents the results of sample t- and F-tests on the difference in mean values and variances of the two weight-normalized slaughter lamb price series. Two-sample t-tests of the null hypothesis of no difference in mean values could not be rejected at the $\alpha = 0.05$ level for each of the two series. Similarly, the F-tests and Bartlett tests both failed to reject the null hypothesis of no differences in the variances of the two prices series at the $\alpha = 0.05$ level.

2.3 REDUCED FORM MODELS OF PRICE DIFFERENCES

This section examines the differences between prices of slaughter lamb procured through formula and cash methods.

2.3.1 Differences between Normalized Real Formula and Cash Slaughter Lamb Prices

Figure 2-3 illustrates the difference between normalized real formula and cash prices of fed slaughter lambs between January 2002 and June 2005. The price difference averaged –$0.003/cwt with a standard deviation of $0.023 over the sample period. This is consistent with the results in Section 2.2 that could not reject the null hypothesis of no difference in the means of the price series. However, the price difference series displays significant variability around an expected value, which is essentially zero. We investigate if this variability is systematic or purely the result of stochastic processes.

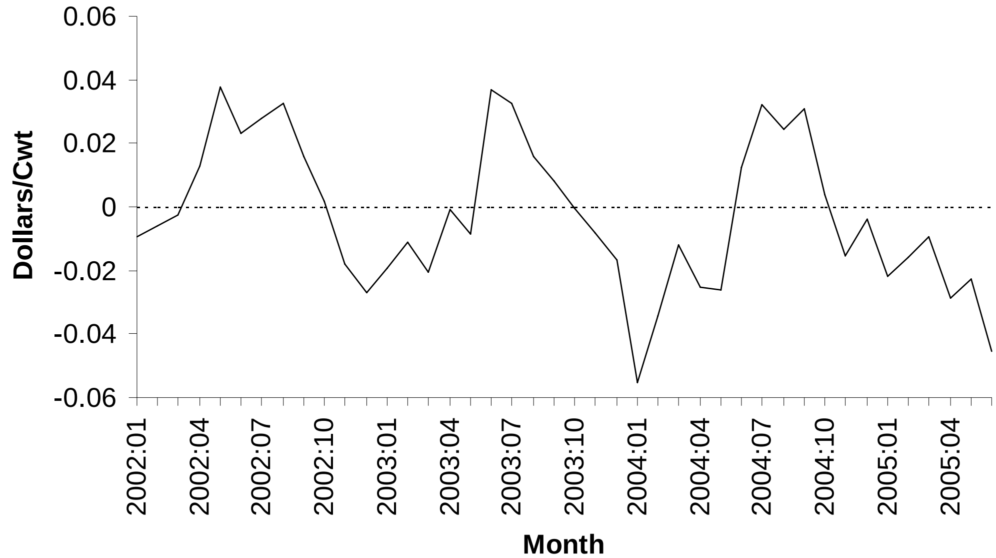
Formula/Cash-Price Reduced Form Model

We posit that factors such as seasonality, wholesale lamb prices, wholesale lamb price risk, sheep and lamb inventory, and number of lambs sold by procurement method affect differences between normalized formula and cash lamb prices. Therefore, the following reduced form model is specified as a means of quantifying potential systematic causes for variations in price differences between formula and cash slaughter lamb prices:

$$FCP = \psi_1 \left(S, FCRP, R, QI, FCN \right) + \mu_t \qquad (2.1)$$

where *FCP* is the normalized real formula slaughter lamb price less the normalized real cash slaughter lamb price; *S* represents a vector of quarterly seasonal binary variables; *FCRP* is the real formula carcass lamb price less the real spot

Figure 2-3. Difference between Real Normalized Formula and Cash Slaughter Lamb Prices, January 2002–June 2005



carcass lamb price ($/cwt); *R* is the standard deviation of the real spot carcass lamb price ($/cwt); *QI* is the January 1 inventory of sheep and lambs (thousand head); *FCN* is the number of lambs sold under formula arrangements less the number of lambs sold under cash terms (thousand head); and μ_t is a white noise disturbance term. Table 2-5 provides descriptive statistics of the variables.

Cash carcass prices are used as a proxy for negotiated carcass prices because the latter are not available. An increase in the difference between formula and cash carcass price (*FCRP*) is expected to increase the difference between normalized formula and cash slaughter lamb price. That is, one would expect that lamb packers would adjust live lamb formula price offers based on changes in their formula arrangements for lamb carcasses. Risk associated with the wholesale lamb carcass market on price of slaughter lambs is considered by including the standard deviation of cash carcass prices (*R*). Formula (and contract) procurement of slaughter livestock is often viewed as a risk-reducing strategy (Schroeder et al., 1991). Thus, if the standard deviation of carcass price increases, one would expect that the difference between formula and cash prices would increase as packers would likely move toward using formulas to procure slaughter lambs.

Table 2-5. Variable Definitions for the Price Differences Model, January 2002–June 2005

Symbol	Definition	Mean	Standard Deviation
FCP	Weight-normalized real formula slaughter lamb price minus the weight-normalized real cash slaughter lamb price, $/cwt	–0.003	0.023
S_2	Second quarter seasonal binary variable	0.286	0.457
S_3	Third quarter seasonal binary variable	0.214	0.415
S_4	Fourth quarter seasonal binary variable	0.214	0.415
FCRP	Real formula carcass lamb price minus the real cash carcass lamb price, $/cwt	–5.507	2.815
R	Standard deviation of real cash carcass price, $/cwt	2.867	1.929
QI	January 1 inventory of sheep and lambs, thousand head	6.256	0.162
FCN	Number of slaughter lambs sold through formula pricing less the number of slaughter lambs sold through cash, head	72,743.45	28,152.53

Sheep and lamb inventory levels (*QI*) represent the pool of available slaughter lambs. However, the expected marginal impact of inventory changes on the difference between formula and cash prices is ambiguous. In general, increases in inventories reduce the spot prices of slaughter livestock (Brester and Marsh, 2001; Marsh, 1994; Wohlgenant, 1989). Thus, holding procurement allocations constant, increases in inventories could increase the formula/cash price spread. However, the opposite could happen if increases in inventories alter the percentage of lambs procured under formula and cash pricing arrangements.

The difference between the number of lamb procured using formula pricing and the number procured using cash pricing (*FCN*) is expected to inversely affect the dependent variable in Eq. (2.1). As more lambs are procured under formula methods (i.e., *FCN* increases), we would expect higher cash lamb prices. Consequently, the difference between formula and cash prices should decline.

Empirical Results for the Formula/Cash-Price Reduced Form Model

Monthly data for the January 2002 to June 2005 period were used to estimate the reduced form model. Lamb and sheep inventories, lamb carcass and slaughter prices, and quantities of lambs obtained by procurement method were obtained from the American Sheep Industry Association (2003–2004) and McDonnell, 2005–2006). All data were deflated by the CPI (1982–84=100). We used quarterly, rather than monthly, seasonal binary variables to obtain a more parsimonious specification.

The model allows for dynamic adjustments because of biological factors and price expectations of market participants. The dynamics are modeled using an autoregressive distributed lag (ARDL) specification (Greene, 2003). The single equation ARDL model is conceptually represented as

$$FCP_t = \frac{B(L)}{A(L)} Z_t + \frac{\mu_t}{A(L)}, \quad t = 1,\ 2,\ \ldots,\ n, \tag{2.2}$$

where FCP_t is the difference between formula and cash lamb prices, and Z_t is a vector of the exogenous variables presented in Eq. (2.1). The error term μ_t is assumed to possess white noise properties and is also uncorrelated with Z_t. The ratio $B(L)/A(L)$ is a rational generating function with polynomial lag operators (Greene, 2003). Eq. (2.2) defines a rational distributed lag process where the price difference (FCP_t) is, conceptually, an infinite distributed lag of Z_t and μ_t. The distributed lags are characterized by polynomial weights. Multiplying Eq. (2.2) by $A(L)$ yields the empirical form:

$$A(L)FCP_t = B(L)Z_t + \mu_t \tag{2.3}$$

with the polynomial lag denominator as

$$A(L) = 1 - a_1 L - a_2 L^2 - \ldots - b_q L^q \tag{2.4}$$

and the polynomial lag numerator as

$$B(L) = b_0 + b_1 L + b_2 L^2 \ldots + b_r L^r\ . \tag{2.5}$$

Thus, $L^q FCP_t = FCP_{t-q}$ and $L^r Z_t = Z_{t-r}$ for the respective polynomial lag operators. For the lamb price difference model, q and r are initially set to a lag order of 2. This implies second order lags on the dependent and independent variables. Although the error term contains no lags in the above transformation, it is usually tested for autoregressive structures in empirical specifications. The ARDL(2,2) specification allows for complex roots and oscillations of the dependent variable.

An ARDL(2,2) version of Eq. (2.1) can be estimated using OLS if μ_t is white noise. If the estimated error term results in an AR(1) or AR(2) process, then nonlinear least squares is the appropriate estimator. Differences in procurement quantities (*FCN*) and procurement prices (*FCP*) could be jointly determined. However, a Hausman specification test failed to reject the null hypothesis of exogeneity of *FCN* at the α = 0.10 level. ADF unit root tests failed to reject the null hypothesis of nonstationarity at the α = 0.10 level for the dependent variable and most of the independent variables. However, the ADF test of the appropriate residuals in Eq. (2.1) indicated that the equation is conintegrated. Because of the large number of parameters generated by the ARDL(2,2) specification, we used a Wald coefficient restriction test to truncate lags on those coefficients that were not jointly statistically significant at the α = 0.10 level.

The coefficient estimates of Eq. (2.1) are presented in Table 2-6. The coefficients were estimated using OLS because the Breusch-Godfrey Lagrangean Multiplier (LM) test for serial correlation failed to reject the null hypothesis of no AR(1) or AR(2) process in the error term at the α = 0.10 level. The second quarter seasonality binary variable (S_2) was omitted because it was statistically insignificant. The AR(1) and AR(2) components of the lagged dependent variable were not statistically significant. The Wald coefficient restriction test indicated the contemporaneous, and one-period lags on the formula less cash carcass price variable (*FCRP*) were jointly significant at the α = 0.05 level. Also, the Wald test indicated that the contemporaneous, one-period, and two-period lags on the price risk variable (*R*) were jointly significant at the α = 0.05 level. Approximately 61% of the variation of the difference between formula and cash lamb prices is explained by variations in formula/cash carcass price differences (*FCRP*), price risk (*R*), sheep and lamb inventories (*QI*), differences between formula and cash lamb procurement numbers (*FCN*), and seasonality (*S*). The positive signs on the three coefficients of carcass price risk are consistent with *a priori* expectations. That is, an increase in output price risk increases the price difference between formula and cash prices.

Table 2-6. OLS Estimates of the Formula/Cash Slaughter Price Difference Reduced Form Model

Regressors	Dependent Variable: Formula Less Cash Slaughter Lamb Price (*FCP*)
Constant	–0.724 (–3.478)
Formula carcass less cash carcass price ($FCRP_t$)	–0.002 (–1.494)
Lagged formula carcass less cash carcass price ($FCRP_{t-1}$)	–0.002 (–1.651)
Standard deviation of cash carcass price (R_t)	0.001 (0.557)
Lagged standard deviation of cash carcass price (R_{t-1})	0.001 (0.634)
Lagged standard deviation of cash carcass price (R_{t-2})	0.004 (2.418)
Inventory of sheep and lambs (QI_t)	1.206 (2.754)
Lagged inventory of sheep and lambs (QI_{t-1})	–1.093 (–2.660)
Formula less cash lamb numbers (*FCN*)	–0.003 (–1.964)
Third quarter seasonal binary variable (S_3)	0.035 (4.967)
Fourth quarter seasonal binary variable (S_4)	0.021 (2.750)
Regression Statistics:	
Adjusted R^2	0.611
Standard error of the regression	0.015
Mean of the dependent variable	–0.003

Note: The model contains 30 degrees of freedom. The critical t-values at the α = 0.05 level is 2.042, and 1.697 at the α = 0.10 level.

2.3.2 Parameter Stability of the Reduced Form Price Differences Model

The above reduced form price difference model is based on a relatively small sample. Consequently, it is important to test the stability of the estimated coefficients. Time-series stability tests are commonly based on recursive residuals. This is particularly the case if one suspects the structure of an industry has changed during the sample period (Brown, Durbin, and Evans, 1975; Greene, 2003).

The cumulative sum of the residuals (or CUSUM) test is often used for determining the stability of estimated parameters. The CUSUM test statistic (W_t) is the ratio of scaled recursive residuals to the standard deviation of the scaled residuals. Under the null hypothesis of stable parameter estimates, W_t has a zero mean and a variance equal to the number of residuals being summed. The test is performed by plotting W_t against time within established 95% or 99% confidence bounds (Greene, 2003).

For the model estimated in Eq. (2.1), the test statistic W_t is bounded by the 95% confidence interval. Results indicated that W_t did not violate the confidence interval boundaries. Hence, the null hypothesis of stable parameter estimates cannot be rejected at the $\alpha = 0.05$ level.

The stability of the parameter estimates indicates that structural change has not occurred during the sample period. These results also indicate that the small price differences among lamb procurement methods noted above were consistent throughout the sample period.

2.4 TIME-SERIES MODELS OF SLAUGHTER LAMB PRICES

Given that the dependent variable in Eq. (2.1) is nearly centered on zero, an autoregressive-moving average model (ARMA) may adequately explain the variation in price differences. In this section, we estimate a time-series model to determine if a purely stochastic process is able to describe the data-generating process as well as the previously estimated economic model. If so, then the value of the economic model would be diminished. Although time-series models ignore economic causality, they may provide information regarding the underlying data-generating process (Greene, 2003).

2.4.1 Formula/Cash Price Differences

We specify a time-series model in which the explanatory variables consist of an r^{th} order lag on the dependent variable [AR(r)] and a q^{th} order lag on the moving average error term [MA(q)] with seasonality included. The r^{th} and q^{th} lag orders need not be equal. Consequently, an ARMA(r,q) model is also estimated to see if noneconomic behavior explains variation in the dependent variable.

The general specification is given by

$$A(L)Y_t = B(L)\mu_t \tag{2.7}$$

where Y_t represents the dependent variable (FCP_t) and μ_t is a white noise disturbance term. The polynomial lag operators *A(L)* and *B(L)* are defined in Eqs. (2.4) and (2.5). Stationarity of the equation requires that the characteristic roots (eigenvalues) of $A(L)$ lie outside the unit circle, and invertability of $B(L)$ requires that its roots (eigenvalues) lie outside the unit circle (Johnston and DiNardo, 1997). Thus, conceptually, an ARMA(q,r) process can be expressed as an infinite autoregressive or moving average error process.

For the normalized formula/cash lamb price difference (*FCP*), the order of the ARMA(q,r) was selected based on adjusted R-squared statistics, standard error of regression, and the Akaike Information Criterion (AIC). Seasonality is also included in the estimated time-series model. The empirical model was estimated as an ARMA(4,4) using nonlinear least squares. The results are reported in Table 2-7.

The adjusted R-square was 0.64, indicating a purely stochastic process explained the behavior of formula/cash lamb price differences about as well as the economic model. The eigenvalues of the AR(4) difference equation consisted of two pairs of conjugate complex roots for which the modulus of each is less than unity. These results imply a stationary (stable) AR process in Eq. (2.7). The MA process was invertible, and the Wald coefficient test indicated that the MA coefficients were jointly significantly different from zero at the α = 0.05 level.

Table 2-7. Parameter Estimates of the Formula/Cash Slaughter Price Difference Time-Series Model

Regressors	Dependent Variable: Formula Less Cash Slaughter Lamb Price (*FCP*)
Constant	–0.008 (–0.831)
Lagged dependent variable (*t-1*)	0.225 (0.943)
Lagged dependent variable (*t-2*)	0.169 (1.171)
Lagged dependent variable (*t-3*)	0.521 (4.113)
Lagged dependent variable (*t-4*)	–0.540 (–3.094)
Lagged error term (*t-1*)	0.020 (0.068)
Lagged error term (*t-2*)	–0.383 (–2.719)
Lagged error term (*t-3*)	–0.856 (–19.171)
Lagged error term (*t-4*)	0.296 (1.299)
Second quarter seasonal binary variable (S_2)	0.003 (0.263)
Third quarter seasonal binary variable (S_3)	0.024 (1.481)
Fourth quarter seasonal binary variable (S_4)	–0.006 (–0.387)
Regression Statistics:	
Adjusted R^2	0.643
Standard error of the regression	0.015
Mean of the dependent variable	–0.003
Akaike information criterion	–5.375

Note: The model contains 26 degrees of freedom. The critical t-values are 1.706 at the α = 0.10 level and 2.056 at the α = 0.05 level.

2.4.2 Summary of the Time-Series Model Results

The time-series model explained nearly as much of the variation in formula/cash prices as the economic model. Thus, it appears that the economic model likely suffers from missing quantifiable information. That is, although a purely stochastic ARMA model may be as useful for prediction as the economic model, it is not helpful for understanding policy analyses. The presence of AR and MA error terms generally imply that an economic model has been misspecified. Often, this misspecification is the result of the inability to properly measure all of the economic variables that underlie the data-generating process. However, when the ARMA(4,4) specification was added to the specification of Eq. (2.1), the parameter estimates on the MA error term structure became statistically insignificant, while the coefficients on the economic variables remained statistically different from zero. Hence, the economic model is a better tool for evaluating the effects of shocks to the lamb industry than a purely stochastic model.

2.5 THE IMPACT OF ALTERNATIVE MARKETING ARRANGEMENTS ON MARKET PRICES

In this section, we present a monthly lamb econometric model for determining the effect of AMAs on market prices based on MPR data. We estimate a monthly model to provide sufficient observations for the model because data on procurement volumes are only available since 2001. We develop a monthly demand and supply structural model for the retail, wholesale, slaughter, and feeder levels and then solve it for equilibrium prices. Because changes in procurement methods may also influence potential lamb processor market power, we develop a function that represents meat packer market power for live lamb purchases. Marginal impacts of lamb procurement methods are obtained by jointly estimating the monthly equilibrium price model and market power equation.

2.5.1 A Monthly Structural Lamb and Sheep Price Model

The equilibrium price model for retail, wholesale, slaughter (fed and cull), and feeder lambs is obtained from a structural model of lamb demand and supply functions within the lamb meat marketing chain. MPR data provide percentages of lamb procurement by lamb packers/processors based on the following categories: formula pricing, forward contracting, negotiation, auctions, packer ownership, and live lamb imports. In our model, we combined the formula-priced and forward-contracted lamb into a single category entitled “formula.” We maintain the packer ownership and import categories and combine the negotiated and auctioned lamb procurement methods into a single category entitled “cash.”[3]

Conceptually, these three approaches (formula, packer ownership, and cash) to lamb procurement by lamb packers could affect retail lamb demand through changes in meat quality. These procurement methods also represent cost shifters (albeit, perhaps differing costs) of the wholesale and slaughter domestic lamb derived supply functions. Following Tomek and Robinson (1990), procurement costs can also be shifters of domestic slaughter lamb derived demand. Each procurement method could have a different impact on domestic wholesale lamb carcass prices and on domestic slaughter lamb prices if they entail different cost or risk factors. This is likely given differences in shares of lamb obtained by each procurement method. From 2001 to 2004, the average proportions of live lambs obtained by procurement method for all U.S. lamb packers were 43.8% formula, 0.9% contracted, 11.7% negotiated, 38.0% auction, 4.7% packer owned, and 0.8% imported (American Sheep Industry Association, 2003–2004).

We develop a monthly structural model of inverse demand and supply functions to capture retail quality effects and the cost impacts of differing procurement methods. Rank identification of the structural model permits econometric estimation of lamb equilibrium prices and, subsequently, specific solutions can be obtained through the reduced form. The reduced form coefficients (multipliers) are then used to quantify the effects of marketing methods (AMA) costs on all market-level sectors resulting from potential limits on procurement methods.

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[3] Negotiated and auction procurement methods have similarities and differences. The methods are similar in that they represent an “open market” approach to price discovery. However, auctions represent a public method of price determination, while negotiations are usually characterized by private treaty agreements. Preliminary research indicated that separating negotiated and auction procurement methods provided no additional information about the use and impacts of AMAs. Therefore, the two procurement methods were combined into a single category.

The monthly structural model specifies inverse demand and supply functions for the retail sector, the wholesale (boxed or cut-out) sector, the slaughter lamb sector, the ewe (cull) slaughter sector, and the feeder lamb sector. The specifications are based on the theory of consumer utility maximization and firm profit maximization whereby input demands and output supplies are derived from first-order conditions from profit-maximizing behavior by competitive firms (Brester and Marsh, 2001; Varian, 1992; Wohlgenant, 1989). Inverse behavioral functions are specified because supply quantities are assumed to be predetermined on a monthly basis. The model is represented by the following:

Retail Sector:

Inverse retail lamb demand:

$$p_r^d = m_1\left(q_r^d, p_r^b, p_r^y, p_r^k, Y, T_q\right) + \mu_1 \quad (2.8)$$

Inverse retail lamb supply:

$$p_r^s = m_2\left(q_r^s, p_{bx}, mc, s\right) + \mu_2 \quad (2.9)$$

Market-clearing quantity:

$$q_r^d = q_r^s = q_r \quad (2.10)$$

Market-clearing price:

$$p_r^d = p_r^s = p_r \quad (2.11)$$

Wholesale (Cut-Out) Sector:

Inverse wholesale lamb demand:

$$p_{bx}^d = m_3\left(q_l^d, p_r, q_s, mc, s\right) + \mu_3 \quad (2.12)$$

Inverse wholesale lamb supply:

$$p_{bx}^s = m_4\left(q_l^s, p_{sl}, cs, pf, po, pc, pi, mpr, s\right) + \mu_4 \quad (2.13)$$

Market-clearing quantity:

$$q_l^d = q_l^s = q_l \quad (2.14)$$

Market-clearing price:

$$p_{bx}^d = p_{bx}^s = p_{bx} \quad (2.15)$$

Slaughter Lamb Sector:

Inverse slaughter lamb demand:

$$p_{sl}^{d} = m_5\left(q_{sl}^{d}, p_{bx}, p_{bp}, cs, pf, po, pc, pi, mpr, s\right) + \mu_5 \quad (2.16)$$

Inverse slaughter lamb supply:

$$p_{sl}^{s} = m_6\left(q_{sl}^{s}, p_{fr}, p_n, s\right) + \mu_6 \quad (2.17)$$

Market-clearing quantity:

$$q_{sl}^{d} = q_{sl}^{s} = q_{sl} \quad (2.18)$$

Market-clearing price:

$$p_{sl}^{d} = p_{sl}^{s} = p_{sl} \quad (2.19)$$

Slaughter Ewe Sector:

Inverse slaughter ewe demand:

$$p_{ew}^{d} = m_7\left(q_{ew}^{d}, p_{bp}, p_{em}, s\right) + \mu_7 \quad (2.20)$$

Inverse slaughter ewe supply:

$$p_{ew}^{s} = m_8\left(q_{ew}^{s}, p_h, s\right) + \mu_8 \quad (2.21)$$

Market-clearing quantity:

$$q_{ew}^{d} = q_{ew}^{s} = q_{ew} \quad (2.22)$$

Market-clearing price:

$$p_{ew}^{d} = p_{ew}^{s} = p_{ew} \quad (2.23)$$

Feeder Lamb Sector:

Inverse feeder lamb demand:

$$p_{fr}^{d} = m_9\left(q_{f}^{d}, p_{sl}, p_n, s\right) + \mu_9 \quad (2.24)$$

Inverse feeder lamb supply:

$$p_{fr}^{s} = m_{10}\left(q_{f}^{s}, p_h, s\right) + \mu_{10} \quad (2.25)$$

Market-clearing quantity:

$$q_{fr}^{d} = q_{fr}^{s} = q_{fr} \quad (2.26)$$

Market-clearing price:

$$p_{fr}^{d} = p_{fr}^{s} = p_{fr} \tag{2.27}$$

Table 2-8 presents variable definitions. Disturbance terms (μ_1 – μ_{10}) are assumed to exhibit white noise properties within equations but contemporaneous correlations across equations. Eqs. (2.8) and (2.9) represent inverse lamb meat demand and supply functions at the retail level. Retail demand by consumers (the price of retail lamb meat $\left(p_r^d\right)$) is a function of per capita retail quantity demanded of lamb $\left(q_r^d\right)$, which includes imported and domestic lamb, the retail prices of meat substitutes including beef $\left(p_r^b\right)$, poultry $\left(p_r^y\right)$, and pork $\left(p_r^k\right)$, per capita consumer expenditures $\left(Y\right)$, and consumer lamb quality preferences $\left(T_q\right)$. Retail supply price $\left(p_r^s\right)$ is a function of per capita retail lamb quantities supplied $\left(q_r^s\right)$, boxed lamb price $\left(p_{bx}\right)$, and retail food marketing costs $\left(mc\right)$. Eqs. (2.10) and (2.11) represent retail market-clearing quantities and prices.

Eq. (2.12) specifies wholesale demand (by retailers) price $\left(p_{bx}^d\right)$ as a function of wholesale quantity demanded of domestic and imported lamb and mutton $\left(q_l^d\right)$, the retail price of lamb (p_r), the wholesale quantity of meat substitutes (beef, pork, and chicken, (q_s), food marketing costs (mc), and seasonality (s). Eq. (2.13) specifies wholesale supply price $\left(p_{bx}^s\right)$ as a function of wholesale quantity supplied of domestic and imported lamb $\left(q_l^s\right)$, price of slaughter lamb (p_{sl}), lamb processing cost (cs), lamb procurement costs of formula arrangements (pf), lamb procurement costs of packer ownership (po), lamb procurement costs of cash transactions (pc), lamb procurement costs of imports (pi), MPR requirements (mpr), and seasonality (s). Eqs. (2.14) and (2.15) represent market-clearing conditions.

Because data related to procurement costs associated with each AMA are not available, volume shares of each marketing alternative are used as proxies. The variable (pf) includes formula and contract volumes, (po) consists of packer ownership volumes, (pc) represents cash (negotiated and auction market volumes), and (pi) represents live import volumes. MPR was generally implemented in April 2001, but actual lamb MPR reported data did not begin until December 2001. Thus, for lamb, the variable (mpr) is a binary variable

Table 2-8. Variable Definitions for the Monthly Lamb Procurement Model, August 2001–December 2004

Symbol	Definition	Mean	Standard Deviation
p_r	Real retail price of domestic lamb, cents per pound	254.51	16.48
p_r^b	Real retail beef price, cents per pound	372.38	36.80
p_r^y	Real retail poultry price, cents per pound	106.43	3.30
p_r^k	Real retail pork price, cents per pound	272.28	8.99
Y	Real per capita consumption expenditures, dollars	14,212	373.68
p_{bx}	Real lamb carcass cut-out value, dollars per cwt	110.91	13.55
p_{em}	Real mutton carcass cut-out value, dollars per cwt	NA	NA
p_{sl}	Real price of domestic slaughter lambs, dollars per cwt	44.64	8.34
p_{ew}	Real price of ewes, dollars per cwt	24.41	3.40
p_{fr}	Real price of feeder lambs, dollars per cwt	48.51	9.14
p_{bp}	Real lamb pelt and drop credit (offal) value, dollars per head	71.16	7.74
p_n	Real price of #2 yellow corn, Central U.S., dollars per bushel	1.23	0.14
p_h	Real price of hay (grass and alfalfa), dollars per ton	39.87	2.79
cs	Real lamb processing and packaging costs, dollars per cwt	16.05	1.13
mc	Index of food marketing costs (1987=100)	NA	NA
q_r	Per capita consumption of lamb, retail weight, pounds	0.30	0.02
q_l	Quantity of domestic lamb and mutton production and imports, carcass weight, million pounds	29.82	4.81
q_{sl}	Quantity of yearling lamb slaughter, live weight, million pounds	30.96	3.93
q_{ew}	Quantity of sheep slaughter, live weight, million pounds	1.83	0.31
q_f	Quantity of feeder lambs, thousand head	4,277.75	172.59
q_s	Quantity of wholesale beef, pork, and chicken production, billion pounds	6.73	0.99
T_q	Retail lamb quality, monthly average yield grade, 1–5	2.68	0.10
CPI	Consumer price index (1982–84=100)	1.83	0.04
pf	Packer formula (formula plus contract) procurement of slaughter lambs, percent	43.20	8.06

(continued)

Table 2-8. Variable Definitions for the Monthly Lamb Procurement Model, August 2001–December 2004 (continued)

Symbol	Definition	Mean	Standard Deviation
po	Packer ownership of slaughter lambs, percent	4.67	0.70
pc	Packer cash (negotiated and auction) procurement of slaughter lambs, percent	51.30	8.24
pi	Packer procurement of imported slaughter lambs, percent	0.81	1.09
mpr	Mandatory price reporting (December 2001–December 2004 = 1; 0 otherwise)	0.62	0.49
t_f	Technological genetics changes, average live lamb slaughter weight, pounds	136.08	4.46
m_k	Estimated oligopsony power	0.00005	0.003
s_i	Quarterly seasonal dummies (i = 2, 3, 4; quarter 1 omitted)	NA	NA

NA = Not applicable.

that accounts for the impact of the legislation on derived supply behavior caused by potential increased market transparency.

Eqs. (2.16) and (2.17) present inverse derived demand and supply equations for the slaughter lamb sector. Slaughter lamb demand (by meat processors) price $\left(p_{sl}^{d}\right)$ is a function of the quantity demanded of slaughter lambs $\left(q_{sl}^{d}\right)$, the output price of boxed lamb (p_{bx}), the joint product value of lamb pelts and drop credits (p_{bp}), lamb processing costs (*cs*), lamb procurement costs (*pf, po, pc, pi*), MPR (*mpr*), and seasonality (*s*). Slaughter lamb supply (by feedlots) price $\left(p_{sl}^{s}\right)$ is a function of quantity supplied of fed slaughter lambs $\left(q_{sl}^{s}\right)$, the input price of feeder lambs (p_{fr}), the input price of corn (p_n), and seasonality (*s*). Eqs. (2.18) and (2.19) provide market-clearing identities.

Note that lamb procurement costs and mandatory price variables are included on the right-hand side of Eqs. (2.13) and (2.16). Changes in procurement costs and market price transparency are expected to shift derived wholesale supplies of boxed lamb and derived processor demand for slaughter lamb. Processors adjust to cost changes by altering sale prices of boxed lamb and purchase prices of live lamb.

Eqs. (2.20) and (2.21) represent inverse slaughter ewe derived demand by processors and inverse derived supply of slaughter ewes by lamb producers. Slaughter ewe derived demand price $\left(p_{ew}^{d}\right)$ is a function of the quantity demanded of slaughter ewes $\left(q_{ew}^{d}\right)$, the joint product value of lamb pelts and drop credit (p_{bp}), the boxed price of mutton (p_{em}), and seasonality (s). Slaughter ewe derived supply price $\left(p_{ew}^{s}\right)$ is a function of the quantity supplied of slaughter ewes $\left(q_{ew}^{s}\right)$, the price of hay (p_h), and seasonality (s). Eqs. (2.22) and (2.23) provide market-clearing identities.

Eqs. (2.24) and (2.25) present inverse derived feeder lamb demand and primary feeder lamb supply equations. Feeder lamb demand (by feedlots) price $\left(p_{fr}^{d}\right)$ is a function of the quantity of feeder lambs demanded $\left(q_{fr}^{d}\right)$, the output price of slaughter lambs (p_{sl}), the input price of corn (p_n), and seasonality (s). Primary inverse feeder lamb supply price $\left(p_{fr}^{s}\right)$ is a function of the quantity supplied of feeder lambs $\left(q_{fr}^{s}\right)$, the input cost of hay (p_h), and seasonality (s). Eqs. (2.26) and (2.27) represent market-clearing identities.

2.5.2 A Monthly Equilibrium Price Model

The empirical model to be estimated uses equilibrium prices for each market level based on market-clearing assumptions for quantities and prices. Thus, Eqs. (2.8) through (2.27) can be reduced to the following five-equation model:

Price of retail lamb:

$$p_r = m_{11}\left(q_r, p_r^b, p_r^y, p_r^k, Y, T_q, p_{bx}, mc, s\right) + \epsilon_1 \tag{2.28}$$

Price of boxed lamb:

$$p_{bx} = m_{12}\left(q_l, p_r, q_s, mc, p_{sl}, cs, pc, po, pm, pi, mpr, s\right) + \epsilon_2 \tag{2.29}$$

Price of slaughter lambs:

$$p_{sl} = m_{13}\left(q_{sl}, p_{bx}, p_{bp}, cs, pf, po, pc, pi, mpr, p_{fr}, p_n, s\right) + \epsilon_3 \tag{2.30}$$

Price of slaughter ewes:

$$p_{ew} = m_{14}\left(q_{ew}, p_{bp}, p_{em}, p_h, s\right) + \epsilon_4 \tag{2.31}$$

Price of feeder lambs:

$$p_{fr} = m_{15}\left(q_{fr}, p_{sl}, p_n, p_h, s\right) + \epsilon_5 \tag{2.32}$$

Eqs. (2.28) through (2.32) express equilibrium prices for each market level in terms of equilibrium quantities and all other pertinent demand and supply shifters. A sixth equation is included in the model to identify changes in potential lamb packer market power (m_k) as a result of changes in lamb procurement methods as follows:

$$m_k = m_{16}\left(pf, po, pc, pi\right) + \epsilon_6 . \qquad (2.33)$$

The model of equilibrium prices consists of a triangular coefficient matrix of the dependent variables because of its recursive structure. For example, retail lamb price, boxed lamb price, and slaughter lamb price are regressors in Eqs. (2.29), (2.30), and (2.32), respectively. Disturbances terms ($\epsilon_1 - \epsilon_6$) are assumed to have a nondiagonal covariance matrix because of potential common specification errors and common stochastic factors (e.g., weather) within the vertical market structure (Johnston and DiNardo, 1997). Market rigidities, biological lags, and price expectations dictate that dynamics be included in the estimation through the use of distributed lags.

Eq. (2.33) is specified such that marginal changes in procurement methods can be related to marginal changes in market power. That is, a policy that limits a specific lamb procurement method might not only increase procurement costs, but it may also ameliorate market power effects. For example, suppose that lamb processors are limited in the percentage of fed lambs that they are allowed to procure through formula and packer ownership methods. Although market cost inefficiencies are likely to be introduced, the action could reduce oligopsony purchasing power.

Several methods exist to estimate the degree of oligopsony market power (Appelbaum, 1982; Muth and Wohlgenant, 1999; Crespi, Gao, and Peterson, 2005; Schroeter, 1988; Stiegert, Azzam, and Brorsen, 1993). However, data limitations in the lamb processing industry prevent the direct application of these approaches. Therefore, the following “market power” equation is specified:

$$LK_t = \psi\left(LC_t, TN_t, s_2, s_3, s_4\right) + \mu_t \qquad (2.34)$$

where *LK* is the four-firm lamb packer concentration ratio (percent); *LC* represents unit lamb processing and packaging costs (dollar/cwt); *TN* represents technological change in the lamb processing industry (trend); s_2, s_3, and s_4 represent seasonal binary variables for the second, third, and fourth quarters of each calendar year; and μ_t is a random error term with white noise properties. From 2001 to 2004, the four-firm lamb packer concentration ratio averaged about 65%. Assuming the variable LK_t includes a measure of market power and that Eq. (2.34) is properly specified (i.e., unit costs and technology are expected to affect concentration), the estimated residuals (i.e., the difference between the actual and predicted values of LK_t) could plausibly represent an estimate of market power. Of course, it is likely that the residuals of Eq. (2.34) contain other factors beyond those associated with market power. However, the estimated residuals would represent the largest market power effects possible.

2.5.3 Data Development and Estimation Procedures for the Monthly Reduced Form Price Model

The sample period for the estimation of the reduced form model consists of 40 monthly observations from August 2001 to December 2004 (voluntary price reporting began in August 2001, even though MPR for lamb did not begin until December 2001). Lamb price, quantity, and processing cost data were obtained from the American Sheep Industry Association (McDonnell, 2005–2006). Prices and quantities of meat substitutes, food marketing costs, corn price, and hay price data were obtained from the USDA (*Red Meats Yearbook*; *Livestock, Dairy, and Poultry Situation and Outlook* reports; *Agricultural Outlook*; *Feed Yearbook*; *Agricultural Statistics*). Food marketing costs were not reported on a monthly basis. Therefore, lamb processing costs were used as a proxy. Boxed mutton price was also not reported on a monthly basis, so the boxed price of lamb was used as a proxy. Lamb packer concentration ratios are only reported on an annual basis (USDA GIPSA). A linear interpolation of the annual observations are used to generate monthly concentration values. All price, expenditures, and processing cost data were deflated by the CPI (CPI, 1982–84=100). CPI data were obtained from the *Economic Report of the President* (various issues).

The market power equation, Eq. (2.34), is estimated in double log form using OLS and monthly data from August 2001 to December 2004. The length of the data series is consistent with that used for the monthly price equilibrium model. The OLS results are as follows:

$$\ln LK_t = \underset{(188.475)}{4.238} - \underset{(-2.761)}{0.023}\ln LC_t - \underset{(-0.561)}{0.0001}TN + \underset{(1.267)}{0.002}s_3 \qquad (2.35)$$

$$\bar{R}^2 = 0.135 \quad S.E. = 0.004 \quad \bar{Y} = 4.175$$

The largest adjusted R^2 and lowest standard error of the estimate were obtained by omitting the second and fourth quarter seasonal binary variables. Other than the constant term, only the lamb processing cost variable is significantly different from zero. The sign indicates that lower unit costs are associated with increases in market concentration. This may reflect advantages gained from scale economies. Nonetheless, the parameter estimate is not economically significant. In addition, note that the equation does not fit the data particularly well. Thus, the residuals of Eq. (2.35) likely contain information beyond that attributable to market power effects. That is, the residuals should represent the largest possible market power effects.

The residuals of Eq. (2.35) are approximately normally distributed (using a Jacque-Bera test statistic) with a mean of –0.0005 and a standard deviation of 0.003. These residuals are used as the dependent variable in Eq. (2.33) of the monthly price model as a proxy for m_k. Because this proxy likely contains information in addition to the effects of market power, the estimated parameters of Eq. (2.33) should be considered an upper bound of the market power effects resulting from changes in procurement methods.

ADF unit root tests indicated the variables of the price equilibrium model (Eqs. [2.28] through [2.33]) were nonstationary. However, ADF tests of the OLS residuals indicated that the equations were cointegrated at the $\alpha = 0.05$ significance level. Thus, the model was estimated with all variables in data levels. The natural logarithm of each variable was used for estimation purposes. Therefore, estimated coefficients are interpreted as elasticities. Livestock and meat quantities are assumed to be predetermined on a monthly basis. Wu-Hausman tests of the exogeneity were performed using the model's exogenous variables as instruments. The null hypothesis of no simultaneous equation bias was rejected at the $\alpha = 0.05$ level. Thus, Eqs. (2.28) through (2.33) were estimated by three stage least squares (3SLS). First-stage instruments included all of the model's exogenous variables. The third-stage generalized least squares (GLS) weighted covariance matrix was not iterated because little efficiency gains occur in small samples (Greene, 2003). The volume shares for the four lamb procurement methods sum to 1.0. Therefore, the smallest lamb procurement variable, live imports (*pi*), was deleted from the empirical specification. For the sample period, domestic lamb processors imported an average of 0.8% of live lambs per year. However, since 2003, U.S. lamb processors have not imported live lambs.

2.5.4 Empirical Results for the Monthly Equilibrium Price Model

Tables 2-9, 2-10, and 2-11 present the 3SLS results for the monthly equilibrium price model. In each equation, distributed lags on the regressors were included to reflect dynamic adjustments. Lagged values of variables were not retained in the model if they were found to be statistically insignificant at the α = 0.10 level in initial regressions. Likewise, contemporaneous variables were not retained in the model if they were not significantly different from zero provided that the one-period lag on the variable was statistically significant. Because of overparameterization of the model, quarterly rather than monthly seasonal binary variables were used.

Most of the estimated coefficients (40 of 49) are significantly different from zero at the α = 0.10 level and possess theoretically correct signs. In the retail lamb price equation (2.28), substitute retail beef and pork prices are positively related to lamb price as expected (Table 2-9). Increases in lamb quality also positively affect lamb price. For example, a 1% decrease in yield grade (which represents an increase in quality) increases retail lamb price by 0.42% (the sum of the contemporaneous and lagged quality coefficients –0.914 and 0.492).

In the boxed lamb price equation (Eq. [2.29]), a 1% increase in food marketing costs (*mc*) decreases the boxed lamb price by 0.19%, which reflects a reduction in wholesale derived demand (Table 2-9). Furthermore, a 1% increase in lagged slaughter lamb price ($P_{sl,t-1}$) increases the boxed lamb price by 0.61%. This input cost change decreases derived wholesale supply. In addition, the impacts of formula and cash procurement are both statistically different from zero. The null hypothesis that these two coefficients were not significantly different from each other could not be rejected at the α = 0.01 level.

Table 2-9. 3SLS (Double Log) Estimates of Retail Lamb Prices and Lamb Cut-Out Values

Regressors	Dependent Variables: Retail Lamb Price (p_r)	Dependent Variables: Lamb Cut Out Price (p_{bx})
Constant	–0.768 (–0.128)	5.751 (5.716)
Per capita lamb consumption (q_r)	–0.165 (–2.205)	
Retail price of beef (p_r^b)	0.366 (1.961)	
Retail price of poultry (p_r^b)	–1.162 (–4.045)	
Retail price of pork (p_r^b)	1.187 (2.583)	
Per capita consumer expenditures (Y)	–0.047 (–0.066)	
Retail lamb quality (T_q)	–0.914 (–3.361)	
Lagged retail lamb quality ($T_{q\ t-1}$)	(0.492) (1.970)	
Quantity of lamb production (q_l)		–0.182 (–4.728)
Food marketing costs (mc)		–0.186 (–2.625)
Lagged price of slaughter lambs ($p_{sl\ t-1}$)		0.614 (7.794)
Quantity of lamb substitutes (q_s)		–0.029 (–0.681)
Retail price of lamb (p_r)		–0.314 (–3.768)
Formula lamb procurement (pf)		–0.265 (–2.178)
Packer ownership (po)		–0.011 (–0.884)
Cash lamb procurement (pc)		–0.217 (–1.558)
Mandatory price reporting (mpr)		–0.026 (–0.923)
Regression Statistics:		
Adjusted R^2	0.512	0.914
Standard error of the regression	0.046	0.037
Log mean of the dependent variable	5.534	4.705

Note: The model contains MT-K degrees of freedom. M is the number of equations (6), T is the adjusted number of observations (40 after allowing for t–1 lagged terms), and K is the number of estimated parameters (49). Thus, for 191 degrees of freedom, the critical t-value at the α = 0.10 level is 1.658.

In the slaughter lamb price equation (Eq. [2.30]), boxed lamb price and pelt/drop credit values positively affect derived slaughter demand (0.359 and 0.537, respectively, Table 2-10).

Table 2-10. 3SLS (Double Log) Estimates of Slaughter Lamb Prices and Slaughter Ewe Prices

	Dependent Variables	
Regressors	**Fed Lamb Price (p_{sl})**	**Slaughter Ewe Price (p_{ew})**
Constant	–2.543 (–2.459)	5.871 (5.887)
Quantity of lamb production (q_l)	–0.147 (–3.010)	
Formula lamb procurement (*pf*)	0.254 (2.077)	
Packer ownership (*po*)	–0.023 (–1.618)	
Cash lamb procurement (*pc*)	0.268 (2.000)	
Mandatory price reporting (*mpr*)	0.129 (5.316)	
Lamb cut-out value (p_{bx})	0.359 (2.431)	0.148 (0.495)
Price of lamb by-products (p_{bp})	0.537 (3.913)	0.133 (0.446)
Lamb processing costs (*cs*)	–0.001 (–0.211)	–0.534 (–2.891)
Lagged price of feeder lambs ($p_{fr\ t-1}$)	0.198 (2.289)	
Lagged price of corn ($p_{n\ t-1}$)	0.171 (2.416)	
Seasonal binary variable (s_3)	–0.029 (–2.538)	
Quantity of ewe production (q_{ew})		–0.592 (–5.641)
Lagged price of hay ($p_{h\ t-1}$)		–0.604 (–3.037)
Regression Statistics:		
Adjusted R^2	0.967	0.428
Standard error of the regression	0.036	0.092
Log mean of the dependent variable	3.790	3.132

Note: The model contains MT-K degrees of freedom. M is the number of equations (6), T is the adjusted number of observations (40 after allowing for t–1 lagged terms), and K is the number of estimated parameters (49). Thus, for 191 degrees of freedom, the critical t-value at the α = 0.10 level is 1.658.

Lagged feeder lamb price and lagged corn price positively affect slaughter lamb price. That is, increases in input costs reduce derived slaughter supply. Specifically, a 1% increase in the lagged feeder lamb price increases slaughter price by 0.20%.

Likewise, a 1% increase in the lagged corn price increases the slaughter lamb price by 0.17%. In addition, the impacts of formula and cash procurement are both statistically different from zero. The null hypothesis that these two coefficients were not significantly different from each other could not be rejected at the α = 0.01 level.

In the slaughter ewe price equation (Eq. [2.31]), a 1% increase in the lagged hay price decreases the ewe price by 0.60% (Table 2-10). That is, higher animal maintenance cost encourages cull ewe slaughter (herd reductions).

In the feeder lamb price equation (Eq. [2.32]), corn price represents a proxy for finishing costs of gain and is a significant shifter of derived demand. A 1% increase in corn price reduces feeder price by 0.12% (Table 2-11). Lamb slaughter price directly influences feeder lamb price. The empirical results indicate that a 1% increase in slaughter lamb price increases feeder lamb price by 0.84%.

2.5.5 Effects of Procurement Methods on Equilibrium Prices

The effects of procurement methods are generally significant in each of the equilibrium price equations. Thus, lamb procurement costs are shifters of derived wholesale supply and slaughter demand. For example, in the boxed lamb price equation, a 10% increase in formula lamb procurement (*pf*) reduces boxed lamb price by 2.65% (Table 2-9). In the slaughter lamb equation, a 10% increase in formula lamb procurement increases slaughter lamb price by 2.54%. These impacts are consistent with the theory that packer/processor formula and contract procurement methods reduce transaction, risk, and logistics costs. If sufficient competition exists within the industry, these cost savings would be distributed among the vertical sectors depending on relative primary demand and supply elasticities and are manifest in a narrowing of the farm-to-wholesale marketing margin (Brester and Marsh, 2001; Tomek and Robinson, 1990).

The effect of lamb procurement through packer ownership (*po*) was not statistically significant in the boxed lamb price equation. However, packer ownership was statistically significant in the slaughter lamb demand price equation. The negative sign suggests that increases in packer ownership of

Table 2-11. 3SLS (Double Log) Estimates of Feeder Lamb Prices and Lamb Packer Market Power

Regressors	Dependent Variables	
	Feeder Lamb Price (p_{fr})	**Lamb Market Power (m_k)**
Constant	9.350 (1.991)	–0.077 (–1.846)
Lagged price of hay ($p_{h\ t\text{-}1}$)	–0.417 (–4.111)	
Price of slaughter lambs (p_{sl})	0.844 (9.108)	
Price of corn (p_n)	–0.123 (–1.710)	
Quantity of feeder lambs (q_{fr})	–1.142 (–2.452)	
Lamb genetics technology (T_f)	0.493 (2.158)	
Formula lamb procurement (*pf*)		0.009 (1.788)
Packer ownership (*po*)		0.002 (3.566)
Cash lamb procurement (*pc*)		0.010 (1.762)
Lagged market power ($m_{k,t\text{-}1}$)		0.723 (8.841)
Regression Statistics:		
Adjusted R^2	0.949	0.807
Standard error of the regression	0.045	0.002
Log mean of the dependent variable	3.872	–0.0005

Note: The model contains MT-K degrees of freedom. M is the number of equations (6), T is the adjusted number of observations (40 after allowing for t–1 lagged terms), and K is the number of estimated parameters (49). Thus, for 191 degrees of freedom, the critical t-value at the α = 0.10 level is 1.658.

lambs reduce slaughter lamb price. However, the magnitude of the coefficient is only –0.023, which suggests that the market power effect is economically small. Given that packer ownership of lambs represented only 4.7% of total procurement volume, the result is not surprising.

The effect of lamb procurement through cash market transactions (*pc*) is statistically significant in the boxed lamb price equation and indicates that a 10% increase in lamb procurement using cash transactions reduces boxed lamb price by 2.17%. A 10% increase in lamb procurement using cash transactions increases slaughter lamb price by 2.68%. Essentially, this procurement method results in a narrowing of the farm-to-wholesale marketing margin. Note that a marginal increase in formula procurement reduces the lamb farm-to-wholesale marketing margin. Likewise, a marginal increase in cash procurement also reduces the lamb farm-to-wholesale margin. The two effects are similar, and both methods have similar procurement volumes (43% for formula and 51% for cash procurement).

2.5.6 Effects of Procurement Methods on Potential Market Power

The estimated market power equation (Eq. [2.33]) included a Koyck distributed lag. The modulus of the function's real root is less than unity, which indicates that the difference equation is stable. Each procurement method variable is statistically significant and jointly significant at the $\alpha = 0.01$ level using a Wald coefficient restriction test. The model explains about 81% of the variation in the dependent variable (Table 2-11).

Results indicate that increases in formula procurement (*pf*) and increases in packer ownership (*po*) increase lamb processors' market power. In all cases, this should be interpreted as potential effects rather than actual effects. We are unable to estimate whether market power is actually exercised in this market. However, we are estimating the potential changes in market power given changes in AMAs should such market power actually exist. Nonetheless, the short-run economic effects are quite small (i.e., a 10% increase in *pf* and *po* increases lamb processors' oligopsony power by 0.10% and 0.02%, respectively). Although contrary to *a priori* expectations, increases in cash procurement methods (*pc*) are positively correlated with market power. Specifically, a 10% increase in *pc* increases market power by 0.10%. This counterintuitive result may be caused by the sample period considered. During the period in which MPR data were gathered, the lamb industry was dominated by a few large packers. Furthermore, overall industry production is quite small. Hence, regardless of procurement method, it is possible that packers were able to exert some market power regardless of procurement method. However, the economic effect of this buying power in all cases was quite small.

2.6 SUMMARY OF THE EXTENT OF USE AND PRICE EFFECTS OF ALTERNATIVE MARKETING ARRANGEMENTS

According to MPR data, lamb packers procure fed lambs primarily through formula price arrangements (42.2%) and auctions (39.4%). Negotiated sales account for 12% of fed lamb procurement, and packer ownership represents 4.9%. Contracted procurement represents only 0.8% of lamb procurement, while imports represent only 0.7%.

This compares favorably with information obtained from packer surveys. Table 7-15 in Volume 2 shows that packers reported obtaining 40.1% of their fed lambs through auctions. Also, packers report obtaining 32.1% from dealers/brokers, and 22.5% from direct trade. The combination of these two (54.6%) is almost identical to the 54.2% obtained from formula and negotiated methods reported in the MPR. In addition, the survey data indicate that packers had procured no lambs through packer ownership or forward contracts, and only 5.3% through marketing agreements.

The small procurement shares for contracts necessitated the aggregation of formula and contract procurement into a single category termed “formula.” Because negotiated and auction prices are generally considered to both represent spot prices, they were aggregated into a single category termed “cash.”

Over the sample period, formula procurement trended downward, while auction procurement trended upward (each about 0.26 percentage points per month).

The means and standard deviations of formula and cash fed lamb prices using MPR data were similar during the sample period. The price series were highly correlated with an estimated correlation coefficient of 0.970. A reduced form model of the difference between normalized formula and cash fed lamb prices indicated that lamb inventories, lamb carcass price risk, and seasonality were the primary determinants of variations in the difference. Changes in lamb inventories had the largest effects on price differences. As inventories increase, the difference between formula/cash prices also increased. The second most important factor was changes in carcass price risk, which was directly related to liveweight price differences between formula and cash prices. In addition, the estimated parameters were found to be stable throughout the sample period indicating that structural change was not occurring. Finally, ARMA time-series models explained a similar amount of the differences between formula and cash prices as did the economic model.

The results of the price equilibrium and market power equations indicate that changes in procurement methods for lamb impose costs on the lamb marketing system by reducing efficiencies but may also provide some benefits by altering potential market power effects. For example, if formula procurement is curtailed, lamb acquisition costs rise. However, some of this increase in costs may be offset by a reduction in oligopsony power. Ultimately, a combination of these effects yields net changes in lamb prices, quantities, and producer surplus.

The implementation of MPR in 2001 was intended to increase pricing efficiency through improved market price transparency (Perry et al., 2005). In addition, its inclusion as a binary variable in the equilibrium price model allows for estimates of the effect of lamb procurement methods net of USDA price reporting regulations. The estimated coefficient for the binary variables was not statistically significant in the boxed lamb price equation. However, it was statistically significant, albeit economically small, in the slaughter lamb equation. The binary variable indicates the MPR increased slaughter lamb price by only 0.129%. Given that lamb markets are relatively thin, the primary impact of MPR may have been to reduce price risk rather than influence price levels (Marsh and McDonnell, 2005).

The AMA method of lamb procurement was found to have a statistically significant, although economically small, effect on lamb prices. For example,

- In the boxed lamb price equation, a 10% increase in the share of formula lamb procurement (*pf*) reduces boxed lamb price by 2.65% probably because of reductions in price risk. A 10% increase in cash procurement (*pc*) also reduces boxed lamb price (2.17%). However, the impact of packer ownership had no statistically significant effect on boxed lamb prices.
- In the slaughter lamb equation, a 10% increase in formula lamb procurement increases the slaughter lamb price by 2.54% probably because of risk reductions. A 10% increase in cash procurement increases slaughter

prices by 2.68%. A 10% increase in packer ownership reduces slaughter lamb prices by 0.23%.

Approximately 60% of the difference between formula and cash lamb prices is explained by variations in formula/carcass price differences, carcass price risk, sheep and lamb inventories, differences between formula and cash lamb procurement numbers, and seasonality. An important result consistent with *a priori* expectations is that an increase in output price risk increases the price difference between formula and cash prices.

3 Alternative Marketing Arrangements and Procurement Costs

Participants in the lamb packer industry interviews indicated that AMAs help packers secure a steady supply of fed lambs for slaughter and coordinate both fed lamb and lamb meat logistics. Although packer ownership of fed lambs is relatively small, such ownership is often used to fill gaps in fed lamb supplies. Also, packers noted that formula arrangements are relatively low-cost methods for acquiring fed lambs. In addition, AMAs reduce the amount of lamb meat that must be frozen, which reduces its value relative to fresh meat, by helping match fed lamb slaughter with lamb meat sales.

Section 2.5 used a monthly reduced form price model to estimate the marginal impacts of changes in AMAs on boxed lamb prices. Results indicated that the use of formula pricing arrangements reduced boxed lamb price because of cost savings. Examples of cost savings include factors such as reductions in logistics and procurement costs, risk, and improved capacity utilization. The following section focuses on a single element of these potential cost savings—reductions in fed lamb procurement costs.

Data limitations do not allow for the direct estimation of a cost function for the lamb packing industry. Consequently, we used MPR data from January 2002 to June 2005 to estimate a farm–processor marketing margin model to examine the impacts of various lamb procurement methods on costs in the lamb packing industry. Three procurement methods are considered: formula, cash, and packer ownership.

3.1 PROCUREMENT COST MODEL

If adequate firm-level data were available, a traditional cost function based on the duality of cost and production functions could be estimated. Applying a cost minimization objective function to such data could yield estimates of optimal input factor demands and total costs (Greene, 2003; Nerlove, 1963). First principles would be used to derive total costs as a function of relative input prices, production volumes, and output prices.

Because data limitations preclude the estimation of a dual cost function, we estimate a farm–wholesale lamb price marketing margin model. The marketing margin represents all costs required to convert fed slaughter lamb into boxed or wholesale lamb. Therefore, the margin represents processing costs, procurement costs, profit, and allowances for risk. Because a procurement cost variable is not directly available, we constructed a proxy by subtracting slaughter costs from the farm–wholesale lamb marketing margin. The difference represents an upper bound on procurement costs. To calculate this proxy, we first add lamb pelt and drop credit values to lamb carcass value to obtain a total wholesale value of lamb. Then, we subtract slaughter lamb value from total wholesale value to obtain our proxy for procurement costs. This proxy is then specified as a function of lamb production, procurement methods, processing costs, and seasonality. This specification is intended to approximate the econometric estimation of a cost function in that production volume and marketing inputs are used to explain marketing margins between farm-level and wholesale-level lamb prices.

The lamb procurement cost model is specified as follows:

$$C = c\left(ql, pf, po, pc, vpc, s\right) + \mu \tag{3.1}$$

where C represents lamb procurement costs in dollars per head, ql is lamb slaughter production (liveweight, million pounds), pf is the percentage of lambs procured by packers using formulas (and contracts), po is the percentage of lambs procured by packers through packer ownership, pc is the percentage of lambs procured by packers through cash (negotiations and auctions), vpc is variable lamb processing costs (dollars/head), s is a vector of quarterly seasonal binary variables, and μ is a random error term (see Table 2-8 for a list of variable definitions). We assume that lamb slaughter production is exogenous on a monthly basis.[1]

Eq. (3.1) is expected to contain market rigidities. Hence, the model is further specified with autoregressive distributed lags (ARDL) to capture noninstantaneous adjustments to exogenous market factors. The dynamic equation is expressed as follows:

$$A(L)C_t = B(L)X_t + \epsilon_t, \qquad t = 1, 2, \ldots, n \tag{3.2}$$

where C_t is the proxy for lamb procurement costs, X_t is a vector of exogenous factors as specified in Eq. (3.1), and ϵ_t is a white noise disturbance term. Although initially assumed to be white noise, Greene (2003) notes that the estimated error term may be autoregressive. The ratio $B(L)/A(L)$ is the rational generating function with a polynomial numerator and denominator as defined in Eqs. (2.4) and (2.5).

Data used for constructing the dependent variable were obtained from the American Sheep Industry Association (2003–2004) and McDonnell (2005–2006). Slaughter costs were only available for January 2002 ($7.50/head) and June 2005 ($9.00/head). Therefore, missing values were obtained through linear interpolation. This proxy for the unobservable dependent margin implies that the parameter estimates of Eq. (3.1) represent upper bounds. Any errors associated with the calculation of *C* are manifest in the error term associated with the estimated equation such that our parameter estimates are unbiased. All observations of the dependent variable *C* were deflated by the CPI (1982 – 84 = 100). The processing cost variable (*vpc*) includes variable costs of processing lamb carcasses. This variable is also deflated by the CPI. Its specification represents a vertical marketing cost (margin) factor. A change in processing (or marketing) costs is expected to affect derived demand for live lambs by lamb packers. The ADF unit root test indicated the existence of unit roots for the variables *C*, *pf*, *po*, and *pc*. Each variable was integrated of order one (I(1)), and the equation was cointegrated at the $\alpha = 0.05$ level.

[1] As in the previous section, we have excluded the percentage of lambs procured through imports from the model to avoid matrix singularity in the regression.

3.2 EMPIRICAL RESULTS

Eq. (3.1) is estimated using nonlinear least squares to accommodate the joint combination of lagged dependent variables and autoregressive errors. The final empirical model included second-order distributed lags on procurement methods and processing costs, contemporaneous lamb production, and a first-order lag on the dependent variable. The final dynamic model was selected based on the values of adjusted R-squared, standard error of regression, and the AIC. The regression results are presented in Eq. (3.3) with values in parentheses representing t-ratios:

$$
\begin{aligned}
C_t = & \underset{(-1.837)}{-39.395} + \underset{(3.158)}{0.760 pf_t} - \underset{(-2.917)}{1.146 pf_{t-1}} + \underset{(0.972)}{0.328 pf_{t-2}} + \underset{(2.957)}{0.710 po_t} - \underset{(-2.850)}{0.0986 po_{t-1}} + \underset{(1.944)}{0.500 po_{t-2}} \\
& + \underset{(2.367)}{0.576 pc_t} - \underset{(-2.894)}{1.080 pc_{t-1}} + \underset{(1.483)}{0.463 pc_{t-2}} + \underset{(0.093)}{0.089 vpc_t} + \underset{(2.743)}{2.885 vpc_{t-1}} - \underset{(-0.522)}{0.301 vpc_{t-2}} \\
& + \underset{(0.841)}{0.043 ql_t} + \underset{(1.171)}{0.451 s2} - \underset{(-1.592)}{0.551 s3} + \underset{(0.726)}{0.258 s4} + \underset{(5.009)}{0.685 C_{t-1}} - \underset{(-2.125)}{0.444 \mu_{t-1}}
\end{aligned}
\tag{3.3}
$$

$\bar{R}^2 = 0.838 \quad S.E. = 0.771 \quad \bar{Y} = 5.352 \quad AIC = 2.624$

The modulus of the difference equation term (0.685) and the inverted autoregressive unit roots (–0.444) are less than unity. Thus, the regression mean and the AR(1) process are stationary. The CUSUM test indicated that the estimated coefficients are stable at the α = 0.05 level.

The critical t-value statistic for the coefficient estimates at the α = 0.05 level (21 degrees of freedom) is 2.080. However, because of potential explanatory power of joint lagged exogenous variables, the Wald coefficient restriction test was applied. The test rejected the null hypothesis that the second-order lags of Eq. (3.3) were not significantly different from zero at the α = 0.05 level. The coefficient on a one-period lag on the dependent variable was significantly different from zero at the α = 0.05 level; however, a two-period lag was not. Therefore, a second order lag on the dependent variable was omitted in the final specification equation. The dynamics of Eq. (3.3) can be expressed in terms of its long-run solution because the equation is stationary. Thus, the intercept and sum of the slope coefficients for each variable are divided by 1 minus the coefficient of the difference equation (1 – 0.685). The long run equation reduces to

$$\begin{aligned} C_t = &-125.063 - \underset{(1.435)}{0.184 pf_t} + \underset{(0.673)}{0.711 po_t} - \underset{(-1.275)}{0.130 pc_t} + \underset{(25.682)}{8.486 vpc_t} + \underset{(0.761)}{0.135 ql_t} \\ &+ 1.432 s2 - 1.749 s3 + 0.819 s4, \end{aligned} \tag{3.4}$$

where the dependent and independent variables represent long-run (mean) values and the coefficients are equilibrium multipliers. The equilibrium elasticities are reported in parentheses.

Of particular interest is the relative effect of packer procurement methods on lamb procurement costs. Increases in formula lamb procurement reduce procurement costs. The same result also occurs for increases in cash procurement methods. For example, a 1% increase in formula procurement decreases lamb procurement costs by 1.44%, while a 1% increase in cash procurement decreases procurement costs by 1.28%. The Wald coefficient restriction test was used to test the equality of the summed slope coefficients in Eq. (3.3) for these two procurement methods. The test indicated that the coefficients for formula and cash purchase methods were not statistically different from each other at the α = 0.05 level.

Packer ownership was directly related to lamb procurement costs. For example, a 1% increase in procurement through packer ownership increased procurement costs by 0.67%. The Wald coefficient restriction test indicated that there was a significant difference between lamb procurement by packer ownership versus formula, and there was a significant difference between packer ownership and cash procurement methods.

The results of Eqs. (3.3) and (3.4) indicate differing impacts of packer procurement methods on lamb procurement costs. Increases in formula and cash procurement methods decrease procurement costs. However, increases in packer ownership increase procurement costs. The implications are that increased formula procurement reduces transactions and logistics costs and contributes to lamb marketing efficiencies (i.e., lower procurement costs). Increases in cash procurement also reduce procurement costs perhaps because these methods increase the price of slaughter lambs, which reduces the marketing margin used as a proxy for procurement costs. However, increases in packer ownership procurement increase procurement costs probably because of the added costs and risks associated with owning live lambs.

The lamb processing cost variable has a positive effect on procurement costs, which is consistent with theoretical predictions. That is, an increase in processing costs causes reductions in derived demand for slaughter lambs and derived supply of wholesale lamb. The long-run elasticity is quite large, which is to be expected given the high correlation between processing costs and the packer slaughter cost variables (a correlation coefficient of –0.92) that were used to construct the dependent variable.

3.3 SUMMARY OF THE EFFECTS OF ALTERNATIVE MARKETING ARRANGEMENTS ON PROCUREMENT COST

Data limitations prevented the direct estimation of an aggregate cost function for the lamb processing sector. However, we estimated a monthly procurement cost model using MPR data and information provided by the American Sheep Industry Association (2003–2004) and McDonnell (2005–2006). The econometric results indicate that increases in formula and cash procurement methods reduce lamb procurement costs, while increases in packer ownership increase procurement costs. Perhaps this is why only a small percentage of fed lambs are procured through packer ownership. The effects of formula and cash procurement methods on procurement costs were similar and not statistically different from one another.

4 Quality Differences Associated with Alternative Marketing Arrangements

AMAs between lamb packers and fed lamb producers may influence retail lamb meat quality. For example, the use of formulas, contracts, and packer ownership may be driven by a desire to procure higher quality fed lambs (Boland, Bosse, and Brester, forthcoming). The desire for higher quality fed lambs is the result of increasing consumer demand for higher quality retail lamb meat.

4.1 LAMB QUALITY

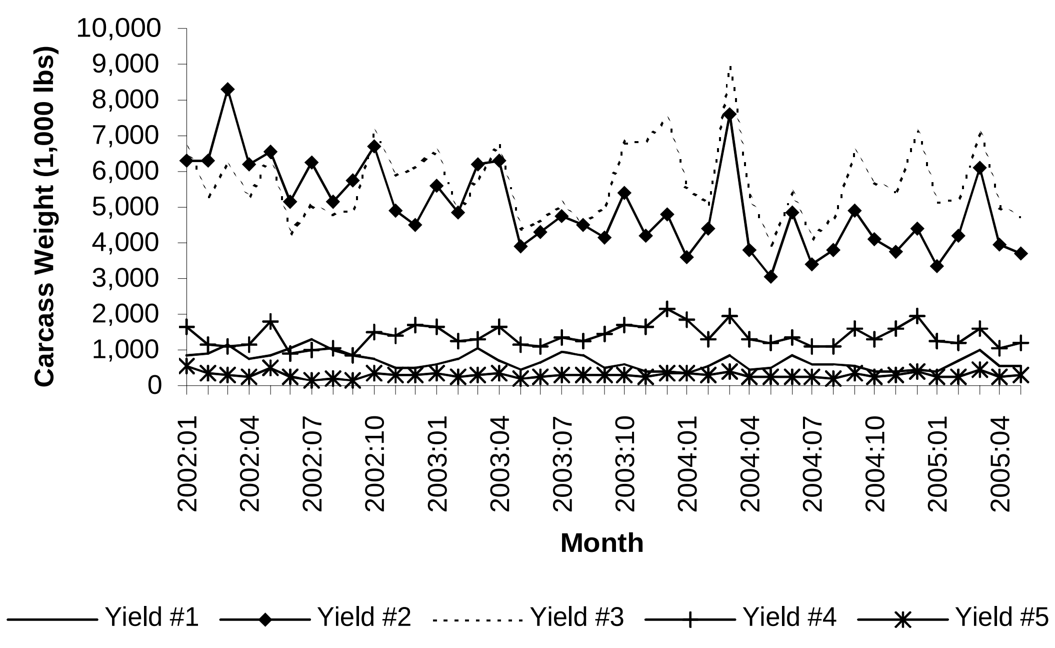
MPR data provided by the American Sheep Industry Association (2003–2004) and McDonnell (2005–2006) include yield grade information for fed slaughter lambs. MPR data indicate that all fed lambs receive yield grades. However, mature sheep (rams and ewes) are not graded. Yield grade scores are integer values ranging from 1 to 5.[1] Yield grades represent relative amounts of boneless trimmed lamb meat obtained from a lamb carcass. Thus, yield grade provides some information about lamb quality. In general, lower yield grade numbers indicate better lamb quality. For example, the Mountain States Lamb Cooperative uses a quality grid based on yield grade. Yield Grade 5 and Yield Grade 4 receive \$0.30/lb and \$0.08/lb discounts, while Yield Grade 2 and Yield Grade 3 receive

[1] In addition to yield grades, fed lamb carcasses are generally graded for quality (i.e., Prime, Choice, and Select). However, MPR data on these quality grade variables were not consistently reported.

$0.08/lb premiums (Boland, Bosse, and Brester, forthcoming). However, Yield Grade 1 receives neither a premium nor a discount. Hence, Yield Grade 1 appears to have lower quality with respect to Yield Grades 2 and 3, but higher quality relative to Yield Grades 4 and 5. Therefore, lower yield grade numbers are associated with higher lamb quality for Yield Grades 2 through 5. However, the use of yield grade as a proxy for lamb quality may bias our results upward, because Yield Grade 1 is not superior to Yield Grades 2 and 3 (although it is of superior quality compared with Yield Grades 4 and 5). However, the data indicate that Yield Grade 1 lambs represented only about 5% of total lamb slaughter in 2004. Hence, the upward bias inherent in our procedure is likely small.

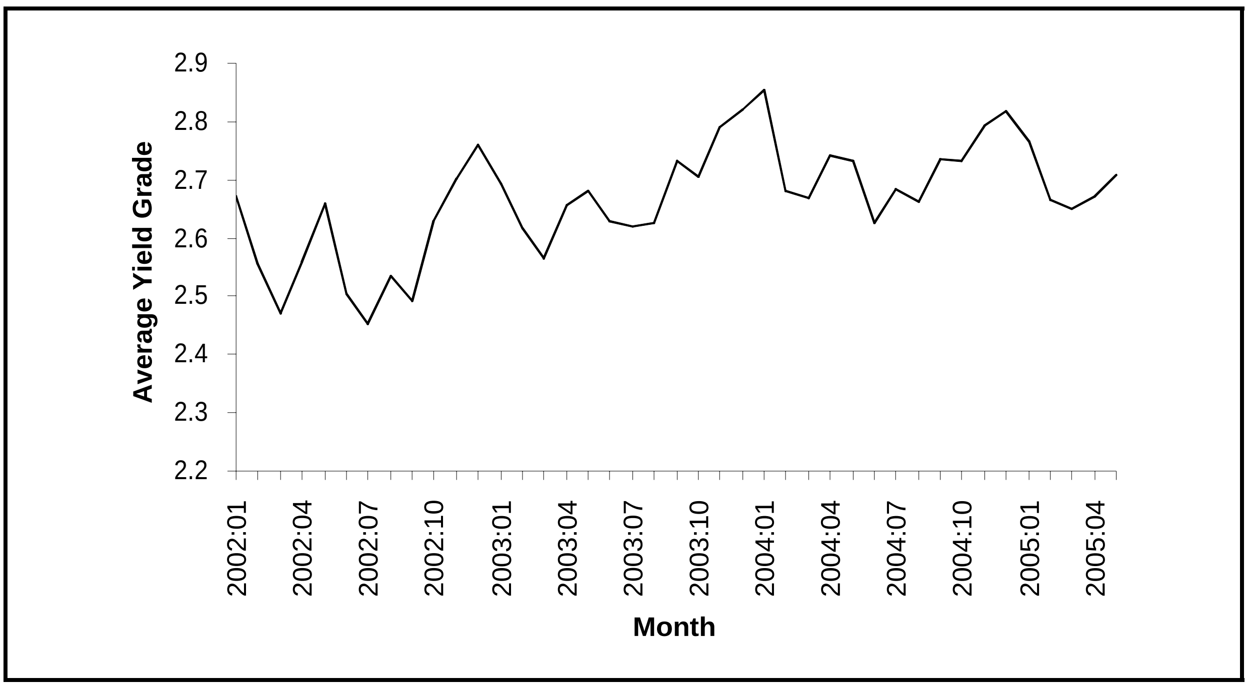
MPR data also report federally inspected carcass production (total weight) for each yield grade category. Thus, carcass weights and yield grade data can be combined to measure the quantity of lamb produced by yield grade. Figure 4-1 presents the carcass lamb production by yield grades for the 2002:1 to 2005:05 period. Yield Grades 2 and 3 dominate (82%) carcass lamb production.

Figure 4-1. Lamb Carcass Production by Yield Grade, January 2002–May 2005



We use average yield grade as an indicator of slaughter lamb quality and quantify the relationship between this variable, other exogenous factors, and procurement method. The yield grade dependent variable is calculated as a weighted average of monthly carcass quantities sold under each yield grade. Figure 4-2 presents the average yield grade (*YG*) over the 2002:1 to 2005:05 period. Average yield grade increased over the period, which corresponds to a decrease in quality. A linear regression of *YG* onto a time trend indicated that yield grade increased about 0.004 (or 0.20%) per month. The coefficient of variation for *YG* was relatively small (about 3.56%). The Jarque-Bera statistic failed to reject the null hypothesis of a normal distribution for *YG*. The ADF unit root test failed to reject the null hypothesis of a unit root in the average yield data at the α = 0.05 level. The results of these tests have implications for the modeling approach described in the next section.

Figure 4-2. Average Yield Grade of Lamb Carcasses, January 2002–May 2005



4.2 MODEL DEVELOPMENT

Average yield grade is expected to be influenced by several factors including feedlot profitability, technology, inventory levels, wholesale demand, and procurement methods. We specify this relationship as

$$YG_t = \zeta_1 \left(PL / PN, Tech, INV, WD, pf, po, pc, s_2, s_3, s_4 \right) + \mu_t . \quad (4.1)$$

Table 4-1 presents the variable definitions and descriptive statistics. Average yield grade (*YG*) is hypothesized to be a function of the slaughter lamb/corn price ratio (*PL/PN*), technology (*Tech*), lamb inventories (*INV*), wholesale demand for lamb (*WD*); formula (*pf*), packer ownership (*po*), cash (*pc*) procurement methods, and seasonality (*s*). The disturbance term μ_t is assumed to possess white noise properties.[2]

Table 4-1. Variable Definitions for the Slaughter Lamb Quality Model

Symbol	Definition	Mean	Standard Deviation
YG	Weighted average yield grade of slaughter lamb	2.67	0.10
PL/PN	Price of slaughter lamb divided by the price of corn	39.72	0.42
Tech	Technological change (lagged average live weight of lamb), pounds	135.34	6.74
INV	Monthly inventory of sheep and lambs, million head	6.26	0.16
WD	Real price of boxed lamb	116.18	12.95
pc	Lamb procurement by formula and contract methods, percent	41.83	6.81
po	Lamb procurement by packer ownership, percent	4.97	2.45
Pc	Lamb procurement by auctions and negotiations, percent	52.47	7.10
S_2	Binary variable for the second quarter	0.27	0.45
S_3	Binary variable for the third quarter	0.22	0.42
S_4	Binary variable for the fourth quarter	0.22	0.42

The price ratio (*PL/PN*) represents the expected profitability of lamb feedlots. *A priori*, an increase in this ratio (an increase in expected profitability) could result in increased average

[2] As in the model presented in Section 2, we have excluded the percentage of lambs procured through imports from the model to avoid matrix singularity in the regression.

liveweight of slaughter lamb and, thus, increase yield grade score (lower quality). Technology (*Tech*) captures improved genetics that could reduce yield grade score (increase quality). Because a specific measure of technological change is not available, a one-period lag on average liveweight of lamb is used as a proxy.

Lamb inventories (*INV*) represent the availability of slaughter lambs. As inventories increase, efficiency gains may occur throughout the feeding–processing sector. Hence, one might expect that larger inventories may be associated with lower yield grades (higher quality). Wholesale lamb demand (*WD*), as measured by the boxed lamb price, is a function of retail consumer demand. As wholesale demand increases, slaughter lamb producers are likely to reduce the length of feeding programs to take advantage of higher lamb prices. Hence, yield grades are likely to decline (an increase in lamb quality) because younger lambs tend to have lower yield grade numbers (higher yields). Average yield grades may also be influenced by seasonal factors. Thus, seasonality is represented by quarterly binary variables (s_2, s_3, s_4).

The lamb procurement variables *pf*, *po*, and *pc* represent the percentage of lambs procured by formula, packer ownership, and cash methods. Procurement methods may affect lamb quality. For example, formula and packer ownership procurement methods may increase lamb quality because both methods allow for better feeding and selection opportunities. We test whether each procurement method significantly influences average yield grade. In addition, if the procurement variables are significantly different from zero, we test whether the coefficients (marginal impacts) differ between the three procurement methods.

4.3 LAMB QUALITY EMPIRICAL RESULTS

The sample period for the quality model consists of monthly data from 2002:01 to 2005:05. All MPR data were obtained from the American Sheep Industry Association (2003–2004) and McDonnell (2005–2006). The boxed lamb price (*WD*) was deflated by the CPI (1982–84=100).

Based on ADF tests, all variables were nonstationary and integrated of order one [I(1)] at the α = 0.05 level. The ADF test of the OLS residuals of Eq. (4.1) rejected the null hypothesis of unit roots; therefore, the equation was cointegrated. Thus, Eq. (4.1) was estimated with the data in level form with distributed lags included to account for expectations and rigidities in lamb quality adjustments. Lags on the independent variables, however, were not statistically significant based on the Wald coefficient restriction test. Also, the Koyck term was not significantly different from zero at the α = 0.10 level and, thus, was omitted.

The Breusch-Godfrey LM test indicated the existence of serial correlation of orders one and two [AR(1) and AR(2)] at the α = 0.05 level for the OLS estimates of Eq. (4.1). Thus, Eq. (4.1) was estimated using nonlinear least squares. The final regression results of the lamb quality equation (estimated in double logs) are presented in Eq. (4.2) with t-ratios in parentheses:

$$\begin{aligned}
\ln YG_t = {} & \underset{(5.771)}{6.660} + \underset{(0.821)}{0.024}\ln PL_t / PN_t - \underset{(-2.954)}{0.319}\ln Tech_t - \underset{(-5.738)}{1.350}\ln INV_t - \underset{(-0.491)}{0.031}\ln WD_t \\
& - \underset{(-2.298)}{0.157}\ln pf_t - \underset{(-0.851)}{0.009}\ln po_t - \underset{(-2.224)}{0.251}\ln pc_t - \underset{(-0.104)}{0.001}s2 + \underset{(0.278)}{0.003}s3 + \underset{(4.319)}{0.039}s4 \\
& - \underset{(-1.928)}{0.295}\mu_{t-1} - \underset{(-3.512)}{0.493}\mu_{t-2}
\end{aligned} \tag{4.2}$$

$$\bar{R}^2 = 0.813 \qquad S.E. = 0.016 \qquad \overline{YG}\ (\log mean) = 0.981$$

The critical t-values at the α = 0.05 level and α = 0.10 level are 2.056 and 1.706, respectively, with 26 degrees of freedom.

The inverted autoregressive roots were conjugate complex (–0.15 ± 0.69*i*) with the modulus equal to 0.706. Thus, the stochastic error structure displayed a stable oscillating pattern (Figure 4-2). Excluding the autoregressive error structure, the CUSUM test of Eq. (4.2) indicated that the estimated coefficients were stable at the α = 0.05 level.

All variables except the intercept, two seasonal dummies, slaughter lamb/corn price ratio (*PL/PN*), boxed lamb price (*WD*), and the packer ownership procurement variable (*po*) were statistically different from zero at the α = 0.05 level.

An increase in technology, as measured by lagged lamb average liveweight, increases lamb quality (i.e., the negative sign indicates a reduction in yield grade score, which is an increase in quality). For example, a 1% increase in technology improves lamb yield grade by 0.32%. McDonnell (2005–2006) has suggested that improved breeding stock genetics occurred throughout the late 1990s. The regression results also indicate that larger lamb inventories are associated with improved lamb quality, perhaps because of improved cost efficiencies. A 1% increase in lamb inventories causes a 1.35% improvement in lamb quality in the short run. The long-run effect is identical because the Koyck term (lagged dependent variable) in Eq. (4.2) was not statistically different from zero.

Formula procurement methods are associated with improved lamb quality. This is consistent with *a priori* expectations that such methods are employed to improve end-use quality. The elasticity estimate indicates that a 1% increase in formula procurement increases quality by 0.157%. Although the negative coefficient on packer ownership indicates that increases in this procurement method may increase quality, its statistical insignificance may be an artifact of the small share of lamb procured through this method.

The effect of cash procurement methods on lamb quality was also statistically significant. Although the absolute values appear to be different, the Wald coefficient test indicated that no significant difference exists (at the α = 0.05 level) between the coefficient estimates of formula and cash procurement methods. This is contrary to the presumption that the quality of lambs procured through cash methods is necessarily poorer than the quality of lambs procured through formula methods.

In addition, the largest percentage of lambs continue to be procured through cash methods (52%, on average, based on MPR data), and previous regression results indicate that only small differences exist between prices of slaughter lambs procured through cash versus formula methods. Recall that MPR data only contain yield grade data that we use as a proxy for quality. However, anecdotal evidence suggests that lamb quality based on quality grades has increased over the sample period. There is a general inverse relationship between quality grade and yield grade. Therefore, we suspect that the positive influence of these two procurement methods on lamb quality reflects a general increase in lamb quality over the sample period.

4.4 SUMMARY OF THE EFFECTS OF ALTERNATIVE MARKETING ARRANGEMENTS ON LAMB QUALITY

We estimated a monthly model to determine if AMAs influence lamb quality. Yield grade was used as a proxy for lamb quality because of a lack of quality grade data. As yield grade score increases, lamb quality declines and retail cutability diminishes. Technological change has likely increased lamb quality over time. Formula procurement methods also increase lamb quality (lower yield grade scores). In addition, the statistical results indicate that lamb quality also increased because of cash market procurement. These results are consistent with anecdotal evidence that the overall quality of U.S. fed lamb has improved in recent years. The most important point is that there does not appear to be any statistically significant difference in the quality of lambs procured through formula and cash procurement methods.

5 Risk Shifting Associated with Alternative Marketing Arrangements

A variety of risks exist in the lamb/lamb meat marketing sector. The survey results reported in Volume 2 indicate that lamb producers use a variety of marketing methods to obviate price risk, market access risk, quality risks, logistical concerns, and price variability. Packers also indicated that they face a variety of risks including price risk, input supply risk, and risk of not meeting downstream retail orders. This section examines the impact of AMAs on the relative amounts of price risk incurred by lamb packers and lamb producers.

5.1 PRICE RISK SHIFTING

AMAs may influence the relative amounts of price risk incurred by lamb producers and lamb packers/processors. For example, cash markets (auctions and negotiations) result in a producer facing all price risk associated with fed lambs. Conversely, a price contract between a lamb packer/processor and a fed lamb producer specifies a transactions price and, thus, reduces the price risk faced by a producer. Formula pricing arrangements also reduce, but do not eliminate, a lamb producer's price risk. Shin and Vukina (2006) suggest that pairwise tests of the variability of prices received under various AMAs provide a measure of risk shifting among vertical sectors of the lamb industry. For different AMA combinations (i, j), the null and alternative hypotheses are given as

$$H_0 : VAR(price\ \ of\ \ AMAi) = VAR(price\ \ of\ \ AMAj), \quad i \neq j$$
$$H_1 : VAR(price\ \ of\ \ AMAi) \neq VAR(price\ \ of\ \ AMAj), \quad i \neq j \tag{5.1}$$

Several tests can be used to test the null hypotheses. Most tests are fashioned as F-distributions or chi-squared distributions under the assumption of independent, normal price samples. Our pairwise test considers the variance of formula prices and cash prices.

5.2 MODELING STRATEGY

The empirical evaluation of risk shifting considers formula and contract lamb purchases as a single category. Formula prices refer to pricing strategies that use a base price and a formula that adjusts this price for quality and other factors. Forward contracts for lambs may stipulate a fixed price, a fixed quantity, a formula for establishing price, or some combination of the three factors. Negotiations and auctions represent cash market methods of procuring lambs. Negotiated prices involve packer bids on slaughter-ready pens of lambs at feedlots. Such negotiations are essentially private treaty sales. Auction markets involve open, public bidding on slaughter-ready lambs. Lambs acquired through packer ownership averaged only 4.67% of total lamb procurement. In addition, data are not available on packing companies' internal pricing of these lambs. Therefore, these lamb purchases are excluded from the analysis.

The empirical approach involves calculating the variance of nominal and real formula and cash procurement prices. A pairwise test of the equality of these variances is conducted using the F-test and Bartlett's test.

5.3 DATA

Monthly price data for formula and cash lamb procurement were obtained from MPR data (American Sheep Industry Association, 2003–2004; McDonnell, 2005–2006). Observations were available for the 2002:01 to 2005:06 period. Table 5-1 presents the descriptive statistics for the price series in both nominal and real terms (1982–84=100).

Table 5-1. Descriptive Statistics of Nominal and Real (1982–84=100) Slaughter Lamb Prices by Procurement Method Using MPR Data, January 2002–June 2005, Dollars per Cwt

	Procurement Method			
	Cash Price		Formula Price	
Statistics	Nominal	Real	Nominal	Real
Mean	90.06	48.41	90.11	48.44
Standard Deviation	14.06	6.60	13.81	6.46
Jarque-Bera	2.08	3.31	3.55	6.30
Probability	0.35	0.19	0.17	0.04

Notes: The Jarque-Bera statistic is a test for the normality of each price series. The associate probability statistic indicates the failure to reject the null hypothesis of a normal distribution for each price series at the $\alpha=0.05$ level.

Cursory observation of the descriptive statistics is consistent with *a priori* expectations. That is, cash prices are expected to display a larger variation than formula prices. This pattern occurs for both nominal lamb prices (standard deviations of 14.06 and 13.81) and real lamb prices (standard deviations of 6.60 and 6.46).

5.4 EMPIRICAL RESULTS

Table 5-2 presents pairwise test results of the equality of the lamb price variances for both nominal and real prices. Two tests are performed. If the price series are statistically independent, a standard F-test is used on untransformed data, while the Bartlett test (chi-square distribution) uses the natural logarithm of the variances.

Table 5-2. Tests for the Equality of Variances between Formula and Cash Slaughter Lamb Prices Using MPR Data, January 2002–June 2005

		Formula Versus Cash Prices	
Test	Degrees of Freedom	Nominal	Real
F-test	41,41	1.034	1.044
P value		0.908	0.891
Bartlett	1	0.013	0.019
P value		0.908	0.891

Notes: The P value for the null hypothesis of equal variances of the pairwise lamb price series is presented below each test statistic.

In all cases, the tests fail to reject the null hypotheses of equal variances at the α = 0.05 level. Thus, based on MPR data, it appears that statistically significant risk shifting from lamb producers to lamb packers/processors has not occurred as a result of AMAs.

5.5 SUMMARY OF ALTERNATIVE MARKETING ARRANGEMENTS AND RISK SHIFTING

AMAs have the potential to shift market price risk between fed lamb producers and lamb processors. The variance of prices for each AMA provides one measure of price risk by market participants. Using MPR data, we evaluated the null hypotheses that nominal and real formula and cash price series have equal variances. In each case, we were unable to reject the null hypothesis. Based on MPR data, statistically significant risk shifting from lamb producers to lamb packers/processors has not occurred as a result of AMAs.

It is important to note that lamb producers and packers use AMAs for reasons other than price risk management. For example, Table 6-22 in Volume 2 shows that the most important factor for using AMAs is that producers can sell lambs at higher prices. This was followed by securing a buyer for lambs and then by price risk reduction. Boland, Bosse, and Brester (forthcoming) also note the importance of market access for producers, but also a desire by processors to acquire slaughter lambs in an environment characterized by declining lamb numbers.

6 Measurement of the Economic Effects of Restricting Alternative Marketing Arrangements

In this section, we estimate short-run and long-run changes in equilibrium prices and quantities of live lamb and lamb meat that would result from changes in current lamb procurement methods. We develop an equilibrium displacement model that incorporates estimated procurement costs, accounts for interrelationships along the lamb marketing chain, and considers potential changes in product quality at the retail level. In addition, we estimate cumulative changes in consumer surplus at the retail level and producer surplus at each level of the lamb marketing chain to determine the economic effects of changes in procurement methods on consumers, producers, and importers of lamb and lamb meat. Finally, we incorporate the potential for lamb processing market power, if it exists, and estimate the effects of changes in that power resulting from changes in livestock procurement methods.

6.1 MODEL DEVELOPMENT

This section describes the modeling strategy for estimating the economic effects of changes in procurement methods on consumers, producers, and importers of lamb and lamb meat. An equilibrium displacement model is presented and used as the primary approach to estimating changes in economic effects. Later sections describe the parameterization of the model and simulation results.

6.1.1 Modeling Strategy

We develop an equilibrium displacement model assuming that limits on current procurement methods will impose additional marketing costs on suppliers. Conceptually, such costs shift relevant supply functions upward and to the left in each affected sector. A reduction in supply at the retail level causes a reduction in quantity demanded at that level. Concurrently, this change causes reductions in derived demand at each upstream level in the marketing chain. In a competitive market, the impacts and distribution of added marketing costs on prices and quantities at each market level are determined by the size of cost impacts and relative supply and demand elasticities at each level.

Figure 6-1 illustrates the relevant market linkages for a simplified case in which the lamb industry marketing chain is separated into a retail and farm sector. To simplify the illustration, fixed input proportions between the farm input (feeder lamb) and marketing services are assumed. Retail demand (D_r) and farm (feeder) supply (S_f) are considered the "primary" relations, while the demand for feeder lambs (D_f) and the retail supply of lamb (S_r) are considered "derived" relations (Tomek and Robinson, 1990). The intersection of demand and supply at each level determines relative market-clearing prices (P_r) and (P_f) and market-clearing quantity (Q_0). In this case, the farm-level market-clearing quantity is represented graphically on a retail weight equivalent basis. The difference in equilibrium prices (P_r – P_f) represents the farm–retail price spread or marketing margin.

If changes in AMAs increased costs only at the retail level, retail supply would shift from S_r to S_r' and the farm-level derived demand for feeder lambs would decline to D_f' (Figure 6-1). Retail price would increase to P_r' and farm price would decline to P_f'. Marketing cost increases would be reflected by a larger marketing margin (P_r' – P_f'), and a new equilibrium quantity would be established at Q_1. If retail demand were relatively inelastic, consumer expenditures would increase, but farm revenues and producer surplus would decline along with farm price and quantity.

Figure 6-1. Effects on the Lamb Sector of Imposing Additional Procurement Costs on the Retail Level

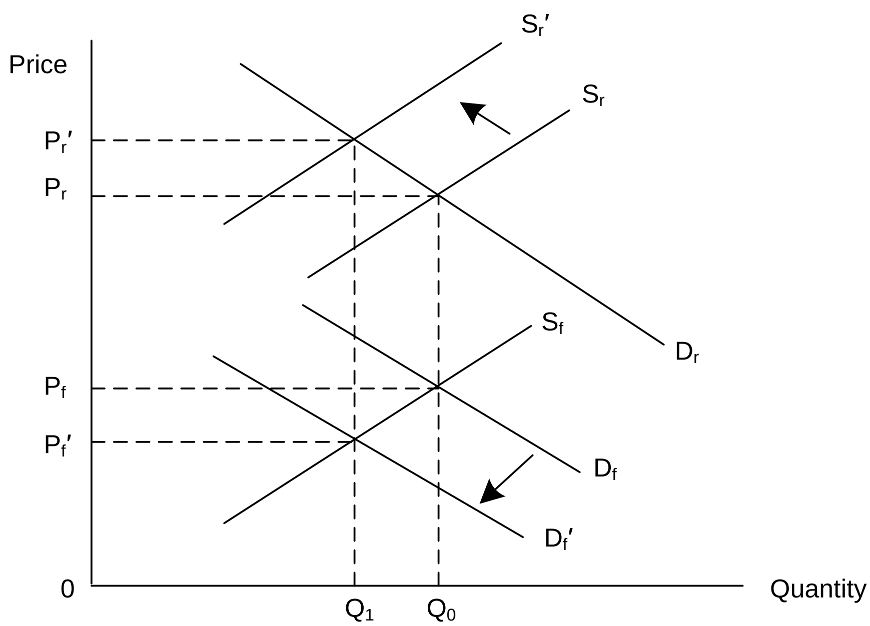


Figure 6-2 extends this simplified case by illustrating a situation in which procurement costs increase at both the retail and farm levels. The initial equilibrium occurs at P_r, P_f, and Q_0. Increased procurement costs associated with AMAs are reflected in reductions in both derived retail supply (S_r'') and primary farm supply (S_f''). The derived demand for lambs declines to D_f''. The new equilibrium prices are at P_r'' and P_f'', and the new equilibrium quantity is Q_2. Whether P_f'' is higher or lower than P_f depends on relative supply and demand shifts and elasticities at each level. However, Q_2 is unambiguously less than Q_0. That is, the quantity of lambs traded decreases because of increased procurement costs.

In Figure 6-2, the new equilibrium farm price P_f'' is higher than the original farm price of P_f. Nonetheless, the higher farm price does not mean that producers are better off because of associated declines in farm output. Producer surplus effects can be measured by the change that results from moving from the original equilibrium (P_f, Q_o) to the new equilibrium (P_f'', Q_2). In Figure 6-3, shaded area *A* represents farm-level producer surplus at the original equilibrium price and

Figure 6-2. Effects on the Lamb Sector of Imposing Additional Procurement Costs on the Retail and Farm Levels

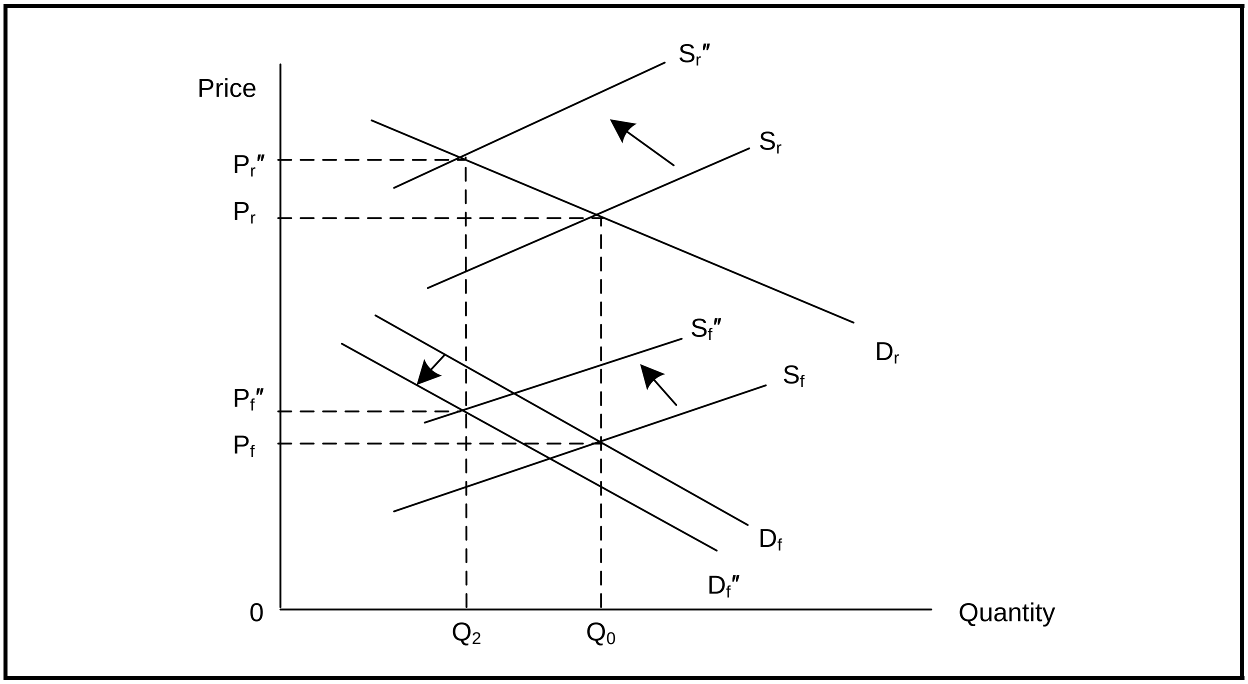
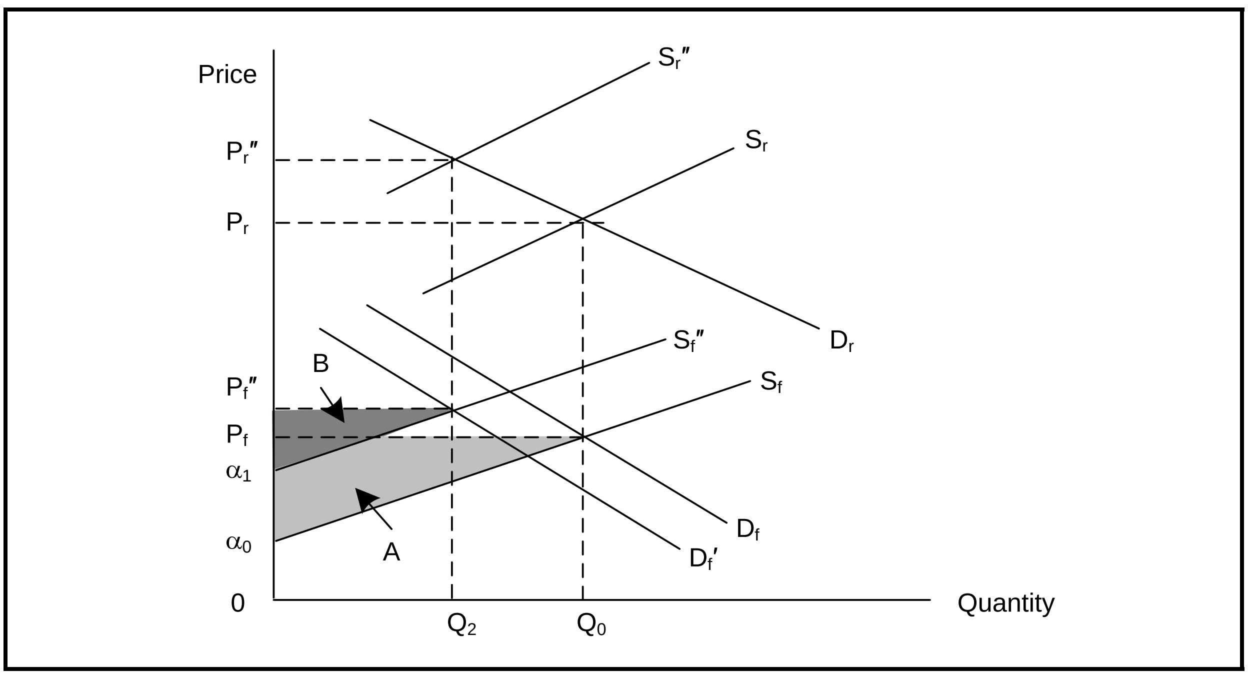


Figure 6-3. Changes in Farm-Level Producer Surplus Resulting From Imposing Additional Procurement Costs on the Retail and Farm Levels



quantity, and shaded area *B* represents farm-level producer surplus as a result of increased procurement costs that affect the retail and farm levels. Assuming linear supply and demand functions, elasticity estimates and equilibrium prices and quantities can be used to calculate the sizes of the shaded areas. Absent a consumer demand increase, the change in producer surplus illustrated in Figure 6-3 must be negative and is expressed as

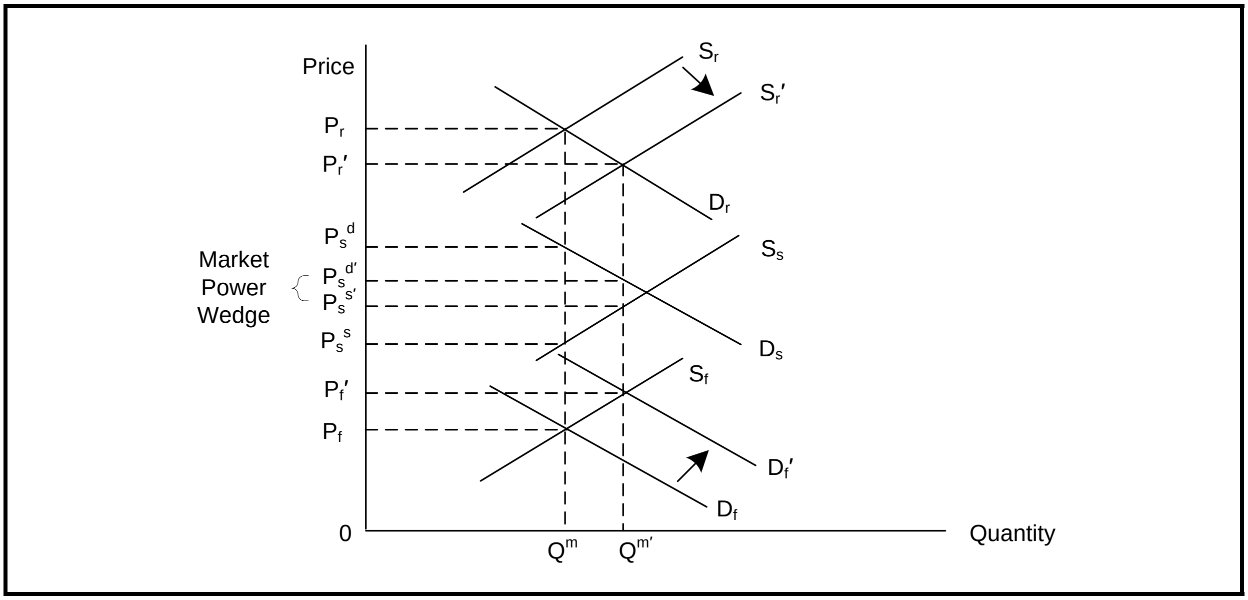
$$\Delta PS = B - A = \left[1/2\left(P_f^{''} - \alpha_1\right)Q_2\right] - \left[1/2\left(P_f - \alpha_0\right)Q_0\right], \quad (6.1)$$

where ΔPS represents the change in producer surplus.

Figure 6-4 illustrates the case in which a third market (slaughter lambs) has been added between the farm and retail levels. Lamb processors have a derived demand for slaughter lambs (D_s). Lamb feedlots provide a derived supply (S_s) of slaughter lambs. In addition, suppose that lamb processors are hypothetically able to use market power to drive a wedge between the slaughter lamb demand price (P_s^d) and the slaughter lamb supply price (P_s^s) at equilibrium quantity Q^m. This results in an equilibrium retail price of (P_r) and an equilibrium farm price of (P_f). A restriction on formula, contracted, or packer ownership marketing arrangements could reduce the potential market power of processors. In this case, the wedge between (P_s^d) and (P_s^s) would narrow, say to ($P_s^{d\prime}$) and ($P_s^{s\prime}$). Quantity equilibrium would be established at $Q^{m\prime}$. This requires an increase in the retail derived supply function to $S_r^{\prime}$ and an increase in the farm-level derived demand function to $D_f^{\prime}$. The size of these shifts depends on the relative sizes of the absolute value of the primary retail-level own-price elasticity of demand and the primary farm-level own-price elasticity of supply (Tomek and Robinson, 1990).

Figures 6-1 through 6-4 illustrate only the “cost side” effects of changes in procurement methods on retail- and farm-level prices and quantities. However, Section 4 reports that changes in procurement methods may also be detrimental to product quality. If so, consumer demand for domestically produced lamb products would decline and be represented by a downward shift in the primary demand curve.

Figure 6-4. Effects of Potential Market Power and Changes in Market Power on Equilibrium Quantities and Prices in the Retail, Slaughter, and Farm Levels



6.1.2 An Equilibrium Displacement Model of the Lamb Industry

An equilibrium displacement model is a linear approximation to a set of underlying and unknown demand and supply functions. The model's accuracy depends on the degree of nonlinearity of the true demand and supply functions and the magnitude of deviations from equilibrium being considered. If these deviations are relatively small, then a linear approximation of the true demand and supply functions should be relatively accurate (Brester, Marsh, and Atwood, 2004; Brester and Wohlgenant, 1997; Wohlgenant, 1993). Although *total* producer surplus measurements obtained from linear supply functions may or may not reflect actual values, *changes* in producer surplus caused by shifts in linear supply or demand functions should approximate actual changes provided that such shifts are relatively small.

A general structural model of supply and demand relationships in the lamb industry provides the framework for an equilibrium displacement model. The lamb industry is modeled as a series of primary and derived demand and supply relations and associated equilibria within the farm-retail marketing chain. The model incorporates variable input proportions among live lamb, lamb meat, and marketing service inputs by allowing production quantities to vary across market levels (Tomek and

Robinson, 1990; Wohlgenant, 1993). The use of variable input proportions accounts for input substitution in response to changing output and input prices (Wohlgenant, 1989).

We model the lamb marketing chain as four distinct sectors: retail (consumer), wholesale (processor), slaughter (lamb feeding), and farm (feeder lamb). In addition, lamb imports at the retail and wholesale levels are included in the model. Although we are unable to test for the existence of oligopsony markdown behavior in the slaughter lamb market because of data limitations, we assume the most general case—that lamb packers may exert oligopsony power in the purchase of slaughter lambs.

In general terms, the structural supply and demand model is given by the following (error terms have been omitted):

Retail Lamb Sector:

Domestic retail lamb primary demand:

$$Q_L^{drd} = f_1\left(P_L^{dr}, P_L^{ir}, \boldsymbol{Z}_L^{dr}\right) \tag{6.2}$$

Domestic retail lamb derived supply:

$$Q_L^{drs} = f_2\left(P_L^{dr}, Q_L^{dws}, \boldsymbol{W}_L^{dr}\right) \tag{6.3}$$

Imported retail lamb primary demand:

$$Q_L^{ird} = f_3\left(P_L^{ir}, P_L^{dr}, \boldsymbol{Z}_L^{ir}\right) \tag{6.4}$$

Imported retail lamb derived supply:

$$Q_L^{irs} = f_4\left(P_L^{ir}, Q_L^{iws}, \boldsymbol{W}_L^{ir}\right) \tag{6.5}$$

Wholesale Lamb Sector:

Domestic wholesale lamb derived demand:

$$Q_L^{dwd} = f_5\left(P_L^{dw}, Q_L^{drd}, \boldsymbol{Z}_L^{dw}\right) \tag{6.6}$$

Domestic wholesale lamb derived supply:

$$Q_L^{dws} = f_6\left(P_L^{dw}, Q_L^{dss}, \boldsymbol{W}_L^{dw}\right) \tag{6.7}$$

Imported wholesale lamb derived demand:

$$Q_L^{idw} = f_7\left(P_L^{iw}, Q_L^{ird}, \boldsymbol{Z}_L^{iw}\right) \tag{6.8}$$

Imported wholesale lamb derived supply:

$$Q_L^{iws} = f_8\left(P_L^{iw}, \boldsymbol{W}_L^{iw}\right) \tag{6.9}$$

<u>*Slaughter Lamb Sector:*</u>

Domestic slaughter lamb derived demand:

$$Q_L^{dsd} = f_9\left(P_L^{dsd}, Q_L^{dwd}, \boldsymbol{Z}_L^{ds}\right) \tag{6.10}$$

Domestic slaughter lamb derived supply:

$$Q_L^{dsd} = f_{10}\left(P_L^{dss}, Q_L^{dfs}, \boldsymbol{W}_L^{ds}\right) \tag{6.11}$$

Potential market power price wedge:

$$p_L^{dsd} = f_{11}\left(P_L^{dss}, \theta\right) \tag{6.12}$$

<u>*Feeder Lamb Sector:*</u>

Domestic feeder lamb derived demand:

$$Q_L^{dfd} = f_{12}\left(P_L^{fd}, Q_L^{dsd}, \boldsymbol{Z}_L^{df}\right) \tag{6.13}$$

Domestic feeder lamb primary supply:

$$Q_L^{dfs} = f_{13}\left(P_L^{df}, \boldsymbol{W}_L^{df}\right) \tag{6.14}$$

Variable definitions are presented in Table 6-1. The four lamb market sectors are linked by downstream quantity (weight) variables among the demand equations and upstream quantity (weight) variables among the supply equations (Wohlgenant, 1993). Each $\boldsymbol{Z}_L^{ij}$ and $\boldsymbol{W}_L^{ij}$ (*i* = domestic [*d*] or imported [*i*] lamb and *j* = market levels [*r*—retail, *w*—wholesale, *s*—slaughter, *f*—farm]) represent vectors of demand and supply shifters. These shifters are defined in Section 6.2.4. that describes the structural model and empirical results.

The equilibrium displacement model was developed by assuming market-clearing quantities (e.g., $Q_L^{drd} = Q_L^{drs} = Q_L^{dr}$). Eqs. (6.2) through (6.14) were then totally differentiated, and log differentials were used to express the relations in elasticity

Table 6-1. Variable Definitions for the Equilibrium Displacement and Structural Models

Symbol	Definition	Mean	Standard Deviation
Q_L^{dr}	Quantity (per capita) of domestic retail lamb, pounds	1.51	0.51
Q_L^{ir}	Quantity (per capita) of imported retail lamb, pounds	0.02	0.02
Q_L^{dw}	Quantity of wholesale domestic lamb, billion pounds	0.34	0.09
Q_L^{iw}	Quantity of wholesale imported lamb, billion pounds	0.07	0.05
Q_L^{ds}	Quantity of domestic slaughter lamb, million pounds	687.08	185.09
Q_L^{df}	Quantity of domestic feeder lambs, million head	7.69	2.45
P_L^{dr}	Real price of domestic retail lamb, cents per pound	285.55	27.99
P_L^{ir}	Real price of imported retail lamb, cents per pound	262.97	31.63
P_L^{dw}	Real price of domestic wholesale lamb, cents per pound	126.15	30.93
P_L^{iw}	Real price of imported wholesale lamb, cents per pound	103.57	23.18
P_L^{dsd}	Real demand price of domestic slaughter lamb, dollars per cwt		
P_L^{dss}	Real supply price of domestic slaughter lamb, dollars per cwt	62.03	17.45
P_L^{df}	Real price of domestic feeder lamb, dollars per cwt	66.25	18.37
$\mathbf{Z}_L^{ij}$	Demand shifters for the *i*th market (import/domestic) at the *j*th market level	—[a]	—[a]
$\mathbf{W}_L^{ij}$	Supply shifters for the *i*th market at the *j*th market level	—[a]	—[a]
$\boldsymbol{\Theta}$	Lamb processor potential market power wedge	—[a]	—[a]
z_L^{dr}	Change in consumer demand for domestic lamb caused by changes in procurement method	—[a]	—[a]
w_L^{dr}	Changes in costs of supplying domestic retail lamb caused by changes in procurement method	—[a]	—[a]
w_L^{dw}	Changes in costs of supplying domestic wholesale lamb caused by changes in procurement method	—[a]	—[a]
w_L^{ds}	Changes in costs of supplying domestic slaughter lamb caused by changes in procurement method	—[a]	—[a]
w_L^{df}	Changes in costs of supplying domestic feeder lamb caused by changes in procurement method	—[a]	—[a]
ρ	P_L^{dsd} / P_L^{dss}	—[a]	—[a]
Q_{be}	Quantity of domestic breeding ewes, million head	7.68	2.75
Q_w^{dw}	Quantity of domestic wholesale wool (graded and scoured), million pounds	91.16	34.37
Q_w^{iw}	Quantity of imported wholesale wool (graded and scoured), million pounds	72.46	30.23

(continued)

Table 6-1. Variable Definitions for the Equilibrium Displacement and Structural Models (continued)

Symbol	Definition	Mean	Standard Deviation
P_L^{de}	Real price of domestic slaughter ewes, dollars per cwt	28.02	6.270
P_L^{dw}	Real price of domestic wholesale wool, cleaned and scoured, cents per pound	73.16	37.700
P_{ct}	Real price of upland cotton, cents per pound	63.50	29.370
P_w	Real domestic wool price, shorn, cents per pound		
P_{sw}	Real domestic wool support price, cents per pound	117.42	61.890
P_w^{iw}	Real import wholesale wool price, cents per pound	283.96	136.060
P_b^r	Real price of retail beef, cents per pound	227.38	41.660
P_k^r	Real price of retail pork, cents per pound	175.53	31.710
P_y^r	Real price of retail poultry, cents per pound	78.91	20.350
P_b^w	Real price of wholesale beef, cents per pound	100.43	29.730
P_k^w	Real price of wholesale pork, cents per pound	59.40	24.420
P_y^w	Real price of wholesale poultry, cents per pound	52.07	17.840
Y	Real per capita personal consumption expenditures, thousand dollars	11.06	1.900
Y_x	Real personal consumption expenditures, billion dollars	2,737.14	744.620
M_c	Index of food marketing costs (1987=100)	313.35	24.000
L_c	Index of food labor costs (1987=100)	324.89	18.170
P_{bp}	Real price of lamb by-products, no. 1 pelt, dollars per pelt	7.18	3.260
E_x	Real U.S./(average Australia and New Zealand exchange rate)	1.11	0.930
E_x^a	Real U.S./Australian exchange rate	1.15	0.930
K	Lamb meat packer four-firm concentration ratio	60.50	9.460
P_n	Real price of no. 2 yellow corn, dollars per bushel	2.66	1.350
P_{hy}	Real price of all hay, dollars per ton	68.33	16.310
R_f	Lamb slaughter price-corn price ratio	26.48	8.130
T	Trend (1970–2003)	16.50	9.960
MD	Binary variable for meat price freeze, 1970–1972=1.0	0.09	0.290
ID	Binary variable for lamb import duty, 1985–1990=1.0	0.18	0.390
WD	Binary variable for loss of wool price support, 1996–2001=1.0	0.82	0.039

[a] Variables without means and standard deviations are inputs to the model and thus do not have data values.

form. This results in the following equilibrium displacement model that was used to approximate changes from initial equilibrium in the U.S. lamb industry:

$$EQ_L^{dr} = \eta_d^{dr} EP_L^{dr} + \eta_d^{ir} EP_L^{ir} + Ez_L^{dr} \tag{6.15}$$

$$EQ_L^{dr} = \epsilon_d^{dr} \; EP_L^{dr} + \tau_d^{wr} EQ_L^{dw} + Ew_L^{dr} \tag{6.16}$$

$$EQ_L^{ir} = \eta^{ir} EP_L^{ir} + \tau_i^{wr} EQ_i^{wr} + EQ_L^{ir} \tag{6.17}$$

$$EQ_L^{ir} = \epsilon^{ir} \; EP_L^{ir} + \tau_i^{wr} EQ_i^{wr} \tag{6.18}$$

$$EQ_L^{dw} = \eta_d^{dw} EP_L^{dw} + \tau_d^{rw} EQ_L^{dr} \tag{6.19}$$

$$EQ_L^{dw} = \epsilon_d^{dw} \; EP_L^{dw} + \tau_d^{sw} EQ_L^{ds} + Ew_L^{dw} \tag{6.20}$$

$$EQ_L^{iw} = \eta_i^{iw} EP_L^{iw} + \tau_i^{rw} EQ_L^{ir} \tag{6.21}$$

$$EQ_L^{iw} = \epsilon^{iw} \; EP_L^{iw} \tag{6.22}$$

$$EQ_L^{ds} = \eta^{ds} EP_L^{ds} + \tau_d^{ws} EQ_L^{dw} \tag{6.23}$$

$$EQ_L^{ds} = \epsilon^{ds} \; EP_L^{ds} + \tau_d^{fs} EQ_L^{df} + Ew_L^{ds} \tag{6.24}$$

$$EP_L^{dsd} = \left(1 / \rho\right) EP_L^{dss} + \left(1 / \rho\right) E\theta \tag{6.25}$$

$$EQ_L^{df} = \eta^{df} EP_L^{df} + \tau_d^{sf} EQ_L^{ds} \tag{6.26}$$

$$EQ_L^{df} = \epsilon^{df} \; EP_L^{df} + Ew_L^{df} \tag{6.27}$$

The term E represents a relative change operator (e.g., $EQ_L^{dr} = dQ_L^{dr} / Q_L^{dr} = d \ln Q_L^{dr}$). Table 6-2 provides definitions for all parameters. In addition, each z_L^{ij} and w_L^{ij} represent single elements of the demand $\left(\boldsymbol{Z}_L^{ij}\right)$ and supply $\left(\boldsymbol{W}_L^{ij}\right)$ shifters. Specifically, these elements represent percentage cost or quality changes from initial equilibria caused by changes in procurement methods. That is, z_L^{dr} represents potential quality shifters for consumer demand for domestic lamb resulting from changes in lamb and meat procurement practices. Similarly, w_L^{ij} represents cost shifters for the primary and derived lamb supply functions, which may result from changes in procurement practices. All other elements of $\boldsymbol{Z}_L^{ij}$ and $\boldsymbol{W}_L^{ij}$ are assumed to remain constant as a result of changes in procurement practices.

Table 6-2. Parameter Definitions, Short-Run and Long-Run Elasticity Estimates Used in the Equilibrium Displacement Model, and Standard Deviations

Parameter	Definition	Estimate[a] Short Run	Estimate[a] Long Run	Standard Deviations[a]
η_d^{dr}	Own-price elasticity of primary demand for retail domestic lamb	–0.523	–1.108	0.160
η_d^{ir}	Cross-price elasticity of demand for retail domestic lamb with respect to the price of retail imported lamb	0.293	0.621	0.117
η_i^{ir}	Own-price elasticity of primary demand for retail imported lamb	–0.407	–0.631	0.262
η_i^{dr}	Cross-price elasticity of demand for retail imported lamb with respect to the price of retail domestic lamb	0.775	1.202	0.330
η_d^{dw}	Own-price elasticity of derived demand for wholesale domestic lamb	–0.350	–1.032	0.064
η_i^{iw}	Own-price elasticity of derived demand for wholesale imported lamb	–0.228	–0.407	0.121
η^{ds}	Own-price elasticity of derived demand for domestic slaughter lamb	–0.333	–0.865	0.043
η^{df}	Own-price elasticity of derived demand for domestic feeder lamb	–0.112	–0.285	0.048
ϵ^{dr}	Own-price elasticity of derived domestic retail lamb supply	0.151	3.963	0.070
ϵ^{ir}	Own-price elasticity of derived imported retail lamb supply	10.000	10.000	NA
ϵ^{dw}	Own-price elasticity of derived domestic wholesale lamb supply	0.158	3.854	0.069
ϵ^{iw}	Own-price elasticity of derived imported wholesale lamb supply	10.000	10.000	NA
ϵ^{ds}	Own-price elasticity of derived domestic slaughter lamb supply	0.118	2.950	0.052
ϵ^{df}	Own-price elasticity of primary domestic feeder lamb supply	0.086	2.261	0.048

[a] Short-run standard deviations for each elasticity are obtained from the structural model that is presented later in the report. Long-run standard deviations are not needed for the analysis.

The equilibrium displacement model was implemented by placing all of the endogenous variables in Eqs. (6.15) through (6.27) onto the left-hand side of each equation:

$$EQ_L^{dr} - \eta_d^{dr} EP_L^{dr} - \eta_d^{ir} EP_L^{ir} = Ez_L^{dr} \tag{6.28}$$

$$EQ_L^{dr} - \in^{dr} EP_L^{dr} - \tau_d^{wr} EQ_L^{dw} = Ew_L^{dr} \tag{6.29}$$

$$EQ_L^{ir} - \eta_i^{ir} EP_L^{ir} - \eta_i^{dr} EP_L^{dr} = 0 \tag{6.30}$$

$$EQ_L^{ir} - \in^{ir} EP_L^{ir} - \tau_i^{wr} EQ_L^{iw} = 0 \tag{6.31}$$

$$EQ_L^{dw} - \eta_d^{dw} EP_L^{dw} - \tau_d^{rw} EQ_L^{dr} = 0 \tag{6.32}$$

$$EQ_L^{dw} - \in^{dw} EP_L^{dw} - \tau_d^{sw} EQ_L^{ds} = Ew_L^{dw} \tag{6.33}$$

$$EQ_L^{iw} - \eta_i^{iw} EP_L^{iw} - \tau_i^{rw} EQ_L^{ir} = 0 \tag{6.34}$$

$$EQ_L^{iw} - \in^{iw} EP_L^{iw} = 0 \tag{6.35}$$

$$EQ_L^{ds} - \eta^{ds} EP_L^{dsd} - \tau_d^{ws} EQ_L^{dw} = 0 \tag{6.36}$$

$$EQ_L^{ds} - \in^{ds} EP_L^{dss} - \tau_d^{fs} EQ_L^{df} = Ew_L^{ds} \tag{6.37}$$

$$\rho EP_L^{dsd} - EP_L^{dss} = E\theta \tag{6.38}$$

$$EQ_L^{df} - \eta^{df} EP_L^{df} - \tau_d^{sf} EQ_L^{ds} = 0 \tag{6.39}$$

$$EQ_L^{df} - \in^{df} EP_L^{df} = Ew_L^{df} \tag{6.40}$$

For any given set of elasticity estimates, Eqs. (6.28) through (6.40) can be used to determine the relative changes in endogenous quantities and prices for any given exogenous changes in costs and/or consumer demand. In matrix notation, Eqs. (6.28) through (6.40) can be written as

$$\boldsymbol{A} \bullet \boldsymbol{Y} = \boldsymbol{B} \bullet \boldsymbol{X}, \tag{6.41}$$

where **A** is a 13x13 nonsingular matrix of elasticities; **Y** is a 13x1 vector of changes in the endogenous price and quantity variables; **B** is a 13x6 matrix of parameters associated with the exogenous variables; and **X** is a 6x1 vector of percentage changes in the exogenous cost, demand, and potential market power shift variables. Relative changes in the endogenous variables (**Y**) caused by relative changes in marketing (procurement) costs and benefits (**X**) are calculated by solving Eq. (6.41) as

$$\boldsymbol{Y = A^{-1} \bullet B \bullet X} \qquad (6.42)$$

6.2 ESTIMATING DEMAND AND SUPPLY ELASTICITIES IN THE LAMB INDUSTRY

Solutions for **Y** in Eq. (6.42) require elasticity estimates for elements of the matrix **A**. The extant literature reports few demand and supply elasticity estimates for the lamb industry. Thus, most of these estimates are obtained by direct estimation.

We estimate a system of structural equations so that resulting elasticity estimates are consistent with respect to sample period and model specification, data generation, methodology, and evaluation procedures. However, it should be noted that several problems occur in estimating lamb demand and supply elasticity coefficients compared with estimating structural elasticities in the beef, pork, and poultry sectors:

- Reported time-series lamb industry data are not as consistent compared with data reported for the other meat sectors, particularly with respect to retail and boxed meat prices, by-product prices, and marketing margins (American Sheep Industry Association, 2003–2004; Babula, 1996).
- Relatively few lamb studies exist for making valid comparisons of elasticity estimates (Babula, 1997). This also makes it difficult to obtain demand and supply elasticity estimates from other external sources.
- Of the lamb studies that exist, the variability of model (structural and time-series) specifications, sample periods, and estimation methods limits validation of our model elasticities with those of other research.

Nonetheless, some elasticity estimates have been reported for certain lamb sectors (e.g., breeding stock, lamb slaughter, imports, and retail demand) and serve as a general benchmark for evaluating our demand and supply parameter estimates (Babula, 1996; Babula, 1997; Capps, Byrne, and Williams, 1995; International Trade Commission, 1999; Van Tassell and Whipple, 1994; Vere, Griffith, and Jones, 2000; Whipple and Menkhaus, 1990; Whipple and Menkhaus, 1989). We discuss comparisons between these published estimates and our estimated elasticities in Section 6.5.

6.2.1 Structural Model Required for Econometric Estimates

To effectively evaluate the economic effects of marketing arrangements in the lamb sector, vertical relationships among demand and supply sectors in the lamb-meat marketing channel should be estimated jointly (Brester, Marsh, and Atwood, 2004; Gardner, 1975; Marsh, 2003; Tomek and Robinson, 1990; Wohlgenant, 1989). In addition, the domestic and import wool and meat sectors should be included (Babula, 1996, 1997; Gardner, 1982; Malecky, 1975). For our structural analysis, the market levels of the lamb industry considered are

1. breeding stock (ewes) and lamb crop production, noted as the feeder lamb level;
2. feedlot production for slaughter, noted as the slaughter lamb level;
3. cull production for slaughter, noted as the slaughter ewe level;
4. carcass production, noted as the wholesale level;
5. retail meat cut production, noted as the retail level;
6. lamb meat imports, specific to the wholesale level;
7. wool production at the wholesale level (wool converted to a scoured basis); and
8. wool imports at the wholesale level (scoured basis for further processing).

The implied demand and supply relationships are characterized by variables unique to each level and also by variables specific to other vertical sectors. For example, meat packer demand for slaughter lambs depends on lamb slaughter price, carcass price at the wholesale level, and marketing costs between packers and retailers.

The advantages of specifying multimarket levels in an econometric model rest with properties of the parameter estimates and comprehensiveness of the comparative statics. A system of demand and supply equations allows parameter estimates to account for vertical information and stochastic error processes that improve the consistency and asymptotic efficiency of parameter estimates (Greene, 2003). For example, parameter estimates of a single-demand equation at the feeder lamb level ignore endogenous, exogenous, and error term information implicit in a demand system that includes upstream slaughter, wholesale, and retail levels (Marsh, 2003; Wohlgenant, 1989).

In a systems model, the comparative statics are contingent on total elasticities. These elasticities measure direct and indirect changes in equilibrium prices and quantities at all market levels from arbitrary shocks (Marsh, 2003; Wohlgenant, 1989). Lamb buyers and sellers at these levels have vested interests in public and private policy changes, which can be evaluated using comparative statics. Examples include lamb quality changes that may shift consumer preferences and demand or restrictions on contracting arrangements that could affect lamb finisher and meat packer transaction and plant utilization costs. The result could be a shift in the feedlot supply of, and the packer demand for, slaughter lambs. Moreover, relative primary demand and supply elasticities, the nature of marketing margins, and the source of market shock(s) determine the distribution of price, quantity, and producer and consumer surplus changes between the marketing levels (Brester, Marsh, and Atwood, 2004; Gardner, 1975; Tomek and Robinson, 1990).

6.2.2 Previous Research on Lamb Industry Elasticities

Research involving demand, supply, and price determination in the sheep and lamb industry is relatively scarce compared with that of other meats (Babula, 1996). This may be the result of the lamb industry’s relatively small share of U.S. per capita meat consumption. For example, 2003 retail per capita consumption of all red meats (beef, veal, pork, and lamb) was 118 pounds, and consumption of all red meat and poultry was 218 pounds (USDA, ERS, 2004b). Per capita lamb consumption was 1.1 pounds in 2003, or one-half of 1% of total meat consumption. In 1970, lamb consumption represented about 2% of total meat consumption.

Lamb’s small market share, however, does not negate its importance to specific consumers and producers of the product. In 2003, U.S. consumers spent about $1.7 billion on retail lamb products, and feeder lamb producers generated about $312.3 million of lambs. The U.S. lamb industry generally produces high-valued cuts for the domestic market and targets cultural and ethnic populations concentrated in the Northeast and

Western states (Jones, 2004b). Lower valued cuts are rendered or sold as pet food. The U.S. exports only small amounts of lamb products. However, most cull ewes and rams are exported to Mexico. The United States imports significant quantities of lamb carcasses and fresh and frozen lamb cuts from Australia and New Zealand. In 2003, lamb imports constituted about 53% of U.S. lamb and mutton consumption (USDA/ERS, 2004a).

Domestic lamb production and marketing are primarily concentrated in Texas, California, Wyoming, South Dakota, and Colorado (USDA/NASS, 2004a). U.S. sheep and lamb production has declined precipitously over the past several decades. Total sheep and lamb inventory has declined from 21.8 million head in 1970 to 6.32 million head in 2003. Concurrently, lamb and sheep slaughter has declined from 10.55 million head to 2.98 million head. Many reasons account for these declines including a long-term decline in the demand for lamb and wool, predator losses, labor costs, termination of wool incentive payments, environmental restrictions, and reduced access to federal grazing lands (Jones, 2004b; U.S. International Trade Commission, 1999).

In light of these problems, research in the lamb industry has focused on supply issues (Purcell, Reeves, and Preston, 1991; Van Tassell and Whipple, 1994; Whipple and Menkhaus, 1989), demand issues (Purcell, 1998; Williams and Capps, 1991; Whipple and Menkhaus, 1989), marketing margin and packer concentration issues (Brester and Musick, 1995; Capps, Byrne, and Williams, 1995; Menkhaus, Whipple, and Ward, 1989), and lamb import issues (Babula, 1996, 1997; U.S. International Trade Commission, 1999). Other research involves econometric modeling of the Australian and New Zealand sheep and lamb industries, including wool markets (Reynolds and Gardiner, 1980; Richie, 1979; Vere, Griffith, and Jones, 2000).

The above studies generally provide information regarding the structure of demand and supply in the lamb industry. A few studies report elasticity estimates. Much of this previous research relates to comparative statics and impact multipliers associated with marketing, risk management, and policy decisions. Also, previous studies evaluated the effects of lamb packer concentration, market price transmissions, and demand and supply variables on lamb marketing margins.

Research on the supply side of the lamb industry has addressed issues related to sheep breeding stock and lamb marketing through the use of structural and time-series models. Van Tassell and Whipple (1994) analyzed the cyclical nature of the U.S. sheep industry in terms of farm prices and sheep breeding inventories using harmonic regressions and both monthly and annual data from 1924 to 1993. GLS methods were used, and results indicated long-term 8- to 13-year cycles for prices and quantities. The Akaike Information Criteria (AIC) was used to detect a 1968 to 1972 structural change, perhaps as a result of the Mideast oil embargo, inflationary pressures, and the U.S. meat price freeze. Whipple and Menkhaus (1989) estimated annual dynamic supply functions for breeding stock, wool production, and lamb slaughter using least squares regression and simulation techniques for the 1924 to 1983 period. Empirical results based on capital formation theory emphasized the importance of output and input prices (including labor cost) on production responses. Estimated long-run supply elasticities (10 years) for breeding stock, lamb slaughter, and wool were elastic (3.05, 2.83, and 1.38, respectively). Vere, Griffith, and Jones (2000) estimated an integrated econometric model of the Australian beef, pork, and lamb industries using quarterly data from 1970 to 1996. Their purpose was to measure the effects of cyclical variations, external events, and policies on the economic activities of the livestock sectors. Structural demand, supply, and price relationships were estimated as partial adjustment processes using simultaneous equations estimators. Estimated supply elasticities for breeding stock ranged from 0.06 to 0.09 in the short run and from 2.52 to 3.34 in the long run. Estimated short-run and long-run lamb marketings (slaughter) supply elasticities were 0.25 and 2.73, respectively. The authors' estimate of the long-run retail elasticity of demand for lamb was –1.54, which was consistent with elastic retail demands for beef (–1.38) and pork (–1.59).

Whipple and Menkhaus (1989), Williams and Capps (1991), Babula (1997), and the International Trade Commission (1999) reported various results from lamb demand research. Estimates of retail primary demand were used to measure consumer responses to marketing and demand diversification programs intended to assist the lamb industry (Jones, 2004a). Estimates of retail demand elasticities varied: Whipple and Menkhaus (1989) reported a retail lamb demand elasticity of –3.96 based on inverting a retail price flexibility estimated by the Yule-Walker approach (1950 to 1987 annual data); Williams and Capps (1991) reported a price elasticity of –0.62 for lamb demand; and Babula's (1997) investigation of the effects of a U.S. countervailing duty on lamb imports estimated the retail demand elasticity as –0.78 using a 3SLS estimator. The U.S. International Trade Commission's investigative report on the U.S. import duty for lamb in 1999 (later rescinded by the World Trade Organization [WTO]) considered a spectrum of retail demand elasticities (–0.75 to –1.25) as relevant for impact analysis.

Analysis of demand and supply behavior in the U.S. lamb industry must consider lamb imports. Imports of high-value lamb carcasses and fresh and frozen lamb meat cuts from Australia and New Zealand have increased, even as overall U.S. lamb consumption has declined (Jones, 2004b). Imports as a share of per capita U.S. lamb consumption have substantially increased from about 6% in 1975 to about 46% in 2003. During the 1985 to 1990 period, the U.S. Department of Commerce imposed a countervailing duty on imports of New Zealand lamb meat. The U.S. government determined that New Zealand lamb industry subsidies were at least partially responsible for increasing import market shares. Babula (1997) econometrically investigated the effects of this countervailing duty on U.S. lamb supply, demand, and price at the meat packing-wholesale level using monthly data from January 1981 to May 1994. Results indicated the countervailing duty increased the wholesale lamb price by 10% and reduced domestic quantity demanded for lamb by 3.5%. The 3SLS estimates of import demand elasticities ranged from –0.08 to –1.14, and cross elasticities (the effect of U.S. lamb price on the demand for lamb imports) ranged from –1.69 to 2.20 (the sign of the former does not meet *a priori* expectations for consumption substitutes). The price elasticity of supply for lamb at the wholesale level was elastic (3.0).

6.2.3 Conceptual Lamb Model for Estimation of Elasticities

This current research requires information on primary and derived demand and supply structures and related price elasticities. Thus, an econometric model of vertical demand and supply relationships in the farm-to-retail marketing system is required. The wool and lamb import markets are necessarily included (Babula, 1997; Gardner, 1982). According to Gardner (1975) and Tomek and Robinson (1990), integrating marketing-chain relationships improves the estimation accuracy of upstream and downstream demand and supply responses. For example, the derived demand elasticity for livestock at the farm level is jointly a function of primary demand, marketing margins, factors specific to other market levels, net imports, and factors specific to the farm level such as feed costs (Marsh, 2003; Wohlgenant, 1989).

A crucial aspect of our econometric model is the estimation of primary demand and primary supply because shifts in these functions affect derived demand and supply functions. Moreover, the effects of initial conditions or shocks in the marketing sector also depend on primary-level elasticities. For example, increased costs incurred by meat packers shift derived slaughter demand and wholesale and retail supply functions. Subsequently, the distribution of these cost changes on prices and quantities at the retail and farm levels is conditional on elasticities of retail demand and farm supply (Brester, Marsh, and Atwood, 2004; Lusk and Anderson, 2004).

The microeconomic theory underlying the behavioral relations of primary consumer demand for lamb and primary producer supply of lamb is derived from first-order conditions of constrained utility maximization and firm profit maximization, respectively (Varian, 1992). Moreover, the derived (input) demands and output supplies in the marketing chain are a function of first-order conditions of firm profit maximization. This optimization principle can be demonstrated by considering a lamb feeding firm that purchases 60- to 80-pound feeder lambs and grain finishes them to 120 to 140 pounds of slaughter weight for sale to meat packers. The firm's unconstrained profit function would be

$$\pi = P_L Q_L - P_f Q_f - \sum_{i=1}^{p} r_i q \ , \qquad (6.43)$$

where π is the feeding firm's profit; P_L is the price of slaughter lambs; Q_L is liveweight quantity of slaughter lambs sold; P_f is price of feeder lambs; Q_f is liveweight quantity of feeder lambs purchased; and r_i and q_i are prices and quantities of other inputs such as feed, labor, medical, and other supplies in the finishing operation. Following Varian (1992), the finisher's supply function for slaughter lambs is based on solving the first-order condition of profit maximization:

$$\frac{\partial \pi \left(P_L, P_f, r_i\right)}{\partial P_L} = Q_L \left(P_L, P_f, r_i\right). \tag{6.44}$$

Eq. (6.44) indicates the supply function of lambs depends on the output price of lambs (P_L), input price of feeder lambs (P_f), and other input costs (r_i).

Similarly, the demand function for feeder lambs is based on solving first-order conditions of profit maximization:

$$\frac{-\partial \pi \left(P_L, P_f, r_i\right)}{\partial P_f} = Q_f \left(P_f, P_L, r_i\right), \tag{6.45}$$

which indicates the input demand function for feeder lambs depends on the input price of lambs, slaughter price of lambs, and other input costs. Since π is a convex function, the second-order derivatives of the left-hand sides of Eqs. (6.44) and (6.45) assure a nonnegative slope of output supply and a nonpositive slope of input demand.

The optimization principle holds for any profit-maximizing (or cost-minimizing) firm operating in competitive marketing channels. Thus, aggregating the relevant micro-level functions of feeder lamb producers, fed lamb producers, lamb packers and processors, and meat retailers yields the appropriate primary and derived market-level functions. The input price vector, r_i, in Eq. (6.43) could also include marketing costs, a relevant proxy for the effects of marketing margins in vertically related agricultural demand and supply functions (Tomek and Robinson, 1990).

6.2.4 Model Specification

Our complete, vertical structural lamb model is an improvement over more limited specifications of previous studies. For purposes of estimating elasticities, we assume that the lamb market is competitive. Hence, individual sellers face infinitely elastic demands and individual buyers face infinitely elastic supplies. This assumption may be questioned because of increased meat packing and retail grocery concentration since the 1980s. However, studies have indicated meat and livestock price distortions from potential market power in these markets are relatively minor (Azzam and Anderson, 1996; Azzam and

Schroeter, 1991; Brester and Marsh, 2001; Marsh and Brester, 2004; Morrison-Paul, 2001).

The structural specifications of the lamb model are as follows:

Domestic Retail Lamb Sector:

Domestic retail lamb demand:

$$Q_L^{drd} = h_1\left(P_L^{drd}, P_L^{ird}, P_B^r, P_K^r, P_Y^r, Y\right) \tag{6.46}$$

Domestic retail lamb supply:

$$Q_L^{drs} = h_2\left(P_L^{drs}, P_L^w, L_c\right) \tag{6.47}$$

Market-clearing quantity:

$$Q_L^{drd} = Q_L^{drs} = Q_L^{dr} \tag{6.48}$$

Market-clearing price:

$$P_L^{drd} = P_L^{drs} = P_L^{dr} \tag{6.49}$$

Imported Retail Lamb Sector:

Imported retail lamb demand:

$$Q_L^{ird} = h_3\left(P_L^{ird}, P_L^{dr}, P_B^r, P_K^r, P_Y^r, Y\right) \tag{6.50}$$

Imported retail lamb supply:

$$Q_L^{irs} = h_4\left(P_L^{irs}, Q_L^{iw}, L_c\right) \tag{6.51}$$

Market-clearing quantity:

$$Q_L^{ird} = Q_L^{irs} = Q_L^{ir} \tag{6.52}$$

Market-clearing price:

$$P_L^{ird} = P_L^{irs} = P_L^{ir} \tag{6.53}$$

Domestic Wholesale Lamb Sector:

Domestic wholesale lamb demand:

$$Q_L^{dwd} = h_5\left(P_L^{dwd}, P_L^{dr}, P_B^w, P_K^w, P_Y^w, M_c\right) \tag{6.54}$$

Domestic wholesale lamb supply:

$$Q_L^{dws} = h_6\left(P_L^{dws}, P_L^{ds}, P_{bp}, L_c\right) \tag{6.55}$$

Market-clearing quantity:

$$Q_L^{dwd} = Q_L^{dws} = Q_L^{dw} \tag{6.56}$$

Market-clearing price:

$$P_L^{dwd} = P_L^{dws} = P_L^{dw} \tag{6.57}$$

Imported Wholesale Lamb Sector:

Imported wholesale lamb demand:

$$Q_L^{iwd} = h_7 \left(P_L^{iwd}, P_L^{dw}, E_x, P_K^w, P_Y^w\right) \tag{6.58}$$

Imported wholesale lamb supply:

$$Q_L^{iws} = h_8 \left(P_L^{iws}, C_L^i, E_x, Q_{az}\right) \tag{6.59}$$

Market-clearing quantity:

$$Q_L^{iwd} = Q_L^{iws} = Q_L^{iw} \tag{6.60}$$

Market-clearing price:

$$P_L^{iwd} = P_L^{iws} = P_L^{iw} \tag{6.61}$$

Domestic Slaughter Lamb Sector:

Domestic slaughter lamb demand:

$$Q_L^{dsd} = h_9 \left(P_L^{dsd}, P_L^{dw}, M_c P_{bp}, K\right) \tag{6.62}$$

Domestic slaughter lamb supply:

$$Q_L^{dss} = h_{10} \left(P_L^{dss}, P_L^f, P_n, P_w\right) \tag{6.63}$$

Market-clearing quantity:

$$Q_L^{dsd} = Q_L^{dss} = Q_L^{ds} \tag{6.64}$$

Market-clearing price:

$$P_L^{dsd} = P_L^{dss} = P_L^{ds} \tag{6.65}$$

Domestic Slaughter Ewe (Cull) Sector:

Domestic slaughter ewe demand:

$$Q_L^{ded} = h_{11} \left(P_L^{ded}, P_L^{dw}, M_c P_{bp}, K\right) \tag{6.66}$$

Domestic slaughter ewe supply:

$$Q_L^{des} = h_{12}\left(P_L^{des}, P_{hy}, P_w, Q_{be}\right) \quad (6.67)$$

Market-clearing quantity:

$$Q_L^{ded} = Q_L^{des} = Q_L^{de} \quad (6.68)$$

Market-clearing price:

$$P_L^{ded} = P_L^{des} = P_L^{de} \quad (6.69)$$

Domestic Feeder Lamb Sector:

Domestic feeder lamb demand:

$$Q_L^{dfd} = h_{13}\left(P_L^{dfd}, R^f\right) \quad (6.70)$$

Domestic lamb crop:

$$Q_L^{dfs} = h_{14}\left(Q_{be}, T\right) \quad (6.71)$$

Domestic breeding ewe supply:

$$Q_L^{des} = h_{15}\left(P_L^{df}, P_{hy}, P_w, P_{sw}, P_L^{de}\right) \quad (6.72)$$

Market-clearing quantity:

$$Q_L^{dfd} = Q_L^{dfs} = Q_L^{df} \quad (6.73)$$

Market-clearing price:

$$P_L^{dfd} = P_L^{dfs} = P_L^{df} \quad (6.74)$$

Domestic Wholesale Wool Sector:

Domestic wholesale wool demand:

$$Q_w^{dwd} = h_{16}\left(P_w^{dwd}, P_w^{iwd}, P_{ct}, Y_x\right) \quad (6.75)$$

Domestic wholesale wool supply:

$$Q_w^{dws} = h_{17}\left(P_w^{dws}, P_{ws}, Q_L^{df}, D_{Lw}\right) \quad (6.76)$$

Market-clearing quantity:

$$Q_w^{dwd} = Q_w^{dws} = Q_w^{dw} \quad (6.77)$$

Market-clearing price:

$$P_w^{dwd} = P_w^{dws} = P_w^{dw} \tag{6.78}$$

Imported Wholesale Wool Sector:

Imported wholesale wool demand:

$$Q_w^{iwd} = h_{18}\left(P_w^{iwd}, P_w^{dw}, P_{ct}, Y_x, E_x^a\right) \tag{6.79}$$

Imported wholesale wool supply:

$$Q_w^{iws} = h_{19}\left(P_w^{iws}, C_w^i, E_x^a, Q_{az}\right) \tag{6.80}$$

Market-clearing quantity:

$$Q_w^{iwd} = Q_w^{iws} = Q_w^{iw} \tag{6.81}$$

Market-clearing price:

$$P_w^{iwd} = P_w^{iws} = P_w^{iw} \tag{6.82}$$

Table 6-1 provides variable definitions for the lamb model. The demand and supply equations are expressed with quantities as dependent variables. For all market-level sectors, prices and quantities are assumed to be in equilibrium within annual time periods.

Eqs. (6.46) and (6.47) represent domestic primary retail demand and derived retail supply of lamb, respectively. Retail demand is a function of domestic retail lamb price $\left(P_L^{dr}\right)$; import retail lamb price $\left(P_L^{ir}\right)$; retail prices of beef, pork, and poultry $\left(P_B^r, P_K^r, P_Y^r\right)$; and per capita personal consumption expenditures (Y). Retail supply is a function of domestic retail lamb price $\left(P_L^{dr}\right)$, wholesale lamb price $\left(P_L^{dw}\right)$, and food labor costs (L_c). Eqs. (6.50) and (6.51) represent import retail demand and import retail supply of lamb, respectively. Import demand is a function of retail import lamb price $\left(P_L^{ir}\right)$, domestic retail lamb price $\left(P_L^{dr}\right)$, and other neoclassical arguments given in Eq. (6.46). Import supply is a function of import retail price $\left(P_L^{ir}\right)$, the wholesale import supply of lamb $\left(Q_L^{iw}\right)$, and food labor costs (L_c). The variable $\left(Q_L^{iw}\right)$ serves as the base for import retail supply and consists of imported wholesale lamb carcasses and lamb cuts (fresh and frozen) that are further processed into retail cuts.

Domestic wholesale demand and supply of lamb are given by Eqs. (6.54) and (6.55). Wholesale demand is a function of wholesale lamb price $\left(P_L^{dw}\right)$, retail lamb price $\left(P_L^{dr}\right)$, wholesale prices of competitive meats $\left(P_B^w, P_K^w, P_Y^w\right)$, and food marketing costs (M_c). Wholesale lamb supply is a function of wholesale lamb price $\left(P_L^{dw}\right)$, input price of slaughter lamb $\left(P_L^{ds}\right)$, lamb by-product value (pelt price, P_{bp}), and food labor cost (L_c).

Wholesale lamb import demand and import supply are represented by Eqs. (6.58) and (6.59). Lamb import demand is a function of wholesale lamb import price $\left(P_L^{iw}\right)$; the price of wholesale lamb $\left(P_L^{dw}\right)$; the U.S./(average of Australian and New Zealand) exchange rate (E_x); and the wholesale prices of beef, pork, and poultry $\left(P_B^w, P_K^w, P_Y^w\right)$. Wholesale lamb import supply depends on lamb import price $\left(P_L^{iw}\right)$, Australian and New Zealand export costs $\left(C_L^i\right)$, the U.S./(average Australian and New Zealand) exchange rate (E_x), and quantity of lamb and sheep production in Australia and New Zealand (Q_{az}).

Domestic lamb slaughter demand and supply are given in Eqs. (6.62) and (6.63). Slaughter (meat packer) demand is a function of slaughter lamb price $\left(P_L^{ds}\right)$, wholesale price of lamb $\left(P_L^{dw}\right)$, food marketing costs (M_c), lamb by-product value (pelt price, P_{bp}), and lamb meat packer concentration (K). Slaughter supply (by lamb feeders) is a function of slaughter lamb price $\left(P_L^{ds}\right)$, input price of feeder lambs $\left(P_L^{df}\right)$, the price of feed corn (P_n), and the price of shorn wool (P_w).

The demand and supply for cull sheep (ewes and rams) is provided by Eqs. (6.66) and (6.67). Packer demand depends on ewe slaughter price $\left(P_L^{de}\right)$, wholesale price of lamb $\left(P_L^{dw}\right)$, food marketing costs (M_c), lamb by-product value (pelt price, P_{bp}), and lamb packer concentration (K). Cull sheep supply is a function of ewe slaughter price $\left(P_L^{de}\right)$, the price of hay (P_{hy}), the price of shorn wool (P_w), and breeding stock inventory (Q_{be}). Age distributions of the breeding stock constrain the supply of cull sheep (Whipple and Menkhaus, 1989).

Domestic demand for feeder lambs (by lamb feeders) and supply of feeder lambs (by lamb producers) are expressed in Eqs. (6.70) and (6.71). The derived demand for feeder lambs represents the major input demanded by lamb finishers. Eq. (6.70) specifies feeder lamb demand as a function of feeder lamb price $\left(P_L^{df}\right)$ and the lamb price-corn price ratio (R^f), which is a proxy for feedlot profitability (Marsh, 1999). The supply of feeder lambs (Eq. 6.71) is expressed as a function of sheep breeding inventories (Q_{be}) and a trend factor (T) to account for changes in technology/productivity of lamb production. Eq. (6.72) represents breeding sheep inventories, which provide the basis for feeder lamb production (Whipple and Menkhaus, 1989). Breeding inventory (or supply of breeding stock) depends on the output price of feeder lambs $\left(P_L^{df}\right)$, price of hay (P_{hy}), the price of shorn wool (P_w), the wool support price (P_{sw}), and the slaughter price of ewes $\left(P_L^{de}\right)$. Breeding inventories are specified to recursively enter Eq. (6.71). Therefore, the economic variables that determine breeding inventories also affect the production of feeder lambs.

Eqs. (6.75) through (6.82) represent the wool sector. Wool has been a critical joint product of the lamb and sheep industry. Producers received wool support (direct) payments under the National Wool Act of 1954 until 1995. The Wool Act was subsequently suspended between 1996 and 2001 (Jones, 2004b). The Farm Security and Rural Investment Act of 2002 reinstated wool price supports through marketing assistance loans and loan deficiency payments for the 2002 to 2007 lamb crops. Before the termination of the 1954 Wool Act, wool revenues accounted for about 20% to 25% of total revenues in the lamb and sheep industry. Since the Act's termination, wool's revenue share has fallen to about 10% (Jones, 2004b).

USDA data indicate that from 1990 to 2003, about 57% of wool consumed in the United States was imported, primarily from Australia, New Zealand, Canada, South Africa, and South America (USDA/NASS, 2004a). The imports consist of graded, clean content wool usable for further processing to produce apparel and carpets.

Domestic wool demand and supply are represented by Eqs. (6.75) and (6.76), respectively. Domestic wool demand depends on domestic wool price $\left(P_L^{dw}\right)$, import wool price $\left(P_L^{iw}\right)$, the price of cotton (P_{ct}), and personal consumption expenditures (Y_x). Domestic wool supply depends on domestic wool market price $\left(P_L^{dw}\right)$, wool support price (P_{sw}), and the potential for wool production, for which the production of lambs serves as a proxy, $\left(Q_L^{df}\right)$, and a wool binary variable (D_{Lw}) to account for the 1996 to 2001 period during which wool price supports were halted.

Wholesale import demand and supply of wool are represented by Eqs. (6.79) and (6.80). Import demand (Eq. [6.79]) is a function of wool import price $\left(P_L^{iw}\right)$, domestic wool price $\left(P_L^{dw}\right)$, price of cotton (P_{ct}), personal consumption expenditures (Y_x), and the United States/Australian exchange rate $\left(E_x^a\right)$. Wool import supply (Eq. [6.80]) is a function of wool import price $\left(P_L^{iw}\right)$, cost of producing wool for export by Australia and New Zealand $\left(C_w^i\right)$, United States/Australian exchange rate $\left(E_x^a\right)$, and quantity of sheep and lambs produced in Australia and New Zealand (Q_{az}).

U.S. trade in live sheep and lambs is very small (Jones, 2004b). Thus, live lamb imports are not considered in the model.

6.2.5 Other Model Considerations

The structural model includes a variety of economic factors, such as feed prices, prices of competitive meats (including lamb imports), personal consumption expenditures, lamb packer concentration, input prices, food marketing costs, and exchange rates. The sample period includes several decades during which other factors may also be of potential significance. Three specific events are the structural change in meat demand and the meat price freeze of the early 1970s (Knutson, Penn, and Boehm, 1990; Van Tassel and Whipple, 1994), the 1993 suspension of the 1954 Wool Act (Public Law 103-130) resulting in no wool price supports from 1996 to 2001 (Jones, 2004b), and U.S. countervailing duties on New Zealand lamb imports from 1985 to 1990 (Babula, 1997). As noted in Table 6-1, these events are accounted for with binary variables labeled *MD*, *WD*, and *ID*, respectively. The meat binary variable (*MD*) is included in all demand equations. The import duty binary variable (*ID*) is included in wholesale and retail lamb demand equations, and the wool binary variable (*WD*) is included in the wool supply equation. In addition, the model should account for dynamic effects such as consumer demand and technology/productivity changes (Brester and Marsh, 2001). Trend variables (T) are used to account for these changes.

6.2.6 Model Dynamics

Conceptually, the lamb and wool model represents a set of economically integrated demand and supply relations in the farm–retail marketing chain. The static form of the model can be represented in general matrix notion as

$$\beta Y_t + \Gamma Z_t = \mu_t , \tag{6.83}$$

where Y_t is a Gx1 vector of endogenous variables, Z_t is a Kx1 vector of exogenous variables, μ_t is a Gx1 vector of disturbance terms, β is a GxG matrix of coefficients for the Y_t vector, and Γ is a GxK matrix of coefficients for the Z_t vector. The model assumes zero off-diagonal terms for the β matrix, rank identification of the Γ matrix, and a nondiagonal covariance matrix for μ_t, or contemporaneously correlated errors (Johnston and DiNardo, 1997). The μ_t's within each equation are assumed to be normally distributed with zero mean and constant variance; however, their time-series properties may be autoregressive (Greene, 2003).

Assuming cointegrated relationships allows the model to be estimated in data-level form by a system's GLS estimator, or Seemingly Unrelated Regressions (SUR). The estimator yields consistent and asymptotically efficient coefficient distributions (Greene, 2003). However, if β is characterized by nonzero off-diagonals (i.e., joint dependency), then 3SLS estimates are appropriate.

The presence of biological lags, technical production constraints, and buyer and seller expectations likely generate dynamics in livestock and meat supply and demand behavior (Brester and Marsh, 1983; Marsh, 2003; Rucker, Burt, and LaFrance, 1984; Tomek and Robinson, 1990; Whipple and Menkhaus, 1989). Thus, Eq. (6.83) is modified to account for partial adjustment processes in the behavioral relations through autoregressive distributed lags (ARDL) or ARMAX (ARDL with autocorrelated errors) (Greene, 2003; Marsh, 2003). In this context, the model can be rewritten as

$$\beta(L)Y_t + \Gamma(L)Z_t = \mu_t , \tag{6.84}$$

where $\beta(L)$ and $\Gamma(L)$ are polynomial lag operators that impose finite lag structures on the endogenous (Y_t) and exogenous (Z_t) vectors. The lag operators are given as

$$\beta(L) = 1 - \beta_1 L - \beta_2 L^2 - \beta_3 L^3 \ldots \beta_p L^p \tag{6.85}$$

and

$$\Gamma(L) = \Gamma_0 + \Gamma_1 L + \Gamma_2 L^2 + \Gamma_3 L^3 \ldots \Gamma_q L^q . \tag{6.86}$$

Thus, the polynomial form $\beta(L)Y_t$ of Eq. (6.85) gives $L^pY_t = Y_{t-p}$, and the polynomial form $\Gamma(L)Z_t$ of Eq. (6.86) gives $L^qZ_t = Z_{t-q}$. Solving for the Y_t vector of Eq. (6.84) gives

$$Y_t = \frac{\Gamma(L)}{\beta(L)} Z_\tau + \frac{1}{\beta(L)} \mu_\tau \,, \qquad (6.87)$$

which conceptually gives Y_T as an infinite distributed lag function of Z_t and μ_t (Greene, 2003). The implied set of polynomial coefficient weights for Z_t are formed by the rational generating function, $\Gamma(L)/\beta(L)$. The infinite moving average (MA) error structure for μ_t is restricted by the polynomial weights of $\beta(L)$. The rational generating function allows for short-run flexibility in the distributed lag patterns of the exogenous variables. However, the long-run behavior of each Z variable is conditioned by $\beta(L)$ (Greene, 2003).

Pragmatically, the empirical lags on the dependent variables (p in Eq. [6.85]) and the independent variables (q in Eq. [6.86]) for livestock and meat are usually of order 1 or 2 (Marsh, 2003). Van Tassell and Whipple (1994) found cyclical lengths in breeding sheep inventories and lamb prices (1924 to 1993 annual data) that averaged between 8 and 13 years. However, they indicated that cycle lengths have shortened in recent years. Thus, for the supply side of the lamb market, p is initially specified in the polynomial denominator as order 2 (permitting complex roots or cycling), and q is initially specified as order 1 in the polynomial numerator. For the demand side of the market, p and q of the polynomials are initially set at lag order 1, which implies geometric distributed lags.

The number of parameters for empirical estimation is relatively large using these initial specifications of lag orders. To achieve a more parsimonious set of parameters and improve estimation efficiency, higher order lags are truncated if they are found to be statistically insignificant. However, for any given variable, if contemporaneous and lag values are all found to be insignificant, the parameter value with the largest t-statistic is retained in the model to maintain theoretical consistency.

6.3 DATA CONSIDERATIONS

The sample period consists of annual data for the years 1970 to 2003. As noted by Capps, Byrne, and Williams (1995), the dearth of published work in the lamb industry can be attributed, in part, to data deficiencies. For the current study, market-level price and quantity data specific to live lamb, lamb meat, wool production, wool and pelt prices, food marketing and labor costs, meat prices, corn and hay prices, and trade data were obtained from various USDA sources. They include the *Agricultural Statistics*; *Livestock, Dairy and Poultry Situation and Outlook* reports; *Red Meats Yearbook*; *Dairy, Livestock, and Poultry: U.S. Trade and Prospects*; and the American Sheep Industry Association. Other data were obtained from the *Economic Report of the President*, international financial statistics of the International Monetary Fund (various issues), and USDA, GIPSA (2002).

Complete data series were available for most of the variables identified in the model. However, a few variables lacked a consistent data series; therefore, missing observations were imputed. These variables included retail lamb and lamb import prices, wholesale lamb import price, lamb pelt price, and wholesale lamb cut-out-value.

The retail lamb price series was the most problematic because it contained several missing observations. The USDA's ERS published average (retail cut) price data for the years 1970 to 1980 and the American Sheep Industry Association (2003–2004) provided average (retail cut) price data for the years 1987 to 1996 and 2001 to 2003. Missing observations for the years 1981 to 1986 and 1997 to 2000 were imputed using least squares regression. Following Capps, Byrne, and Williams (1995), available data on retail lamb prices were initially regressed onto a constant term, lamb carcass price, trend, and trend squared. However, the trend variables were deleted from the model because they were found to be statistically insignificant. The retail lamb import price series was constructed by adding the domestic wholesale-retail basis (retail price less wholesale price) for lamb to the wholesale import price of lamb.

The wholesale price of imported lamb was calculated by dividing the U.S. import value of lamb, mutton, and goat meat (fresh and frozen) by import quantities (carcasses and primals on a carcass equivalent basis) (*USDA Dairy, Livestock, and Poultry: U.S. Trade and Prospects*). This import price measure is quite aggregate but was included because the American Sheep Industry Association could provide only cost, insurance, and freight (c.i.f.) price data for Australia and New Zealand lamb carcasses and primals from 1998 to the present. The correlation between calculated import prices and American Sheep Industry Association's c.i.f. data for the years 1998 to 2003 was relatively high.

Data for lamb pelt prices (a proxy for lamb by-product values) was reported for the years 1976 to 2003 (American Sheep Industry Association). The use of econometrically backcasted pelt prices for the 1970 to 1975 period resulted in poor empirical results. Consequently, the shorn wool market price was used as a proxy for pelt price in the appropriate regression equations.

Prices of lamb carcasses (East Coast) are used as measures of domestic wholesale prices in the model. Lamb cut-out values may be a better measure for this series. However, cut-out values have only been reported since 2001. All price and value variables were deflated by the CPI (CPI, 1982–84=100) obtained from the *Economic Report of the President*.

6.4 STATISTICAL AND ESTIMATION PROCEDURE CONSIDERATIONS

A series of diagnostic tests were conducted to ensure appropriate statistical properties of the data. For example, unit root and cointegration tests were used to examine the time-series properties and stationarity of the data. If the data are found to be nonstationary and not cointegrated, then subsequent regression results could yield spurious results and misleading inferences. ADF unit root tests indicated unit roots (or nonstationarity) in many of the lamb model variables. Unit roots may cause spurious regression results (i.e., unreliable asymptotic t-values and inconsistent parameter estimators) if the equations to be estimated are not cointegrated (Johnston and DiNardo, 1997). However, ADF tests of OLS residuals of each lamb equation rejected the null hypothesis of unit roots at the α = 0.05 level. Thus, the model was estimated in data-level form (but with all variables in natural logarithms).

Wu-Hausman tests were conducted to identify potential joint endogeneity in the right-hand-side variables (Johnston and DiNardo, 1997). The rational lag structure of Eq. (6.83) resulted in insignificant coefficients for several contemporaneous prices, leaving only lag orders of t–1 as statistically significant (particularly in the supply equations). Thus, Wu-Hausman tests were conducted only in the equations with significant slope coefficients on current period (t) prices (primarily the demand functions). Results for those equations failed to reject the null hypothesis of no simultaneous equations bias at the α = 0.05 level.

Based on the lamb model assumptions and statistical tests, the Eviews 5.1 SUR estimator with iterative nonlinear GLS solutions was used because of the potential for a nondiagonal covariance matrix and AR errors (Quantitative Micro Software, 2004). Because the model is specified with equilibrium quantities as dependent variables, the demand and supply equations are estimated in separate blocks to reduce demand and supply identification problems.

In applied agricultural economics research, demand and supply equations are often econometrically estimated using a combination of inverse and ordinary demand and supply functions to aid in identifying supply and demand functions (Eales and Unnevehr, 1993; Eales, 1996; Marsh, 2003; Babula, 1997). However, the equilibrium displacement model for lamb is specified such that estimates of elasticities (rather than flexibilities) of demand and supply are required. Theoretically, the inverses of price flexibilities obtained from inverse demand and/or supply functions provide lower-bound estimates for elasticities. Empirically, these inverses often generate unreasonably large elasticity estimates. We investigated this issue by estimating the demand functions of our model as price-dependent relations. This approach yielded several inconsistencies among estimates across the model. Therefore, we ameliorated the identification issues by estimating ordinary demand functions and ordinary supply functions in separate regression blocks.

Finally, the entire rational distributed lag model was also estimated using quarterly data. However, a lack of consistently reported quarterly data required the use of a variety of proxies to complete each series. Consequently, empirical results of the quarterly model were determined to be inferior to the results of the annual model for the purposes of this study.

6.5 EMPIRICAL RESULTS

Table 6-2 presents SUR estimates for lamb market-level demand and supply elasticities, and Table 6-3 presents the SUR estimates of the lamb market-level transmission elasticities. The empirical results support the rational lag hypotheses because each equation contains a significant parameter estimate of the lagged dependent variable for first-order difference equations or geometric distributed lags (Pindyck and Rubinfeld, 1998). However, the sheep breeding or stock adjustment equation (of supply) was estimated as a second-order difference equation with two real roots resulting in dampened polynomial lags (Griliches, 1967). Based on Durbin h tests, the demand and supply equations did not require AR error corrections in the GLS estimator.

Table 6-3. Parameter Definitions, Quantity Transmission Elasticity Estimates, and Variances

Parameter	Definition	Estimate[a]	Standard Deviation[a]
τ_d^{rw}	Percentage change in domestic wholesale lamb quantity given a 1% change in domestic retail lamb quantity	0.839	0.066
τ_i^{rw}	Percentage change in imported wholesale lamb quantity given a 1% change in imported retail lamb quantity	1.027	0.024
τ_d^{ws}	Percentage change in domestic slaughter lamb quantity given a 1% change in domestic wholesale lamb quantity	0.999	0.008
τ_d^{sf}	Percentage change in domestic feeder lamb quantity given a 1% change in domestic slaughter lamb quantity	1.075	0.060
τ_d^{wr}	Percentage change in domestic retail lamb quantity given a 1% change in domestic wholesale lamb quantity	0.843	0.069
τ_i^{wr}	Percentage change in imported retail lamb quantity given a 1% change in imported wholesale lamb quantity	0.892	0.021
τ_d^{ws}	Percentage change in domestic wholesale lamb quantity given a 1% change in domestic slaughter lamb quantity	1.008	0.008
τ_d^{fs}	Percentage change in domestic slaughter lamb quantity given a 1% change in domestic feeder lamb quantity	0.783	0.042

[a] These estimates are obtained from the structural model that is presented later in the report.

The SUR blocks indicated contemporaneously correlated errors, with zero-order correlations running as high as 0.89 within the demand block and as high as 0.95 within the supply block. The systems estimator also provided the standard errors and covariances of the parameter estimates required for the equilibrium displacement model (Brester, Marsh, and Atwood, 2004). The adjusted R^2's and standard errors of regression are presented but should be interpreted with caution because of the GLS error covariance transformations of the product moment matrices (Greene, 2003).

Estimating fully specified supply and demand models is necessary to obtain consistent estimates of the elasticities needed to implement the equilibrium displacement model. In general, the following discussion of the estimated elasticities focuses on those that are used in the equilibrium displacement model.

6.5.1 Domestic Demand

SUR estimators provide consistent elasticity estimates for use in the equilibrium displacement model. All of the estimates of interest (own-price and cross-price elasticities) are significantly different from zero at the α = 0.05 level.[1] The price elasticities follow two patterns that are consistent with stable difference equations and marketing margin behavior (Griliches, 1967; Tomek and Robinson, 1990). First, the short-run elasticities are considerably smaller than the long-run elasticities. This suggests that consumers and intermediate purchasers are influenced by habit formations and institutional rigidities (Pollack, 1970). These expectations are manifest in partial adjustment processes as evidenced by significant and less-than-unity coefficient estimates on lagged dependent variables. Second, the absolute value of demand elasticity coefficients decrease from the retail level to the farm level. This is consistent with relative price spreads and primary and derived demand theory (Gardner, 1975; Tomek and Robinson, 1990; Wohlgenant, 1989).

Table 6-2 summarizes the demand elasticity estimates obtained from the SUR estimates presented in Tables 6-4 through 6-7. The long-run elasticities are calculated by dividing the short-run elasticities by 1.0, minus the estimated coefficients of the

[1] Some of the parameter estimates (elasticities) in the demand block were not statistically different from zero at the α = 0.05 level. The meat demand binary variable (MD) was omitted from several demand equations, and the import duty binary variable (ID) was omitted from the wholesale lamb demand equation.

Table 6-4. SUR (Double Log) Estimates of Domestic and Imported Retail Lamb Demand

Regressors	Dependent Variables: Domestic Retail Lamb Demand $\left(Q_L^{dr}\right)$	Dependent Variables: Imported Retail Lamb Demand $\left(Q_L^{ir}\right)$
Constant	5.109 (2.038)	–24.485 (–3.765)
Domestic retail lamb price $\left(P_L^{dr}\right)$	–0.523 (–3.277)	0.775 (2.352)
Imported retail lamb price $\left(P_L^{ir}\right)$	0.293 (2.516)	
Retail beef price $\left(P_b^{r}\right)$	–0.041 (–0.352)	0.576 (1.490)
Retail pork price $\left(P_K^{r}\right)$	–0.201 (–1.489)	0.309 (0.773)
Retail poultry price $\left(P_Y^{r}\right)$	0.350 (2.033)	0.600 (1.200)
Per capita expenditures (*Y*)	–0.567 (–1.390)	1.667 (1.861)
Meat binary variable (*MD*)	0.254 (4.707)	1.524 (7.852)
Import binary variable (*ID*)	0.054 (2.324)	
Lagged domestic retail lamb demand $\left(Q_{Lt-1}^{dr}\right)$	0.528 (6.913)	
Lagged imported retail lamb price $\left(P_{Lt-1}^{ir}\right)$		–0.407 (–1.549)
Lagged imported retail lamb demand $\left(Q_{Lt-1}^{ir}\right)$		0.355 (4.209)
Trend (*T*)	0.003 (0.307)	0.043 (1.826)
Regression Statistics:		
Adjusted R^2	0.958	0.911
Standard error of the regression	0.051	0.176
Log mean of the dependent variable	0.351	–3.970

Table 6-5. SUR (Double Log) Estimates of Domestic and Import Wholesale Lamb Demand

Regressors	Dependent Variables	
	Domestic Wholesale Lamb Demand $\left(Q_L^{dw}\right)$	**Imported Wholesale Lamb Demand** $\left(Q_L^{iw}\right)$
Constant	2.040 (2.056)	–10.508 (–4.347)
Domestic wholesale lamb price $\left(P_L^{dw}\right)$	–0.350 (–5.478)	
Domestic retail lamb price $\left(P_L^{dr}\right)$	0.039 (0.480)	
Wholesale beef price $\left(P_B^{w}\right)$	–0.020 (–0.425)	0.513 (1.742)
Wholesale pork price $\left(P_K^{w}\right)$	–0.010 (–0.213)	0.110 (0.655)
Wholesale poultry price $\left(P_Y^{w}\right)$	–0.049 (–0.892)	0.726 (2.056)
Food marketing costs (M_c)	–0.068 (–0.410)	
Trend (T)	–0.017 (–5.269)	0.089 (4.877)
Lagged domestic wholesale lamb demand $\left(Q_{Lt-1}^{dw}\right)$	0.661 (10.474)	
Lagged imported wholesale lamb price $\left(P_{Lt-1}^{iw}\right)$		–0.228 (–1.888)
Lagged domestic wholesale lamb price $\left(P_{Lt-1}^{dw}\right)$		0.555 (2.462)
Exchange rate (E_x)		–0.074 (–0.435)
Meat binary variable (MD)		1.568 (7.667)
Lagged imported wholesale lamb demand $\left(Q_{Lt-1}^{iw}\right)$		0.440 (5.734)
Regression Statistics:		
Adjusted R^2	0.973	0.901
Standard error of the regression	0.040	0.202
Log mean of the dependent variable	–1.132	–2.951

Table 6-6. SUR (Double Log) Estimates of Domestic Slaughter Lamb and Ewe Demand

Regressors	Dependent Variables	
	Domestic Slaughter Lamb Demand $\left(Q_L^{ds}\right)$	Domestic Ewe Demand $\left(Q_L^{de}\right)$
Constant	5.513 (4.233)	11.324 (3.280)
Domestic slaughter lamb price $\left(P_L^{ds}\right)$	–0.333 (–7.670)	
Lagged domestic wholesale lamb price $\left(P_{Lt-1}^{dw}\right)$	–0.011 (–0.196)	
Food marketing costs (M_c)	–0.217 (–1.456)	–1.109 (–2.254)
Lamb by product price (P_{bp})	0.036 (2.961)	0.092 (1.720)
Lamb packer concentration (K)	–0.062 (–1.668)	–0.085 (–0.517)
Trend (T)	–0.016 (–5.436)	–0.033 (–4.678)
Lagged domestic slaughter lamb demand $\left(P_{Lt-1}^{ds}\right)$	0.615 (9.529)	
Slaughter ewe price $\left(P_L^{de}\right)$		–0.245 (–2.605)
Domestic wholesale lamb Price $\left(P_L^{dw}\right)$		–0.281 (–1.836)
Meat binary variable (MD)		–0.150 (–1.602)
Lagged domestic ewe demand $\left(Q_{Lt-1}^{de}\right)$		0.385 (3.877)
Regression Statistics:		
Adjusted R^2	0.980	0.919
Standard error of the regression	0.035	0.108
Log mean of the dependent variable	6.484	3.687

Table 6-7. SUR Double Log Estimates of Domestic Feeder Lamb, Domestic Wool, and Imported Wool Demand

	Dependent Variables		
Regressors	**Domestic Feeder Lamb Demand** $\left(Q_L^{df}\right)$	**Domestic Wholesale Wool Demand** $\left(Q_w^{dw}\right)$	**Imported Wholesale Wool Demand** $\left(Q_L^{df}\right)$
Constant	1.297 (2.907)	7.983 (1.058)	11.039 (1.361)
Domestic feeder lamb price $\left(P_L^{df}\right)$	–0.112 (–2.339)		
Lagged lamb-corn price ratio $\left(R_{t-1}^{f}\right)$	0.055 (1.828)		
Trend (*T*)	–0.015 (–3.612)	0.029 (1.112)	–0.024 (–0.671)
Lagged domestic feeder lamb demand $\left(Q_{Lt-1}^{df}\right)$	0.606 (5.615)		
Lagged domestic wholesale wool price $\left(P_{w\,t-1}^{dw}\right)$		–0.126 (–1.390)	0.522 (2.731)
Lagged cotton price ($P_{c\ t-1}$)		0.255 (2.047)	0.256 (1.420)
Expenditures (Y_x)		–1.080 (–1.105)	–1.148 (–1.046)
Lagged domestic wholesale wool demand $\left(Q_{w\,t-1}^{dw}\right)$		0.922 (9.480)	
Imported wholesale wool price $\left(P_w^{iw}\right)$			–0.647 (–3.215)
Exchange rate $\left(E_z^{u}\right)$			–0.811 (–3.890)
Meat binary variable (*MD*)			0.329 (1.581)
Lagged imported wholesale wool $\left(Q_{w\,t-1}^{iw}\right)$			0.661 (6.961)
<u>*Regression Statistics:*</u>			
Adjusted R^2	0.98	0.739	0.793
Standard error of the regression	0.043	0.184	0.220
Log mean of the dependent variable	1.973	4.694	4.153

appropriate lagged dependent variables. The short-run and long-run retail demand elasticities for lamb are –0.523 and –1.108, respectively. This estimate is similar to other elasticities in the literature with the exception of Whipple and Menkhaus (1989), who reported a retail lamb demand elasticity of –3.96. The TAMRC industry study (1991) reported a retail lamb demand elasticity of –0.62, while the ITC (1999) used retail demand elasticities for lamb ranging from –0.75 to –1.25 for assessing the impact of lamb imports. Babula (1997) reported a similar estimate of –0.78. The cross elasticity of retail import price on retail domestic lamb consumption was inelastic at 0.293 in the short run and 0.621 in the long run. Other studies did not report this cross effect at the retail level. However, Babula (1997) reported a cross elasticity of domestic wholesale lamb demand with respect to the price of New Zealand lamb imports of 0.017.

The short-run and long-run demand elasticities at the wholesale level were –0.350 and –1.032, respectively. Both were more inelastic than the retail demand elasticities, which is consistent with Gardner's (1975) relative price spread theory. Whipple and Menkhaus (1989) reported a wholesale elasticity also consistent with margin theory, but the elasticity was highly elastic at –3.78. Our estimate is similar to that of Babula (1997), who reported a wholesale demand elasticity estimate of –0.78.

At the slaughter level, the short-run and long-run derived demand elasticities were both inelastic. For fed slaughter lambs, the elasticities were –0.333 and –0.865. For culled ewes, the short-run and long-run slaughter demand elasticities were –0.245 and –0.398. Whipple and Menkhaus (1989) reported a slaughter-level demand elasticity of –3.28, while Babula (1996) used simulated multipliers from a VAR model and obtained a slaughter demand elasticity of –0.699. The derived demand for feeder lambs represents the major input demanded by lamb finishers. The short-run and long-run demand elasticities at this level are relatively inelastic (–0.112 in the short run and –0.285 in the long run). Note that the lamb slaughter price/corn price ratio (a proxy for lamb finishing profitability) is also quite inelastic at 0.055 (see Table 6-7). The inelasticity of these coefficients suggests lamb feeders attempt to fully use feedlot capacities and feed lambs to specific slaughter weights and grades required by meat packers.

6.5.2 Lamb Import Demand

The retail and wholesale import demands for lamb are characterized by statistically significant coefficients with signs that meet a priori expectations for the own-price and cross-price effects (Tables 6-4 and 6-5). For the retail import demand equation, the short-run own-price (or import price) and cross-price (with respect to U.S. price) elasticities of demand were –0.407 and 0.775 (Table 6-4). The respective long-run elasticities were –0.631 and 1.202. For the wholesale import demand equation, the short-run own-price and cross-price elasticities of demand were –0.228 and 0.555 (Table 6-5). The long-run own-price and cross-price elasticities of demand were –0.407 and 0.991. Babula (1997) estimated U.S. wholesale import demands for New Zealand lamb and Australian lamb. Import own-price elasticity was estimated as –0.08 for New Zealand and –1.14 for Australia. Babula's cross-price elasticity of demand for New Zealand lamb with respect to U.S. lamb price was 2.20. However, his cross-price elasticity of demand estimate Australian lamb with respect to U.S. lamb price was –1.69, which has an a priori incorrect sign. Overall, Babula's (1997) relative magnitudes of own-price and cross-price effects (especially for New Zealand lamb) are similar to those found in our model at the wholesale level. He concluded that the U.S. market considers imports from Australia and New Zealand as close substitutes, but his study was not definitive concerning the degrees to which U.S. consumers differentiate between U.S.-produced lamb and imported lamb.

6.5.3 Wool Demand

Wool demand in the model comprises domestic and import demands for clean, graded scoured wool that is used for processing into apparel, carpets, etc. (USDA/NASS, 2004a). U.S. wool production and wool imports have significantly declined because of a combination of declining sheep numbers and increased demand for synthetic and cotton fibers. For example, from 1970 to 2003 U.S. wool production declined from 161.6 million pounds to 38.5 million pounds, or 76%, while imports of wool (primarily from Australia) declined from 126.9 million pounds to 21.8 million pounds, or 83%. In 2003, imported wool accounted for 36% of U.S. clean wool supplies, which compares to a 44% market share in 1970.

Although estimated wool elasticities are not used in the equilibrium displacement model, they are briefly discussed in this section for comparison with those reported in other published research. The short-run demand elasticity for domestic wool is estimated to be –0.126 (Table 6-7), and the long-run demand elasticity is –1.615. Babula's (1996) simulated multipliers from a VAR lamb and wool model indicated a domestic wool demand elasticity of –0.385.[2] The price of upland cotton was statistically significant with elasticity coefficients of 0.255 in the short run and 1.540 in the long run. This result indicates the importance of the price of fiber substitutes on the demand for wool.

The own-price elasticity of demand for U.S. wool imports is –0.647 in the short run and –1.909 in the long run. The cross effect of U.S. cotton price on import wool demand is statistically weak with a short-run elasticity coefficient of 0.256 and a long-run elasticity coefficient of 0.755.

6.5.4 Demand Quantity Transmission Elasticities

Estimates of quantity transmission elasticities are used in the equilibrium displacement model to provide linkage between the vertically connected demand sectors. These estimates are obtained from the SUR estimation of four equations separate from the structural model. The transmissions elasticity estimates are summarized in Table 6-3. Table 6-8 provides the complete SUR estimation results of regressing the appropriate quantity variable at each level onto the appropriate upstream quantity variable. Double log specifications are used so that resulting parameter estimates are interpreted as transmission elasticities.

6.5.5 Supply

The supply block of the lamb model consists of equations for breeding stock, lamb crop, lamb slaughter, culled ewe slaughter, wholesale lamb, and domestic wool production (Tables 6-9 through 6-11). Retail lamb supply is based on primary feeder lamb supply and a price transmission relationship. A majority of the slope coefficients are statistically

[2] As noted in Section 6.2, contemporaneous and lagged values of the independent variable were included in initial specifications. For each variable, if either estimated coefficient was found to be not significantly different from zero, it was omitted from the final specification.

Table 6-8. SUR (Double Log) Demand Quantity Transmission Elasticities

	Dependent Variables			
Regressors	**Domestic Wholesale Lamb Quantity** $\left(Q_L^{dw}\right)$	**Imported Wholesale Lamb Quantity** $\left(Q_L^{iw}\right)$	**Domestic Slaughter Lamb Quantity** $\left(Q_L^{ds}\right)$	**Domestic Feeder Lamb Quantity** $\left(Q_L^{df}\right)$
Constant	–1.429 (–47.099)	1.121 (11.646)	7.616 (826.479)	–0.903 (–2.303)
Domestic retail lamb quantity $\left(Q_L^{dr}\right)$	0.839 (12.794)			
Imported retail lamb quantity $\left(Q_L^{ir}\right)$		1.027 (42.632)		
Domestic wholesale lamb quantity $\left(Q_L^{dw}\right)$			0.999 (124.265)	
Domestic slaughter lamb quantity $\left(Q_L^{ds}\right)$				1.075 (17.849)
Regression Statistics:				
Adjusted R^2	0.882	0.977	0.998	0.897
Standard error of the regression	0.109	0.098	0.012	0.101
Log mean of the dependent variable	–1.117	–2.926	6.550	6.086

significant at the α = 0.10 level (trend variables were omitted). All own-price supply elasticities are significant at the α = 0.05 level. The rational lag structure resulted in substantial differences between short-run and long-run supply elasticities. For livestock production, biological rigidities are generally manifest in relatively inelastic short-run supply responses. However, in the long run, relaxed biological constraints and near constant-returns-to-scale technologies cause relatively large supply responses (Marsh, 2003; Wohlgenant, 1989). The following discussion primarily focuses on those supply elasticities that are used in the equilibrium displacement model.

The primary supply of lambs consists of two equations: the breeding inventory equation and lamb crop equation. Breeding inventories represent the production base for producing young lambs. Thus, the breeding ewe function recursively determines the lamb crop. The short-run and long-run sheep breeding inventory elasticities are 0.096 and 2.526, respectively

Table 6-9. SUR (Double Log) Estimates of Domestic Lamb Crop and Breeding Ewe Supply

Regressors	Dependent Variables: Domestic Feeder Lamb Supply $\left(Q_L^{df}\right)$	Dependent Variables: Domestic Breeding Ewe Supply $\left(Q_{be}\right)$
Constant	0.209 (1.695)	0.069 (0.521)
Breeding sheep inventory $\left(Q_{be}\right)$	0.895 (18.632)	
Trend (*T*)	0.001 (0.514)	
Lagged domestic feeder lamb price $\left(Q_{Lt-1}^{df}\right)$		0.096 (2.878)
Lagged hay price $\left(P_{hy\,t-1}\right)$		–0.107 (–2.670)
Lagged domestic wool price $\left(P_{w\,t-1}\right)$		0.031 (1.827)
Lagged price of slaughter ewes $\left(P_{L\,t-1}^{de}\right)$		–0.029 (–0.846)
Lagged domestic breeding ewe supply $\left(Q_{be\,t-1}\right)$		1.309 (11.972)
Lagged domestic breeding ewe supply $\left(Q_{be\,t-2}\right)$		–0.347 (–3.224)
Regression Statistics:		
Adjusted R^2	0.991	0.991
Standard error of the regression	0.029	0.031
Log mean of the dependent variable	1.991	1.936

(Table 6-9). The long-run period corresponds to Van Tassell and Whipple's (1994) 8- to 10-year sheep cycle. Whipple and Menkhaus (1989) reported a 3-year sheep breeding supply elasticity of 0.87 and a long-run supply breeding elasticity of 3.05. Vere, Griffith, and Jones (2000) reported short-run and long-run supply elasticities for Australian breeding stock inventories of 0.095 and 2.530, respectively.

The model's lamb crop equation is specified as a static function of the breeding herd inventory. However, the dynamics of breeding stock imply dynamics in the lamb crop. The comparative static relationship between the two functions can be demonstrated by

Table 6-10. SUR (Double Log) Estimates of Domestic Slaughter Lamb and Slaughter Ewe Supply

Regressors	Dependent Variables	
	Domestic Slaughter Lamb Supply $\left(Q_L^{ds}\right)$	Domestic Slaughter Ewe Supply $\left(Q_L^{de}\right)$
Constant	0.255 (0.947)	2.025 (4.472)
Lagged domestic slaughter lamb price $\left(P_{Lt-1}^{ds}\right)$	0.118 (2.255)	
Domestic feeder lamb price $\left(P_L^{df}\right)$	–0.166 (–4.829)	
Lagged corn price $\left(P_{nt-1}\right)$	–0.046 (–2.383)	
Domestic wool price $\left(P_w\right)$	0.054 (2.540)	0.085 (1.550)
Lagged domestic slaughter lamb supply $\left(Q_{Lt-1}^{ds}\right)$	0.960 (25.536)	
Domestic slaughter ewe price $\left(P_L^{de}\right)$		–0.306 (–3.814)
Hay price $\left(P_{hy}\right)$		–0.032 (–0.262)
Breeding sheep inventory $\left(Q_{be}\right)$		0.687 (5.419)
Lagged slaughter ewe supply $\left(Q_{Lt-1}^{de}\right)$		0.298 (3.040)
Regression Statistics:		
Adjusted R^2	0.960	0.933
Standard error of the regression	0.049	0.097
Log mean of the dependent variable	6.484	3.687

Table 6-11. SUR (Double Log) Estimates of Domestic Wholesale Lamb and Wool Supply

	Dependent Variables	
Regressors	**Domestic Wholesale Lamb Supply** $\left(Q_L^{dw}\right)$	**Domestic Wholesale Wool Supply** $\left(Q_w^{dw}\right)$
Constant	0.098 (0.130)	2.491 (8.525)
Domestic wholesale lamb price $\left(P_L^{dw}\right)$	0.158 (2.281)	
Domestic slaughter lamb price $\left(P_L^{ds}\right)$	–0.235 (–4.080)	
Lamb by product price $\left(P_{bp}\right)$	0.055 (2.498)	
Food labor costs $\left(L_c\right)$	–0.035 (–0.236)	
Lagged domestic wholesale lamb supply $\left(Q_{L\,t-1}^{dw}\right)$	0.959 (26.243)	
Domestic wholesale wool price $\left(P_w^{dw}\right)$		0.032 (2.868)
Wool support price $\left(P_{sw}\right)$		0.133 (5.932)
Domestic feeder lamb supply $\left(Q_L^{df}\right)$		0.767 (10.294)
Wool binary variable (*WD*)		–1.584 (–5.869)
Lagged domestic wholesale wool supply $\left(Q_{w\,t-1}^{dw}\right)$		0.273 (3.980)
Regression Statistics:		
Adjusted R^2	0.957	0.995
Standard error of the regression	0.051	0.028
Log mean of the dependent variable	–1.132	4.418

$$Q_t^b = \alpha_0 + \alpha_1 P_{t-1} + \alpha_2 Z_t + \lambda Q_{t-1}^b \tag{6.88}$$

$$Q_t^L = \beta_0 + \beta_1 Q_t^b + \beta_2 T \,, \tag{6.89}$$

where Q_t^b is quantity supplied of breeding stock, P_{t-1} is lagged output price, Z_t is a vector of relevant exogenous variables, Q_t^L is quantity of lamb crop, and T is trend. For the first-order difference equation, Eq. (6.88), the dynamic adjustment to a shock in P_{t-1} is

$$\partial Q_t^b \ / \ \partial P_{t-1-j} = \alpha_1 \left(1 + \lambda + \lambda^2 + \lambda^3 + \ldots\right) \quad j = 0, 1, 2, \ldots \tag{6.90}$$

with the short-run elasticity of supply given as α_1 and the long-run elasticity of supply solved as $\alpha_1/(1-\lambda)$ (Pindyck and Rubinfeld, 1998). Because the marginal (first-derivative) relationship between the two functions is

$$\partial Q_t^L \ / \ \partial Q_t^b = \beta_t \ , \tag{6.91}$$

multiplying α_1 and $\alpha_1/(1-\lambda)$ by β_1 provides estimates of short-run and long-run lamb crop supply elasticities. Specifically, the short-run lamb supply elasticity of 0.086 is obtained by multiplying the breeding sheep inventory elasticity of 0.895 by the lagged feeder lamb price coefficient of 0.096 (Table 6-9). The long-run feeder lamb supply elasticity is obtained by first adding the two difference equation estimates in the ewe supply equation (1.309 + (–0.347)). The sum (0.962) is then subtracted from 1.0 to obtain 0.038. The short-run feeder lamb supply elasticity is then divided by 0.038 to obtain a long-run estimate of 2.261. Wool price is a significant factor in the breeding inventory equation. The short-run and long-run elasticity of sheep breeding inventory with respect to wool price is 0.031 and 0.821, respectively. Vere, Griffith, and Jones (2000) normalized feeder lamb price by wool price in the Australian breeding inventory equation. However, Whipple and Menkhaus (1989) explicitly measured wool price in the breeding stock equation and obtained a wool elasticity of 1.38. In our model, the support price of wool was not statistically significant and, therefore, was omitted from the breeding inventory equation.

The slaughter supply of fed lambs is positively affected by slaughter lamb price, with short-run and long-run own-price supply elasticities of 0.118 and 2.950, respectively (Table 6-10). Whipple and Menkhaus (1989) estimated short-run and long-run supply elasticities for slaughter lamb as 0.01 and 2.83, respectively. Note that pelt (by-product) price is statistically significant with short-run and long-run price elasticities of 0.054 and 1.35. Whipple and Menkhaus (1989) also indicated that the elasticity of lamb slaughter with respect to pelt price (using wool price as a proxy) was significant with a long-run estimate of 1.38 for a 10-year sheep cycle.

The price elasticities in the ewe slaughter supply equation are statistically significant, but the negative coefficients are contrary to theoretical expectations (Table 6-10). For example, the short-run and long-run supply elasticities are –0.306 and –0.436, respectively.[3] Negative supply elasticities often occur in models of livestock-meat supply relationships because of problems created by multicollinearity, units of observation, or the withholding or acceleration of marketings because of changing price expectations (Nelson and Spreen, 1978; Marsh, 1994). Pelt price shows a positive effect on cull slaughter but is statistically weak.

The wholesale supply of lamb (carcass weight) is derived from primary production of lambs and dressed weights of slaughter lambs. The behavioral relationship indicates lamb packers positively respond to wholesale price changes and negatively respond to changes in the input price of slaughter lambs (Table 6-11). The coefficient for food labor costs was not statistically significant. The short-run and long-run own-price elasticities of wholesale supply are 0.158 and 3.854, respectively, while the slaughter price elasticities were –0.235 and –5.875, respectively. Babula (1997) estimated an inverse lamb supply elasticity of 0.352 at the wholesale level. Inverting this estimate results in a wholesale lamb supply elasticity estimate of 2.84.

The retail supply elasticity could not be estimated because of multicollinearity problems. Therefore, a retail supply elasticity of lamb ϵ^{dr} was imputed using Gardner's (1975) model assuming fixed input proportions between primary farm supply and derived retail supply. Gardner's formula is

$$\epsilon^{dr} = \left(\partial \ln Q_L^{df} \;/\; \partial \ln P_L^{df}\right) \times \left(\partial \ln P_L^{df} \;/\; \partial \ln P_L^{df}\right), \qquad (6.92)$$

where the first term on the right-hand side is the primary elasticity of feeder lamb supply (short run = 0.086, long run = 2.261), and the second term is the estimated price transmission elasticity of lamb feeder supply price with respect

[3] Although these elasticities do not meet *a priori* expectations, the inclusion of the ewe supply equation is used to avoid omitted variable bias. These supply elasticities, however, are not needed for the equilibrium displacement model.

to lamb retail supply price. The following nonlinear least squares regression was used to estimate the price transmission elasticity:

$$\ln P_L^{df} = -4.726 + 1.569 \ln P_L^{dr} + 0.703 u_{t-1}, \qquad (6.93)$$

where u_{t-1} is a first-order autoregressive error term. The price transmission estimate of 1.569 was used in Eq. (6.92) to obtain short-run (0.151) and long-run (3.963) retail supply elasticities.

A wholesale supply function for wool was estimated to account for the equilibrium relationship in the wool market (wholesale wool demand estimated above). Because wool is a co-product of lamb production, lamb crop, wool price, and wool support price were specified in the supply equation. The lamb crop elasticity coefficient is 0.767, indicating that for every 1% increase in the lamb crop, wool supplies increase by 0.77% (Table 6-11). The short-run and long-run wool supply elasticities with respect to wool market price are 0.032 and 0.044, respectively, while the commensurate length-of-run elasticities for wool support price payments are 0.133 and 0.183. Whipple and Menkhaus (1990) did not estimate a support price elasticity for wool, but their free market price elasticity for wool supply was 1.38. Babula's (1996) VAR and simulated multiplier analysis yielded a wool supply elasticity of 0.27. Vere, Griffith, and Jones (2000) estimated the Australian wool supply elasticities to be about 0.05 in the short run and 0.24 in the long run.

Supply functions for U.S. imports of wholesale and retail lamb meat and imports of wholesale wool were not estimated. It is assumed that under the Tariff Rate Quotas (TRQ) established by GATT and the WTO, import supplies facing the United States are highly elastic (i.e., changes in U.S. demand for these imports would have negligible effects on import prices up to the TRQ) (Babula, 1997). Consequently, for the equilibrium displacement model, an arbitrary large supply elasticity coefficient of 10.0 was assumed for wholesale- and retail-level lamb import supplies.

6.5.6 Supply Quantity Transmission Elasticities

Estimates of quantity transmission elasticities are used in the equilibrium displacement model to provide a linkage between the vertically connected supply sectors. These estimates were obtained from the SUR estimation of four equations separate from the structural model. The supply quantity transmission elasticities are summarized in Table 6-3. Table 6-12 provides the complete SUR results of regressing the appropriate quantity variable at each level onto the appropriate downstream quantity variable. Double log specifications are used so that resulting parameter estimates are interpreted as transmission elasticities.

Table 6-12. SUR (Double Log) Supply Quantity Transmission Elasticities

	Dependent Variables			
Regressors	**Domestic Retail Lamb Quantity** $\left(Q_L^{dr}\right)$	**Imported Retail Lamb Quantity** $\left(Q_L^{i}\right)$	**Domestic Wholesale Lamb Quantity** $\left(Q_L^{dw}\right)$	**Domestic Slaughter Lamb Quantity** $\left(Q_L^{ds}\right)$
Constant	1.313 (16.612)	–1.329 (–20.920)	–7.670 (–145.490)	1.737 (6.755)
Domestic wholesale lamb quantity $\left(Q_L^{dw}\right)$	0.843 (12.285)			
Imported wholesale lamb quantity $\left(Q_L^{iw}\right)$		0.892 (42.286)		
Domestic slaughter lamb quantity $\left(Q_L^{ds}\right)$			1.008 (124.265)	
Domestic feeder lamb quantity $\left(Q_L^{df}\right)$				0.783 (18.550)
Regression Statistics:				
Adjusted R^2	0.806	0.977	0.998	0.904
Standard error of the regression	0.121	0.093	0.013	0.080
Log mean of the dependent variable	0.372	–3.940	–1.117	6.550

6.5.7 Elasticity Summary

SUR estimation of annual rational distributed lag demand and supply equations in the lamb marketing channel yielded statistically significant price elasticity estimates that were generally consistent with *a priori* expectations. That is, coefficient signs were consistent with theoretical constructs, and long-run elasticities were more elastic than short-run elasticities because technical, biological, and institutional constraints are less restrictive over time. Some of the market-level elasticities were comparable to other lamb studies. For some of the data series, missing observations were imputed from observed data.

The estimated model also yielded price elasticities across sectors that conform to relative price spreads and primary and derived demand and supply expectations. That is, regardless of whether agricultural markets are characterized by fixed or variable input proportions, margin theory would indicate smaller demand elasticities proceeding from primary demand to derived demands and larger elasticities proceeding from primary supply to derived supplies (Gardner, 1975; Wohlgenant, 1989). The consistency of these results lends credibility to the market-level economic surplus measurements in the equilibrium displacement model (Brester, Marsh, and Atwood, 2004).

6.6 OLIGOPSONY MARKDOWN PRICING

Eq. (6.25) in the equilibrium displacement model indicates that potential oligopsony power in the domestic wholesale processing sector may drive a price wedge between the derived demand price of slaughter lambs (P_L^{dsd}) and the derived supply price of slaughter lambs (P_L^{dss}). The variable ρ represents the ratio P_L^{dsd} / P_L^{dss}. Thus, in the absence of oligopsony markdown power, the value of ρ equals 1 as $P_L^{dsd} = P_L^{dss}$. The value of ρ increases as oligopsony power increases. As illustrated in Figure 6-4, increases in potential market power would cause a larger price wedge between P_L^{dsd} and P_L^{dss} and reductions in quantity from the perfectly competitive market equilibrium.

6.6.1 Estimates of Oligopsony Markdown Price Distortions

Published estimates of the degree of oligopsony markdown power are not available for the lamb industry. In addition, the direct estimation of a markdown model is not possible because of data limitations. Therefore, we use estimates of markdown pricing from the beef industry as a proxy for markdown pricing in the lamb industry within the equilibrium displacement model. The beef and lamb processing industries have approximately the same concentration ratios and use similar technologies. Hence, estimates from the beef industry should be reasonable proxies for the lamb processing industry.

Schroeter (1988) extended Appelbaum's (1979, 1982) model for estimating monopoly market power to the estimation of monopsony price distortions in the slaughter cattle market. Using annual data from 1951 to 1983, Schroeter reported markdown price distortions ranging from 0.009 to 0.025 depending on the year. The average price distortion for the reported years was 0.013. This corresponds to an estimate of ρ of 1.013.

Azzam and Schroeter (1991) considered the degree of oligopsony price distortions across 13 regional slaughter cattle markets in 1986. Their estimate of markdown price distortions was less than 1%. This was a lower estimate of price distortions than the 1.2% to 2.5% estimates reported by earlier research (Menkaus, St. Clair, and Ahmaddaud, 1981; Quail et al., 1986; Ward, 1981). Koontz, Garcia, and Hudson (1993) used data from 1980 to 1986 and estimated slaughter cattle price distortions of 0.5% to 0.8% in a dynamic model of two-phase collusive pricing strategies. Muth and Wohlgenant's (1999) estimate of oligopsony markdown price behavior was not statistically different from zero using a variety of functional forms for the beef industry. Using quarterly data from 1978 to 1993, Weliwita and Azzam (1996) estimated oligopsony price distortions of 2.7% for fed cattle markets during a time of declining beef demand. Stiegert, Azzam, and Brorsen (1993) reported monopsony markdown pricing estimates ranging from 0% to 3.8% depending on the year considered. The average of their annual estimates was 1.31%.

6.6.2 Effects of Oligopsony Markdowns

The above estimates of oligopsony markdown price distortions in slaughter cattle prices range from 0% to 3.8%. However, some have postulated that data limitations result in estimates of ρ that are biased downward. Hence, we assume that ρ ranges from 1.0 to 1.05. Because estimates vary, the equilibrium displacement model will treat ρ as a random variable that ranges between 1.0 and 1.05 with most of the mass centered over 1.015 (the median of reported estimates for the beef industry) for the slaughter lamb sector.

To allow for the possibility of market power, we assume the data used in the model have been generated by a lamb processing industry that has exercised small amounts of oligopsony pricing power in the slaughter lamb sector.

Therefore, although a restriction on the amount of a given AMA is likely to increase processing costs, it could also have an offsetting effect by reducing potential market power.

To illustrate this case, we use the elasticity estimates presented above to parameterize the equilibrium displacement model. Note that this is merely a simplified illustration. Simulations are presented in Section 6.10 that use actual estimates of changes in AMAs. For this illustration, assume that a reduction in an AMA increases processing costs by 5%. We further assume that ρ is equal to 1.015. The short-run (year 1) changes in equilibrium prices and quantities from a nonstochastic simulation are presented in the first column of Table 6-13. Prices and quantities change in the expected directions. For example, retail domestic lamb prices increase by 7.71%, while retail domestic lamb quantities decline by 4.02%. Imported retail and wholesale lamb prices and quantities all increase. Slaughter and feeder lamb prices and quantities all decline.

Table 6-13. Short-Run Percentage Changes in Prices and Quantities Given a 5% Increase in Wholesale Domestic Processing Costs (a Decrease in the Wholesale Domestic Derived Lamb Supply Function) and a 0.5 Percentage Point Reduction in Potential Market Power using a Nonstochastic Simulation

Endogenous Variables	No Change in Potential Market Power	A Reduction in Potential Market Power
Retail domestic lamb price	7.71%	7.62%
Retail domestic lamb quantity	–4.02%	–3.97%
Retail imported lamb price	0.06%	0.06%
Retail imported lamb quantity	5.95%	5.88%
Wholesale domestic lamb price	7.51%	7.42%
Wholesale domestic lamb quantity	–6.00%	–5.93%
Wholesale imported lamb price	0.60%	0.59%
Wholesale imported lamb quantity	5.98%	5.90%
Slaughter lamb demand price	–11.48%	–11.53%
Slaughter lamb supply price	–11.66%	–11.20%
Slaughter lamb quantity	–2.17%	–2.08%
Feeder lamb price	–11.77%	–11.31%
Feeder lamb quantity	–1.01%	–0.97%

The second column of Table 6-13 presents changes in equilibrium prices and quantities caused by a 5% increase in processing costs coupled with a 0.005 percentage point reduction in potential market power (i.e., a reduction in ρ from 1.015 to 1.01). The accompanying reduction in potential market power offsets some of the effects of the cost increases. Note that price and quantity changes are slightly smaller in this second case. The only exception is that the slaughter lamb demand price declines by 11.53% in this case rather than 11.48% in the preceding case. This represents a loss of potential market power by the processing sector.

6.7 QUALITY CHANGES CAUSED BY CHANGES IN PROCUREMENT METHODS

Restrictions on slaughter lamb procurement methods may potentially affect the quality of lamb meat. Changes in AMAs may influence genetic development, lamb feeding, nutrition, logistics, and price incentives related to quality. Changes in lamb meat quality are manifest in consumer demand. If domestic lamb quality is reduced, then consumer demand for domestic lamb meat will decline relative to other lamb (i.e., imported lamb) and lamb meat substitutes. Such a decline is then transferred to upstream derived demands for wholesale lamb meat, slaughter lambs, and feeder lambs. Although no direct measure of lamb meat quality is available at the retail level, MPR data provide measures of lamb carcass quality in terms of yield grades. Therefore, the impacts of changes in AMAs on carcass yield grades are used to proxy changes in lamb meat quality at the retail level.

Eq. (2.28) in Section 2.5 presented estimates of changes in yield grade on domestic retail demand prices. Eq. (4.2) in Section 4.3 presented the estimates of the effects of AMAs on carcass lamb quality. The results indicated that the procurement of slaughter lambs through packer ownership did not have a statistically significant effect on carcass quality. However, formula procurement directly influenced quality. These results are combined in the next section to calculate the impacts of a 25% and a 100% reduction in the use of AMAs to procure slaughter lambs.

6.7.1 Changes in Retail Demand (Meat Quality) Resulting from a 25% Reduction in Formula Slaughter Lamb Procurement

A comparative statics procedure is used to estimate the impacts on retail demand of a reduction in formula lamb procurement. Packer ownership did not have a statistically significant effect on lamb quality. The impacts are obtained by using the product of elasticities presented in Table 2-9 and Eq. (4.2). Specifically, the reduction in retail demand is given by

$$\frac{\%\Delta p_r}{\%\Delta pf} = \left(\frac{\%\Delta p_r}{\%\Delta YG}\right)\left(\frac{\%\Delta YG}{\%\Delta pf}\right) \times -25.0\,, \tag{6.94}$$

where the left-hand term is the percentage change in inverse retail lamb demand given a percentage change in formula procurement. The first term on the right side of Eq. (6.94) is the percentage change in retail price given a percentage change quality (yield grade, T_q), which was estimated based on Eq. (2.28). The second term on the right side represents the percentage change in yield grade caused by percentage change in formula procurement as presented in Eq. (4.2). The last term on the right side represents a 25% reduction in formula procurement.

Using estimates presented in Sections 2.5 and 4.3, a reduction in formula procurement is estimated to reduce retail lamb demand by 1.65% as calculated in Eq. (6.95):

$$(-0.422) \times (-0.157) \times (-25.0) = -1.65\%\,. \tag{6.95}$$

6.7.2 Changes in Retail Demand (Meat Quality) Resulting from a 100% Reduction in Formula Slaughter Lamb Procurement

Eq. (6.94) is also applied to the case in which formula lamb procurement is reduced by 100% (i.e., eliminated). Eq. (6.96) indicates that this scenario would result in a reduction of retail demand for domestic lamb meat of 6.63%:

$$(-0.422) \times (-0.157) \times (-100.0) = -6.63\%\,. \tag{6.96}$$

6.8 COST CHANGES CAUSED BY CHANGES IN PROCUREMENT METHODS

Restrictions on slaughter lamb procurement methods necessarily impose additional costs on lamb packers. Costs increase because of changes in market risk, transactions costs, and logistics (i.e., utilization of plant capacities). These costs may be absorbed by packers and/or reflected as changes in output and input prices of wholesale lamb and slaughter lamb, respectively.

6.8.1 Simulation Inputs for a 25% Reduction in Formula and Packer Owner Slaughter Lamb Procurement

Consider a new requirement that forces lamb packers to reduce their formula and packer ownership procurement of slaughter lambs by 25%. Theoretically, this is illustrated by an upward shift in the domestic wholesale derived supply function (Eq. [6.55]). Comparative statics of the monthly structural model presented above are used to estimate the size of this shift. We assume that the 25% reduction in both formula and packer ownership procurement will be reallocated to cash procurement. However, given that packer ownership procurement was not statistically significant in Eq. (2.29), the marginal impact of the decrease in packer ownership procurement is zero.

The marginal impact of the 25% reduction in formula procurement (*pf*) and packer ownership (*po*) is calculated using the estimated coefficient of –0.265, which measures the effects of a reduction in the lamb cut-out price (Table 2-9). The resulting change in wholesale slaughter supply costs equals:

$$\begin{gathered}\left(\frac{\partial p_{bx}}{\partial pf} \times -25.00\right) + \left(\frac{\partial p_{bx}}{\partial po} \times -25.00\right) = \\ (-0.265 \times -25.00) + (0.0 \times -25.00) = 6.63\% \end{gathered} \quad . \qquad (6.97)$$

Thus, slaughter costs are expected to increase by 6.63% because of the reduction in formula and packer ownership procurement methods. This is represented by a decrease in the domestic wholesale slaughter lamb supply function.

However, the reallocation of 25% of lamb procurement to the cash procurement (*pc*) will increase wholesale derived slaughter supply because of cost reductions. The marginal impact of this increase is calculated using the estimated coefficient (–0.217) for cash procurement (*pc*) (Table 2-9) such that wholesale slaughter supply equals:

$$\frac{\partial p_{bx}}{\partial pc} \times 25.0 = -0.217 \times 25.0 = -5.43\%. \qquad (6.98)$$

Thus, slaughter lamb costs are expected to decrease by 5.43% because of the increase in cash procurement. This is represented by an increase in the domestic wholesale slaughter supply function.

In summary, the net effect of a 25% reallocation of lamb procurement from formula and packer ownership methods to cash procurement is to increase slaughter costs by 1.20% (6.63% minus 5.43%). Thus, the domestic wholesale slaughter supply curve is shifted vertically upward by 1.20%.

6.8.2 Simulation Inputs for a 100% Reduction in Formula and Packer Ownership Slaughter Lamb Procurement

A second scenario is used to estimate cost changes resulting from a total ban on formula and packer procurement of slaughter lambs. Following the above example, 100% of packer ownership lamb procurement is allocated to cash procurement but does not have a statistically significant effect on wholesale supply. However, the reallocation of 100% of formula procurement to cash procurement increases wholesale slaughter supply costs. The cost increase caused by this reallocation equals

$$\begin{gathered}\left(\frac{\partial p_{bx}}{\partial pf} \times -100.0\right) + \left(\frac{\partial p_{bx}}{\partial po} \times -100.0\right) = \\ \left(-0.265 \times -100.0\right) + \left(0.0 \times -100.0\right) = 26.5\%\end{gathered}. \qquad (6.99)$$

The cost reduction caused by this reallocation equals

$$\frac{\partial p_{bx}}{\partial pc} \times 100.0 = -0.217 \times 100.0 = -21.7\%. \qquad (6.100)$$

The net effect of a 100% reallocation of formula and packer ownership lamb procurement to the cash procurement method is to increase slaughter costs by 4.80% (26.5% minus 21.7%). Thus, the domestic wholesale slaughter supply curve is shifted upward and to the left by 4.80% in this scenario.

6.9 ESTIMATED CHANGES IN POTENTIAL MARKET POWER CAUSED BY CHANGES IN PROCUREMENT METHODS

If present, oligopsony power in the lamb packing sector is likely manifest in downward pressure on slaughter lamb prices. Figure 6-4 illustrated the hypothetical market power impacts as a wedge between slaughter lamb demand price and slaughter lamb supply price. The size of this wedge depends on the relative size of oligopsony power. Nonetheless, if oligopsony market power is related to AMAs, then reductions in formula and packer ownership procurement should reduce market power and narrow the difference between slaughter lamb demand and supply prices.

Eqs. (2.28) through (2.33) were used to obtain an estimate of the impact of formula procurement and packer ownership on potential market power. The following two sections present the calculations needed to use these estimates of changes in market power in the equilibrium displacement model.

6.9.1 Estimated Changes in Potential Market Power Caused by a 25% Reduction in Formula and Packer Ownership Procurement

The empirical estimation of Eq. (2.33) required the use of the residuals from Eq. (2.34) as a proxy for potential market power. Table 2-11 presents the empirical results of the estimation of Eq. (2.33). The results indicate that a 1% decrease in formula and packer ownership procurement is related to a 0.009 and a 0.002 percentage point decline in potential market power (ρ), respectively. Thus, Eq. (6.99) presents the calculations used to estimate the change in potential market power resulting from a 25% reduction in both formula and packer ownership procurement:

$$\begin{aligned}&\left(\frac{\partial M_k}{\partial pf} \times -25.00\right) + \left(\frac{\partial M_k}{\partial po} \times -25.00\right) = \\ &(0.009 \times -25.00) + (0.002 \times -25.00) = -0.275\,\% \quad . \qquad (6.99)\end{aligned}$$

Thus, a 25% reduction in formula and packer ownership procurement is expected to reduce potential market power by 0.275 percentage points.

6.9.2 Estimated Changes in Potential Market Power Caused by a 100% Reduction in Formula and Packer Ownership Procurement

An analogous procedure is followed to estimate the impact of a 100% reduction (i.e., complete elimination) of formula and packer ownership procurement on potential market power. The 100% reduction in both methods yields:

$$\left(\frac{\partial M_k}{\partial pf} \times -100.0\right) + \left(\frac{\partial M_k}{\partial po} \times -100.0\right) = \qquad (6.100)$$
$$(0.009 \times -100.0) + (0.002 \times -100.0) = -1.100\%$$

Thus, a 100% reduction in formula procurement is expected to reduce potential market power by 1.100 percentage points.

6.10 SIMULATION RESULTS

In this section, we present the results of simulations of potential changes in AMAs that would reduce or eliminate various procurement methods. The simulations are conducted using the inputs described in Sections 6.7, 6.8, and 6.9.

6.10.1 Results of a 25% Reduction in Formula and Packer Ownership Procurement

A 25% reduction in formula and packer ownership procurement is expected to have three initial effects on the lamb sector. First, lamb meat quality is expected to decline and decrease primary demand by 1.65% (Eq. 6.95). Second, processing costs would increase because of changes in procurement methods. Thus, the domestic wholesale derived supply function is expected to shift upwards and to the left by 1.20% (Section 6.8.1). Third, potential market power is expected to decline by 0.275 percentage points (Eq. 6.99). These three inputs are used in the equilibrium displacement model to estimate price, quantity, and producer and consumer surplus changes resulting from a 25% reduction in formula and packer ownership procurement.

Table 6-14 reports simulated mean changes in the endogenous price and quantity variables and associated 95% confidence intervals for a 25% reduction in formula and packer ownership procurement. All mean estimates are significantly different from zero at either the 5% or 10% level. The short-run time period represents changes in prices and quantities that occur at the end of Year 1.

Table 6-14. Percentage Changes in Prices and Quantities Given a 25% Reduction in Formula and Packer Ownership Lamb Procurement[a]

Endogenous Variables	Short Run	Long Run (Year 10)
Retail domestic lamb price	–0.53%[a] (–1.34, 0.33)	–0.06%[a] (–0.23, 0.15)
Retail domestic lamb quantity	–1.40% (–1.82, –1.10)	–1.59% (–1.83, –1.40)
Retail imported lamb price	–0.004%[a] (–0.02, 0.002)	–0.001%[a] (–0.004, 0.003)
Retail imported lamb quantity	–0.40[a] (–1.31, 0.21)	–0.07%[a] (–0.32, 0.17)
Wholesale domestic lamb price	1.17% (0.44, 2.08)	0.28% (0.12, 0.70)
Wholesale domestic lamb quantity	–1.57% (–2.05, –1.25)	–1.62% (–2.30, –1.27)
Wholesale imported lamb price	–0.04%[a] (–0.14, 0.02)	–0.007%[a] (–0.03, 0.02)
Wholesale imported lamb quantity	–0.41%[a] (–1.30, 0.21)	–0.07%[a] (–0.33, 0.17)
Slaughter lamb demand price	–3.10% (–4.22, –2.26)	–0.42% (–0.75, –0.31)
Slaughter lamb supply price	–2.88% (–4.00, –2.02)	–0.15% (–0.49, –0.04)
Slaughter lamb quantity	–0.55% (–1.12, –0.13)	–1.26% (–1.80, –0.90)
Feeder lamb price	–3.42% (–9.39, –0.70)	–0.61% (–1.39, –0.28)
Feeder lamb quantity	–0.29% (–0.87, –0.04)	–1.18% (–1.77, –0.74)

[a] This scenario corresponds to a 1.65% decrease in retail lamb demand, a 1.20% decrease in wholesale domestic derived lamb supply, and a 0.275% reduction in potential lamb packer oligopsony power.

[b] Significantly different from zero at the 10% level. All other values are significantly different from zero at the 5% level.

In the short run, all prices decline with the exception of a small increase in domestic wholesale lamb prices. Retail domestic lamb price declines by 0.53%, slaughter lamb supply price declines by 2.88%, and feeder lamb price declines by 3.42%. In addition, all quantities (except import retail and wholesale lamb, which are not statistically affected) decline by a small amount. Essentially, these results reflect that the positive effect of reduced potential oligopsony processor market power is unable to offset the negative effects of increased processing costs and decreased retail demand.

To estimate long-run effects, we assume that the lamb market would return to an equilibrium after 10 years of adjustments to the change in lamb procurement. We multiplicatively increase supply and demand elasticities between the short-run estimates (year 1) and long-run estimates (year 10). The long-run results represent changes in prices and quantities that would occur in year 10 relative to initial levels. The long-run price effects follow the short-run results in terms of direction. However, the long-run changes in prices are much smaller than the short-run changes because of increasing supply and demand elasticities. For example, slaughter lamb supply price declines by 0.15%, and feeder lamb prices decline by 0.61% in the long run. However, the long-run quantity declines are slightly larger than the short-run declines because of, again, more elastic supply responses over time.

Table 6-15 presents changes in producer surplus at each level of the marketing chain and changes in consumer surplus at the retail level. In general, most estimates are at least significantly different from zero at the α = 0.10 level. Short-run results are presented in the first column, and long-run results are presented in the second column. Changes in producer surplus contain a dynamic element in that producer surplus increases or decreases over time. Therefore, it is appropriate to consider *cumulative* changes in producer surplus that accrue as an industry adjusts from a short-run to a long-run equilibrium. To simulate these cumulative effects, we assume that it takes 10 years to adjust from the short run to the long run in the meat industry.

The third column of Table 6-15 presents the simple summation of producer and consumer surplus changes over 10 years for each market level. The fourth column presents the present value of these changes in producer and consumer surplus assuming a 5% discount rate. Over the 10-year adjustment period, all sectors except wholesale domestic lamb producers lose surplus.

The fifth column of Table 6-15 presents changes in cumulative net present value of producer and consumer surplus for each sector as a percentage of the total net present value of

Table 6-15. Changes in Producer and Consumer Surplus Given a Given a 25% Reduction in Formula and Packer Ownership Lamb Procurement, Million $[a,b]

	Short Run	Long Run (Year 10)	Cumulative	Cumulative Present Value	Percent of Total Present Value Cumulative Surplus
Producer Surplus					
Retail domestic lamb producer surplus	–$17.18	–$5.18	–$125.06	–$100.55	–1.72%
Retail imported lamb producer surplus	–0.16[c]	–0.003[c]	–0.51[d]	–0.43[d]	–0.15[d]
Wholesale domestic lamb producer surplus	–2.23[c]	0.003	8.02	6.49[c]	0.29[c]
Wholesale imported lamb producer surplus	–0.14[c]	–0.02[c]	–0.43[d]	–0.37[d]	–0.28[d]
Slaughter lamb producer surplus	–13.53	–1.26	–65.05	–54.65	–2.79
Feeder lamb producer surplus	–8.44	–1.51	–53.84	–44.24	–3.81
Total change in domestic producer surplus	–41.40	–7.92	–235.93	–192.95	–1.73
Total change in imported producer surplus	–0.30[c]	–0.05[c]	–0.94[d]	–0.80[d]	–0.19[d]
Total change in producer surplus	–41.70	–7.97	–236.87	–193.75	–1.67
Consumer Surplus					
Retail domestic lamb consumer surplus	–27.98	–16.30	–230.43	–182.09	–2.07
Retail imported lamb consumer surplus	–14.15[c]	–1.39[c]	–39.33[d]	–34.14[d]	–0.76[d]
Total change in consumer surplus	–42.13	–17.69	–269.76	–216.23	–1.63

[a] Producer and consumer surplus are calculated relative to 2000–2003 average quantities and prices.

[b] This scenario corresponds to a 1.65% decrease in retail demand, a 1.20% decrease in wholesale domestic derived lamb supply, and a 0.275% reduction in potential lamb packer oligopsony power.

[c] Significantly different from zero at the 10% level.

[d] Not significantly different from zero.

cumulative producer and consumer surplus. In total, consumers lose 1.63% cumulative surplus over the 10-year adjustment period. In addition, domestic slaughter lamb producer surplus declines by 2.79% and domestic feeder lamb producer surplus declines by 3.81% over the same period.

6.10.2 Results of a 100% Reduction in Formula and Packer Ownership Procurement

A 100% reduction in formula and packer ownership procurement is expected to: (1) reduce retail demand for domestic lamb by 6.63% (Eq. [6.96]), (2) increase wholesale processing costs by 4.80% (Section 6.8.2) (Eq. [6.98]), and reduce potential market power by 1.10 percentage points (Eq. [6.100]). Table 6-16 reports mean changes in the endogenous price and quantity variables and associated 95% confidence intervals for a 100% reduction in formula and packer ownership procurement. All mean estimates are at least significantly different from zero at the 10% level. With the exception of wholesale domestic lamb prices, all prices and quantities decline in the short run. Retail domestic lamb price declines by 2.15%, and retail domestic lamb quantities decline by 5.60%. Slaughter and feeder lamb prices decline by 11.51% and 13.65%, respectively.

The long-run price and quantity results follow the short-run results in terms of direction with generally smaller price declines and larger quantity declines. Again, these results are consistent with increasing supply and demand elasticities over time. For example, slaughter lamb supply prices decline by 0.60%, and feeder lamb prices decline by 2.46% in the long run. However, slaughter and feeder lamb quantities decline by 5.04% and 4.74% in the long run.

Table 6-17 presents changes in producer surplus at each level of the marketing chain and changes in consumer surplus at the retail level. In general, most estimates are at least significantly different from zero at the α = 0.10 level. Short-run results are presented in the first column, and long-run results are presented in the second column. The third column of Table 6-17 presents the simple summation of producer and consumer surplus changes over 10 years for each market level.

Table 6-16. Percentage Changes in Prices and Quantities Given a 100% Reduction in Formula and Packer Ownership Lamb Procurement[a]

Endogenous Variables	Short Run	Long Run (Year 10)
Retail domestic lamb price	–2.15%[b] (–5.45, 1.29)	–0.23%[b] (–0.92, 0.59)
Retail domestic lamb quantity	–5.60% (–7.29, –4.39)	–6.38% (–7.36, –5.63)
Retail imported lamb price	–0.02%[b] (–0.06, 0.009)	–0.003%[b] (–0.02, 0.01)
Retail imported lamb quantity	–1.66[b] (–5.29 0.77)	–0.27%[b] (–1.31, 0.69)
Wholesale domestic lamb price	4.66% (1.74, 8.32)	1.10% (0.49, 2.81)
Wholesale domestic lamb quantity	–6.30% (–8.19, –4.99)	–6.49% (–9.20, –5.09)
Wholesale imported lamb price	–0.17%[b] (–0.56, 0.09)	–0.03%[b] (–0.13, 0.07)
Wholesale imported lamb quantity	–1.66%[b] (–5.28, 0.76)	–0.26%[b] (–1.31, 0.68)
Slaughter lamb demand price	–12.42% (–16.88, –9.06)	–1.67% (–3.01, –1.23)
Slaughter lamb supply price	–11.53% (–16.02, –8.09)	–0.60% (–1.95, –0.15)
Slaughter lamb quantity	–2.21% (–4.47, –0.53)	–5.04% (–7.23, –3.61)
Feeder lamb price	–13.67% (–37.61, –2.79)	–2.46% (–5.60, –1.13)
Feeder lamb quantity	–1.15% (–3.49, –0.16)	–4.75% (–7.10, –2.99)

[a] This scenario corresponds to a 6.63% decrease in retail lamb demand, a 4.80% decrease in wholesale domestic derived lamb supply, and a 1.10% reduction in potential lamb packer oligopsony power.

[b] Significant from zero at the 10% level.

Table 6-17. Changes in Producer and Consumer Surplus Given a 100% Reduction in Formula and Packer Ownership Lamb Procurement, Million $[a,b]

	Short Run	Long Run (Year 10)	Cumulative	Cumulative Present Value	Percent of Total Present Value Cumulative Surplus
Producer Surplus					
Retail domestic lamb producer surplus	–$68.43	–$20.41	–$498.68	–$401.11	–7.36%
Retail imported lamb producer surplus	–0.66[c]	–0.11[c]	–2.10[d]	–1.79[d]	–0.64[d]
Wholesale domestic lamb producer surplus	–9.86	0.12	30.61	24.66[c]	1.10[c]
Wholesale imported lamb producer surplus	–0.56[c]	–0.01[c]	–1.76[d]	–1.50[d]	–1.16[d]
Slaughter lamb producer surplus	–53.91	–5.04	–258.42	–217.11	–12.29
Feeder lamb producer surplus	–33.55	–5.94	–213.06	–175.15	–16.05
Total change in domestic producer surplus	–165.75	–31.27	–939.55	–768.72	–7.28
Total change in imported producer surplus	–1.22[c]	–0.20[c]	–3.85[d]	–3.28[d]	–0.81[d]
Total change in producer surplus	–166.96	–31.47	–943.40	–772.00	–7.04
Consumer Surplus					
Retail domestic lamb consumer surplus	–109.66	–63.86	–902.15	–712.90	–8.92
Retail imported lamb consumer surplus	–57.28[c]	–5.63[c]	–160.63[d]	–139.40[d]	–3.18[d]
Total change in consumer surplus	–166.94	–69.49	–1,062.78	–852.30	–6.88

[a] Producer and consumer surplus are calculated relative to 2000–2003 average quantities and prices.

[b] This scenario corresponds to a 6.63% decrease in retail lamb demand, a 4.80% decrease in wholesale domestic derived lamb supply, and a 1.10% reduction in potential lamb packer oligopsony power.

[c] Significant from zero at the 10% level.

[d] Not significantly different from zero.

The fourth column of Table 6-17 presents the present value of 10 years of changes in producer and consumer surplus assuming a 5% discount rate. Over the 10-year adjustment period, the only sector that does not lose producer surplus is the wholesale domestic lamb sector.

The fifth column of Table 6-15 presents changes in cumulative net present value of producer and consumer surplus for each sector as a percentage of the total net present value of cumulative producer and consumer surplus. All consumers lose 6.88% of cumulative surplus over the 10-year adjustment period. In addition, domestic slaughter lamb producer surplus declines by 12.29% and domestic feeder lamb producer surplus declines by 16.05% over the same period.

6.10.3 Results of a 100% Reduction in Formula and Packer Ownership Procurement Assuming the Elimination of Potential Oligopsony Power

For illustration purposes, it is instructive to consider a case in which a 100% reduction in formula and packer ownership procurement would completely eliminate potential oligopsony market power. The research presented above does not support such a scenario. However, if the goal of a complete elimination of formula and packer ownership procurement is to eliminate potential oligopsony power, it is interesting to consider a hypothetical situation in which that actually occurs. Note that oligopsony power could still occur within cash markets. However, we abstract from that possibility in this simulation.

This simulation follows that of Section 6.10.2, except that the potential market power parameter (ρ) is assumed to decline from a mean value of 1.015 (and variations between 1.0 and 1.05) to a value of 1.0 that contains no variation. That is, no price wedge would exist between the demand and supply prices for slaughter lambs after the 100% reduction in formula and packer ownership procurement.

Table 6-18 reports mean changes in the endogenous price and quantity variables and associated 95% confidence intervals for this scenario. All short-run estimates are significantly different from zero at the 5% level as are most of the long-run estimates.

Table 6-18. Percentage Changes in Prices and Quantities Given a 100% Reduction in Formula and Packer Ownership Lamb Procurement and Elimination of Potential Oligopsony Power[a]

Endogenous Variables	Short Run	Long Run (Year 10)
Retail domestic lamb price	–2.23% (–5.54, 1.16)	–0.26%[b] (–0.96, 0.44)
Retail domestic lamb quantity	–5.56% (–7.21, –4.37)	–6.35% (–7.19, –5.57)
Retail imported lamb price	–0.02% (–0.06, 0.01)	–0.001%[b] (–0.02, 0.001)
Retail imported lamb quantity	–1.72 (–5.39, 0.62)	–0.31%[b] (–1.38, 0.50)
Wholesale domestic lamb price	4.59% (1.71, 8.22)	1.00% (0.45, 2.61)
Wholesale domestic lamb quantity	–6.23% (–8.08, –4.97)	–6.36% (–8.68, –5.01)
Wholesale imported lamb price	–0.17% (–0.56, 0.07)	–0.03%[b] (–0.14, 0.05)
Wholesale imported lamb quantity	–1.72% (–5.36, 0.63)	–0.31%[b] (–1.40, 0.51)
Slaughter lamb demand price	–12.46% (–16.90, –9.13)	–2.02% (–3.25, –1.61)
Slaughter lamb supply price	–11.15% (–15.66, –7.76)	–0.55% (–1.80, –0.13)
Slaughter lamb quantity	–2.14% (–4.36, –0.51)	–4.61% (–6.58, –3.21)
Feeder lamb price	–13.23% (–36.80, –2.71)	–2.25% (–5.16, –1.01)
Feeder lamb quantity	–1.11% (–3.42, –0.16)	–4.34% (–6.53, –2.71)

[a] This scenario corresponds to a 6.63% decrease in retail lamb demand and a 4.80% decrease in wholesale domestic derived lamb supply.

[b] Not significantly different from zero.

The results reported in Table 6-18 are almost identical to those reported in Table 6-16. That is, even if eliminating formula and packer ownership lamb procurement would completely eliminate potential oligopsony power, the net effects would be to reduce price and quantities in almost all sectors because of additional processing costs and reductions in lamb meat quality.

Table 6-19 presents changes in producer surplus at each level of the marketing chain and changes in consumer surplus at the retail level in response to this hypothetical scenario. Again, the results are virtually identical to those reported in Table 6-17.

6.10.4 Potential Market Power, Processing Costs, and AMAs

Section 6.10.3 illustrates a hypothetical case in which a 100% reduction in formula and packer ownership procurement would completely eliminate potential oligopsony market power. However, these results are dependent upon the assumption of the initial size of oligopsony markdown pricing behavior. That is, if such market power is large enough initially, then elimination of that market power could theoretically offset increased processing costs and reduced lamb quality in terms of changes in producer surplus.

Therefore, the equilibrium displacement model was used in a static simulation to determine the minimum size of initial market power for which, upon its removal through the complete elimination of AMAs, slaughter lamb producers would be invariant to such an action. The model indicates that an initial oligopsony markdown pricing of fed lambs of 10.5% would have to exist in order for benefits and costs of reducing AMAs to be equivalent. Although empirical estimates of oligopsony markdowns in the lamb industry do not exist, the largest of such estimates in the beef industry have generally been less than 3.8%.

Finally, it is interesting to consider relative magnitudes of negative effects of changes in AMAs in processing costs and lamb quality versus the positive effects of reductions in potential market power. A static simulation was conducted to further investigate these tradeoffs. The above simulation was repeated (a 100% reduction in AMAs and the complete elimination of market power), and the negative impacts on processing costs and lamb quality were altered until the discounted net present value of fed lamb producer surplus was unaffected by changes in AMAs. The results indicate that fed lamb producers would be

Table 6-19. Changes in Producer and Consumer Surplus Given a 100% Reduction in Formula and Packer Ownership Lamb Procurement and Elimination of Potential Oligopsony Power, Million $[a,b]

	Short Run	Long Run (Year 10)	Cumulative	Cumulative Present Value	Percent of Total Present Value Cumulative Surplus
Producer Surplus					
Retail domestic lamb producer surplus	–$68.71	–$20.24	–$497.79	–$400.63	–7.36%
Retail imported lamb producer surplus	–0.69	–0.13[c]	–2.41[d]	–2.03[d]	–0.74[d]
Wholesale domestic lamb producer surplus	–9.84	0.11	29.35[c]	23.63[c]	1.05[c]
Wholesale imported lamb producer surplus	–0.58	–0.10[c]	–2.02[d]	–0.17[d]	–1.32[d]
Slaughter lamb producer surplus	–52.15	–4.61	–246.72	–207.58	–11.68
Feeder lamb producer surplus	–32.46	–5.45	–202.99	–167.14	–15.26
Total change in domestic producer surplus	–163.15	–30.19	–918.15	–751.72	–7.12
Total change in imported producer surplus	–1.27	–0.23[c]	–4.44[d]	–3.74[d]	–0.92
Total change in producer surplus	–164.42	–30.42	–922.59	–755.46	–6.89
Consumer Surplus					
Retail domestic lamb consumer surplus	–108.91	–63.44	–894.30	–706.73	–8.83
Retail imported lamb consumer surplus	–59.77	–6.66[c]	–184.24	–158.22[d]	–3.62[d]
Total change in consumer surplus	–168.88	–70.10	–1,078.54	–864.95	–6.99

[a] This scenario corresponds to a 6.63% decrease in retail lamb demand and a 4.80% decrease in wholesale domestic derived lamb supply.

[b] Producer and consumer surplus are calculated relative to 2000–2003 average quantities and prices.

[c] Significant from zero at the 10% level.

[d] Not significantly different from zero.

indifferent to the elimination of AMAs if that action would cause no change in retail lamb quality and only a 1% increase in processing costs. Note that Section 6.7.2 estimates that the complete elimination of AMAs would reduce retail demand because of a reduction in lamb meat quality by 6.63%, and Section 6.8.2 indicates that this action would increase processing costs by 4.80%.

6.11 SUMMARY OF CHANGES IN PROCUREMENT METHODS ON PRICES, QUANTITIES, AND PRODUCER SURPLUS

We developed a stochastic, dynamic, equilibrium displacement model of the U.S. lamb industry. The model includes supply and demand relations for the feeder lamb, fed lamb, lamb slaughter, domestic and import wholesale carcasses, and domestic and import retail demand sectors. The model explicitly considers oligopsony markdown pricing behavior by lamb packers and correlations among elasticity estimates. We do not directly estimate whether such market power actually exists; rather, we consider a variety of impacts that would result from changes in AMAs if market power were being exercised in the industry. The model is parameterized by econometrically estimating a structural demand and supply system of equations using publicly available annual data from 1970 to 2003.

The equilibrium displacement model also requires estimates of changes in costs that may occur if restrictions are placed on specific AMAs. We estimated a monthly, reduced form model of retail lamb, boxed lamb, slaughter lamb, slaughter ewe, and feeder lamb prices. A potential market power equation based on packer concentration ratios is included. The system is estimated using monthly MPR data. The monthly model is used to estimate changes in marginal costs at the packer level and changes in potential oligopsony market power in response to assumed restrictions on the use of AMAs. In addition, we incorporate the potential change in lamb meat quality resulting from potential changes in AMAs.

Specifically, we simulate the results of a 25% reduction in the procurement of fed lambs by formula and packer ownership procurement methods. We also simulate changes caused by a 100% reduction in formula and packer ownership procurement of fed lambs. In both cases, it is assumed these reductions cause increased procurement via other methods.

The equilibrium displacement model quantifies the effects of the above changes in AMAs on annual equilibrium prices, quantities, producer surplus, and consumer surplus over a 10-year period. In addition, Monte Carlo simulations (1,000) are used to construct empirical probability distributions so that the statistical significance of each endogenous variable can be evaluated. Empirical results are reported for short-term (1 year), long-term (10 years), and cumulative effects.

In general, the simulations indicate that the only sector that does not lose producer (consumer) surplus in the long run is the wholesale domestic lamb sector.

For illustration purposes, a third simulation was conducted in which a 100% reduction in formula and packer ownership procurement was assumed to completely eliminate potential oligopsony market power. The results were not significantly different from those reported above. That is, even if eliminating formula and packer ownership lamb procurement would completely eliminate potential oligopsony power, the net effects would be to reduce price, quantities, and producer and consumer surplus in almost all sectors because of additional processing costs and reductions in lamb meat quality.

Finally, two additional simulations were conducted. The first these evaluated the amount of oligopsony markdown pricing that must currently exist so that the complete elimination of that potential market power (by eliminating the use of AMAs) would result in no change in producer surplus at the slaughter lamb level. The analysis indicates that the current level of markdown pricing would have to be 10.5%, which is much larger than empirical estimates from the beef industry. The second additional simulation evaluated the amount of increased processing costs that could be offset by reductions in potential market power so that producer surplus in the slaughter lamb sector would be unaffected. The simulation indicates that a 1% increase in processing costs could be offset by reductions in potential market power. However, under the scenario in which a 100% reduction in AMAs occurs, we estimate that processing costs would increase by 4.80%.

7 Implications of Alternative Marketing Arrangements

Based on the evidence from this study, we expect the use of AMAs in the lamb industry to increase somewhat over the next several years.

In this section, we describe the implications of AMAs based on the outcome of the combined set of research activities conducted for the study. Based on the industry interviews, surveys, and analyses of MPR data, we expect the use of AMAs in the lamb industry to increase somewhat over the next several years for three reasons. First, the domestic lamb industry continues to contract. Hence, AMAs will likely be used to a greater extent so that lamb packers can maintain fed lamb procurement. Second, the domestic lamb industry faces strong competition from lamb imports. Therefore, AMAs will likely be used to improve quality as the industry tries to address import competition. Third, if a country of origin labeling (COOL) requirement or a national animal identification system is implemented, the cost of lamb production will increase and likely cause some small producers to exit. In an effort to improve traceability, the use of AMAs may increase.

In the subsections below, we assess the economic incentives for and implications of changes in the use of AMAs. This discussion is within the context of hypothetical restrictions on the use of AMAs given the current levels of use of AMAs and the current institutional structures within the lamb industry.

7.1 ASSESSMENT OF ECONOMIC INCENTIVES FOR INCREASED OR DECREASED USE OF ALTERNATIVE MARKETING ARRANGEMENTS

In this section, we summarize our findings related to the economic incentives for changes in the use of AMAs in the lamb industry. This discussion is within the context of expected changes and hypothetical restrictions on the use of AMAs.

***Summary measure* of the economic incentives associated with the use of AMAs.** Buyers and sellers of livestock and meat face a number of economic incentives associated with using alternative marketing arrangements versus cash markets. Buyers of livestock and meat may choose to use specific marketing arrangements because they reduce the cost of procurement, improve the quality of animals and products purchased, aid in risk management, and improve logistics. Likewise, sellers of livestock and meat may choose to use specific marketing arrangements to improve market access, reduce transactions costs, increase prices, and reduce risk.

Empirical analyses indicate that small but statistically significant effects result from restrictions on the use of AMAs.

Empirical analyses indicate that small but statistically significant effects result from restrictions on the use of AMAs. Depending on the size of restrictions on the use of AMAs, lamb meat quality declines and reduces the demand for domestic lamb meat between 1.65% and 6.63%. In addition, processing costs increase between 1.20% and 4.80%. Finally, oligopsony markdowns decline from an assumed initial level of 1.5% to between 1.22% and 0.4% depending on the size of AMA reductions.

Section 6 presented measures of the economic incentives associated with the use of AMAs based on consumer and producer surplus changes that would result if their use were restricted. Several scenarios were evaluated under the assumption that reductions in AMAs would reduce retail lamb quality, increase packer processing costs, and reduce potential oligopsony markdown pricing (market power) of fed lambs.

One scenario assumed that the use of AMAs might be reduced by 25%. For the lamb industry, this is modeled as a 25% reduction in both formula and packer ownership procurement methods. A second scenario considers the effects of a 100%

These results indicate that, in the short run, the positive effect of reduced potential oligopsony processor market power that might result from restricting AMAs is unable to offset the negative effects of increased processing costs and decreased retail demand.

reduction in formula and packer ownership procurement methods. For both scenarios, short-run (1 year) results indicate that all prices decline with the exception of a small increase in domestic wholesale lamb prices, and almost all live lamb and lamb meat quantities decline. Furthermore, consumer surplus and producer surplus declines for every sector except for a small increase in the producer surplus of wholesale domestic lamb production. These results indicate that, in the short run, the positive effect of reduced potential oligopsony processor market power that might result from restricting AMAs is unable to offset the negative effects of increased processing costs and decreased retail demand.

***System-wide long-run effects* of major types of marketing arrangements on the livestock and meat industries.** To examine the long-run effects of AMAs, we calculated the consumer and producer surplus changes due to hypothetical restrictions over a 10-year period. Again, two primary scenarios are considered: (1) a 25% reduction in formula and packer ownership fed lamb procurement and (2) a 100% reduction in formula and packer ownership procurement.

These results indicate that, in the long run, the positive effect of reduced potential oligopsony processor market power that might result from restricting AMAs is unable to offset the negative effects of increased processing costs and decreased retail demand.

For both scenarios, long-run results indicate that all prices decline with the exception of a small increase in domestic wholesale lamb prices, and almost all live lamb and lamb meat quantities decline. Furthermore, consumer surplus and producer surplus decline for every sector except for a small increase in the producer surplus of wholesale domestic lamb production. These results indicate that, in the long run, the positive effect of reduced potential oligopsony processor market power that might result from restricting AMAs is unable to offset the negative effects of increased processing costs and decreased retail demand.

The *most significant* types of spot and AMAs based on the likelihood that the arrangement is or will be used extensively in the livestock and meat industries, including the types of marketing arrangements that are likely to *grow in importance* and usage and those that are likely to decrease in importance. Based on MPR data, about one-half of fed lambs are procured through cash means (auctions and negotiations), and most of the remainder are procured through formulas and contracts. Only about 5% of fed lambs are procured through packer ownership. In contrast, the survey results indicate that approximately 80% of fed lambs are procured through cash means.

Continued demands for higher quality lamb and competition from imports is likely to increase the use of formula procurement methods in an attempt to provide incentives for quality improvements.

It is unlikely that packer ownership of lambs will increase in the future. Lamb packers have yet to embrace this method, and it is unlikely that such a change will occur in this small, niche market. However, if the domestic lamb industry continues to contract, contracts will likely be used to a greater extent as lamb packers attempt to secure fed lamb supplies. In addition, continued demands for higher quality lamb and competition from imports is likely to increase the use of formula procurement methods in an attempt to provide incentives for quality improvements. As a result, the use of auctions is likely to decline, although direct negotiations between producers and packers may increase.

Summary effects of *combinations of marketing arrangements* across different stages of the supply chain (e.g., used by a combination of producers, packers, retailers, food service operators, exporters). At a strategic level, producers, packers, meat processors, and retailers decide to procure inputs that will satisfy the quality, volume, and price requirements of their buyers. For example, based on the industry interviews, some marketing arrangements are used upstream (e.g., between the producer and packer) to meet requirements for meat products downstream (e.g., between the packer and retailer). However, based on the data maintained by packers and processors, it is difficult to specifically model the relationship among marketing arrangements across multiples stages of production. The available lamb transactions data do not allow for a comparison of the use of AMAs for fed lamb purchases with AMAs used for lamb meat sales.

Based on the analysis of the MPR data, we found that the use of AMAs is associated with higher quality fed lamb purchased by packers.

Major summary effects of AMAs on consumer demand. Consumer demand for meat is affected by the use of AMAs if those arrangements allow for the production of higher quality products and/or sale of lamb products at lower prices. Based on the analysis of the MPR data, we found that the use of AMAs is associated with higher quality fed lamb purchased by packers. Thus, restrictions on the use of AMAs are likely to reduce the quality of retail lamb meat and increase competitive pressure from lamb imports.

7.2 IMPLICATIONS OF EXPECTED CHANGES IN USE OF ALTERNATIVE MARKETING ARRANGEMENTS OVER TIME

In this subsection, we summarize our findings related to the implications of expected changes in the use of AMAs in the fed lamb and lamb meat industry. This discussion is within the context of expected changes and hypothetical restrictions on the use of AMAs.

Implications changes in the use of marketing arrangements on *price discovery*. Price discovery refers to the process by which a buyer and a seller agree on a price for a specific transaction. Thus, price discovery depends on the pricing method used for each type of marketing arrangement. The association between types of marketing arrangements and types of pricing methods in the lamb industry is as follows:

- Auction barns: auction (open bid) pricing
- Negotiations or direct trade: individually negotiated pricing
- Marketing agreements: formula pricing
- Forward contracts: formula pricing
- Packer ownership: internal transfer pricing

In the case of formula pricing, base prices are generally established by those reported in an earlier week by the AMS or, in some cases, plant averages. AMS prices were historical averages obtained from voluntary price reporting from auction markets. For several years, AMS prices were those developed from MPR data obtained from the largest packers.

Because prices are reported under MPR for different types of marketing arrangements, the effect of marketing arrangement use on the price discovery process is minimal.

In either case, if the base price does not reflect current and expected supply and demand conditions, then the price discovery process is impeded. However, because prices are reported under MPR for different types of marketing arrangements, the effect of marketing arrangement use on the price discovery process is minimal. This may not have been the case under voluntary price reporting.

Over the MPR sample period, formula procurement volumes trended downward, while auction procurement volumes trended upward (each about 0.26 percentage points per month). The means and standard deviations of formula and cash fed lamb prices using MPR data were similar during the sample period.

The price series were highly correlated with an estimated correlation coefficient of 0.970.

Approximately 60% of the difference between formula and cash lamb prices is explained by variations in formula/carcass price differences, carcass price risk, sheep and lamb inventories, differences between formula and cash lamb procurement volumes, and seasonality. An important result consistent with *a priori* expectations is that an increase in output price risk increases the price difference between formula and cash prices.

Implications of expected changes in the use of marketing arrangements on *thin markets*. Markets are considered thin when the volume of transactions is so small that prices are highly volatile and may not reflect supply and demand conditions or livestock and meat quality. Of course, animals that are procured using AMAs are not sold in auction markets. More importantly, most of the price, quantity, and quality information in these cases was not publicly reported in the past. Thus, without publicly reported data, AMAs can cause cash markets to become relatively thin.

Historically, most livestock prices were determined in spot markets either through auctions or direct negotiations between buyers and sellers. Traditionally, spot market prices were voluntarily reported to AMS' Market News system by buyers and sellers. These reported prices were often the basis for negotiating other prices among buyers and sellers.

In 1999, the Livestock Mandatory Reporting Act was passed by Congress with implementation beginning in April 2001 and ending in 2005 for lamb prices. The Mandatory Reporting Act has recently been reauthorized, but implementation will not likely occur until late 2007. The purposes of MPR were to provide market price and quantity information for cattle, hogs, lamb, and meat products that (1) could be readily understood by market participants; (2) provide information on price discovery, quantity, and quality of livestock and livestock products procured and sold under AMAs; (3) improve USDA price-reporting services; and (4) encourage competition. Azzam (2003) notes that the driving force for MPR was the assumption that market price transparency would promote competition. The comparative statics of his theoretical model suggest that livestock producers may not *directly* benefit from the increased transparency of reported prices. Rather, if the pooling of information among packers is a relatively low-cost activity, then MPR may increase competition among packers in procuring fed livestock inputs.

MPR differed from voluntary reporting in that large lamb packers (those with average annual slaughter capacity exceeding 75,000 head) and importers were now required to submit summary information electronically to the USDA AMS. In addition, MPR required that prices and terms of sales be reported beyond those transactions that occur in spot markets, and that premiums and discounts for quality characteristics be reported. MPR required not only the usual reporting of prices, but also the method of procurement.

Although empirical research seems to suggest an inverse relationship between captive supplies and cash-market prices, establishing a causal link has been elusive. Xia and Sexton (2004) note that removing a share of cattle from the cash market affects both supply and demand in that market. In a competitive market, the effect on price is ambiguous because it depends on the relative magnitudes of the shifts and on demand and supply elasticities.

It should be noted that formal commodity futures markets for lamb meat and fed lambs do not exist. Thus, AMAs may be the only price risk management tool available for lamb producers.

Implications of expected changes in the use of marketing arrangements on *risk management*. The use of AMAs for fed lamb marketing does not appear to shift risk between producers and packers. However, the implementation of MPR in 2001 was intended to increase pricing efficiency through improved market price transparency (Perry et al., 2005). Our research indicates that the Mandatory Reporting Act had a statistically significant, albeit economically small, effect on slaughter lamb prices. The implementation of the Act increased slaughter lamb price by 0.129%. Given that lamb markets are relatively thin, the primary impact of the Act may have been to reduce price risk rather than influence price levels (Marsh and McDonnell, 2005).

Finally, it should be noted that formal commodity futures markets for lamb meat and fed lambs do not exist. Thus, AMAs may be the only price risk management tool available for lamb producers.

Restrictions on the use of AMAs would likely put lamb at a competitive disadvantage relative to other meat and to imported lamb.

Implications of expected changes in the use of marketing arrangements on *competitiveness among meats*. Competitiveness among meats changes if prices or quality of products change. Based on the simulations conducted in this volume, restrictions on the use of AMAs appear to decrease the quality of lamb meat more than that of beef and pork. Although lamb is not a strong substitute for beef and pork, restrictions on the use of AMAs do place it at a competitive disadvantage to these other meats.

More importantly, however, it appears that imported lamb is a strong substitute for domestic lamb. Hence, the loss of competitiveness in response to restrictions on the use of AMAs is much more pronounced with respect to lamb imports.

If AMAs reduce the viability of public auctions, it may be that small producers will not be able to obtain market access.

Implications of expected changes in the use of marketing arrangements on *ease of entry* into each stage of the livestock and meat industries. Ease of entry (or the extent of entry barriers) refers to whether individuals who would like to enter the lamb production industry are able to do so. Ease of entry may be affected by the availability of AMAs because financing of production operations often depends on the assurance of market access and price risk management. However, for small producers, it may be more difficult to secure AMAs because it is more costly for packers to negotiate with many small producers relative to fewer large producers. Hence, if AMAs reduce the viability of public auctions, it may be that small producers will not be able to obtain market access.

If restrictions on AMAs reduce the competitiveness of domestic lamb meat relative to lamb imports, then concentration in the lamb packing and processing industry is likely to increase in response to declining domestic demand.

Implications of expected changes in the use of marketing arrangements on *concentration* in livestock production and feeding and in meatpacking, *structure* of the livestock industry, and *structure* of the meatpacking industry. Based on the analyses conducted for this study, there are no clear effects of the changes in the use of AMAs on concentration in the lamb industry. Concentration as measured by the four-firm concentration ratio (CR4) has been relatively flat while the use of AMAs has increased. However, as noted above, increased use of AMAs may reduce the viability of auctions. Thus, one could expect increases in the concentration of the livestock feeding sector. In addition, if restrictions on AMAs reduce the competitiveness of domestic lamb meat relative to lamb imports, then concentration in the lamb packing and processing industry is likely to increase in response to declining domestic demand.

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Appendix A: Stochastic Equilibrium Displacement Models

Elasticity-based computable equilibria (equilibrium displacement models) or partial equilibria models are commonly used when assessing the effects and/or the costs of potential changes in economic policy or structure. Elasticity-based computable equilibria models are attractive in that they are obtained by simple manipulation or row operations of differential approximations to economic models and are accurate to the degree that the underlying system can be linearly approximated (Davis and Espinoza, 1998; Brester, Marsh, and Atwood, 2004).

In economic modeling, the system's actual parameters are usually unknown and must be estimated or assumed. Most studies use some combination of assumed, previously published, and/or statistically estimated shares and elasticities. In all cases, it should be recognized that uncertainty exists with respect to the model's actual parameters and, as a result, with respect to the policy effects derived using estimated parameters. Davis and Espinoza (1998) illustrate the importance of examining the sensitivity of changes in prices and quantities (as well as producer and consumer surplus) relative to variations in selected elasticity estimates. Also, as a practical matter, the amount of uncertainty with respect to model parameters may vary across parameters. For example, if a number of researchers and statistical methodologies have obtained similar estimates for a given elasticity, the degree of uncertainty with respect to the given elasticity will be less than for a parameter for which published estimates have varied widely across researchers and methodologies.

An additional complication in policy models is that subsets of the model's economic parameters are likely to be correlated, nonnormally distributed, and possibly intractable. For example, elasticities of supply in a vertically structured model might be positively correlated and restricted to be positive, while own-demand elasticities might be positively correlated and restricted to be negative (Davis and Espinoza, 1998). Brester, Marsh, and Atwood (2004) use Monte Carlo simulations of an equilibrium displacement model in which elasticities among vertical demand and supply sectors are correlated.

As indicated below, if independent marginal distributions of a model's parameters can be approximated, Monte Carlo simulation techniques can be used to introduce correlation between marginal pseudo-samples from possibly widely divergent statistical families of distributions. However, in such cases, the common methods for generating correlated multivariate normal random variates are inappropriate if applied directly to the marginal pseudo-samples themselves.

We use a variant of the Iman-Conover (1982) process for generating correlated random variables. The Iman-Conover process is attractive in that marginal distributions can be simulated independently from most continuous distributions. Each of the independently generated marginal samples is then merely reordered to obtain a rank correlation similar to the desired correlation structure. The Iman-Conover process is straightforward and easy to implement in most common spreadsheets and statistical packages. The following examples were developed in "R"—a free public source statistical modeling software package.

We first demonstrate why traditional procedures for generating correlated multivariate normal random variates are inappropriate for a general set of marginal distributions. We then demonstrate the use of Iman-Conover procedures for introducing correlation while preserving all marginal pseudo-samples.

A.1 GENERATING MULTIVARIATE NORMAL PSEUDO-SAMPLES

The most commonly used procedures for generating correlated multivariate normal samples exploit the fact that linear combinations of normal random variates are themselves normally distributed. Assume that an n by k multivariate normal "sample" Z_C with covariance matrix Σ is desired. A common procedure to generate such a sample matrix is to initially populate an n by k matrix Z_1 with randomly and independently generated normal (0,1) random variates. If the random variates in Z_1 are independently generated, the expected covariance matrix of Z_1 is a k by k identity matrix I_1. However, for finite samples the realized sample covariance matrix is computable as

$$\hat{\Sigma}_{Z_1} = Z_1' \left[\frac{1}{n-1} \left(I_n - \frac{1}{n} \underline{1}_n \underline{1}_n' \right) \right] Z_1' \hat{C} Z_1 \qquad \text{(A.1)}$$

and may not equal I_k. In the above expression, $\underline{1}_n$ is an n by 1 vector with each element equal to 1, and $\hat{C}$ is the sample covariance operator. Procedures similar to those presented in Greene (2003) can be used to easily demonstrate that $Y'\hat{C}Y$ is the sample covariance matrix of any corresponding sample matrix Y.

Before proceeding, we apply an Iman-Conover "whitening" process by factoring $\hat{\Sigma}_{Z_1} = U'U$ using a Cholesky or similar factorization algorithm. If Z_1 was generated randomly, the matrix U will be nonsingular and a "whitened" sample matrix Z_W can be constructed as $Z_W = Z_1U^{-1}$. Because the columns of Z_W are linear combinations of the columns of Z_1, the n by k sample Z_W will be multivariate normal with sample covariance matrix:

$$\hat{\Sigma}_{Z,W} = Z_W'\hat{C}Z_W = \left(U^{-1}\right)' Z_1'\hat{C}Z_1U^{-1} = \left(U^{-1}\right)' \hat{\Sigma}_{Z_1}U^{-1} = \left(U'\right)^{-1}U'UU^{-1} = I_k. \quad \text{(A.2)}$$

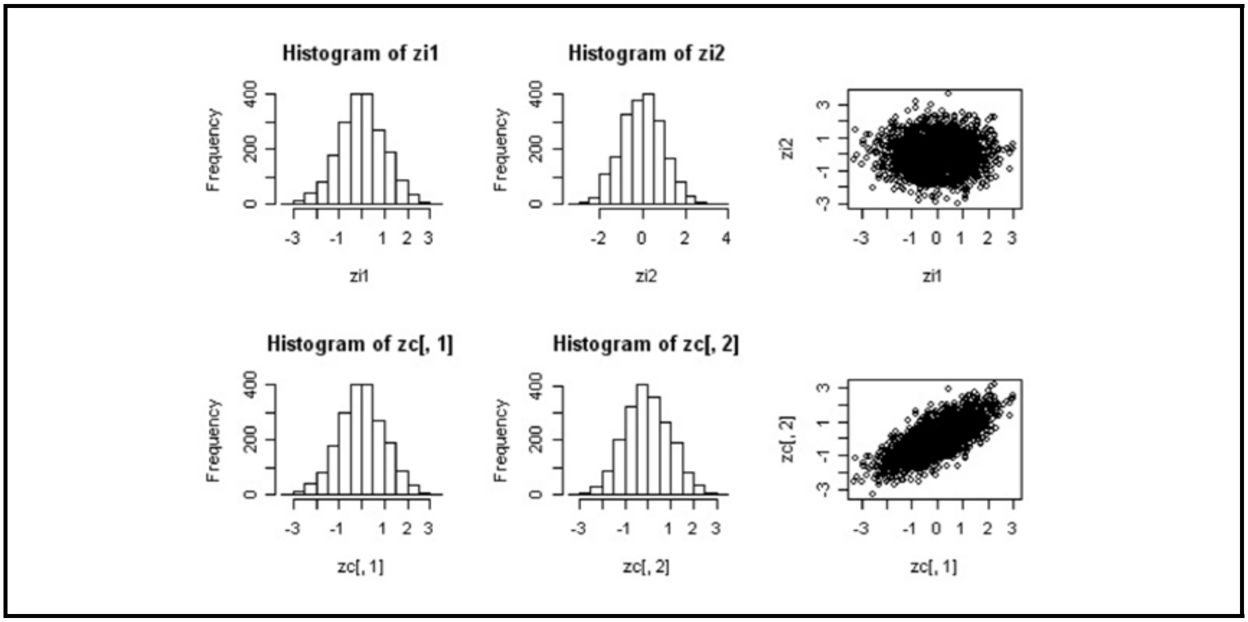
Obtaining a multivariate normal sample Z_C with sample covariance matrix Σ is accomplished by factoring $\Sigma = V'V$ and generating $Z_C = Z_WV$, which has sample covariance matrix:

$$\hat{\Sigma}_{Z_C} = Z_C'\hat{C}Z_C = V'Z_W'\hat{C}Z_WV = V'\hat{\Sigma}_{Z_W} = V'V = \Sigma. \quad \text{(A.3)}$$

Because each column of Z_C is generated as linear combinations of the columns of Z_W, the columns in Z_C are distributed multivariate normal while having a sample covariance equal to the desired covariance matrix Σ. The panels in Figure A-1 plot the results of applying the above process with 2,000 observations on two normal variates with a target correlation of 0.7. The top three panels are histograms of the two independently generated normal (0,1) variates and a joint scatter plot. The bottom three panels in Figure A-1 present histograms and a joint scatter plot of the two marginals after the above transformations were applied. The resulting correlation between the two marginals is 0.7.

In the following discussion we return to the multivariate normal matrix Z_C because it is integral to the variant of the Iman-Conover procedure that we use. In the next section, we demonstrate why the above process for generating correlated random variables (taking linear combinations of independently generated marginals) is not appropriate when working with nonadditively regenerative marginal distributions.

Figure A-1. Plots of Normally Random Variates Before and After Transformation

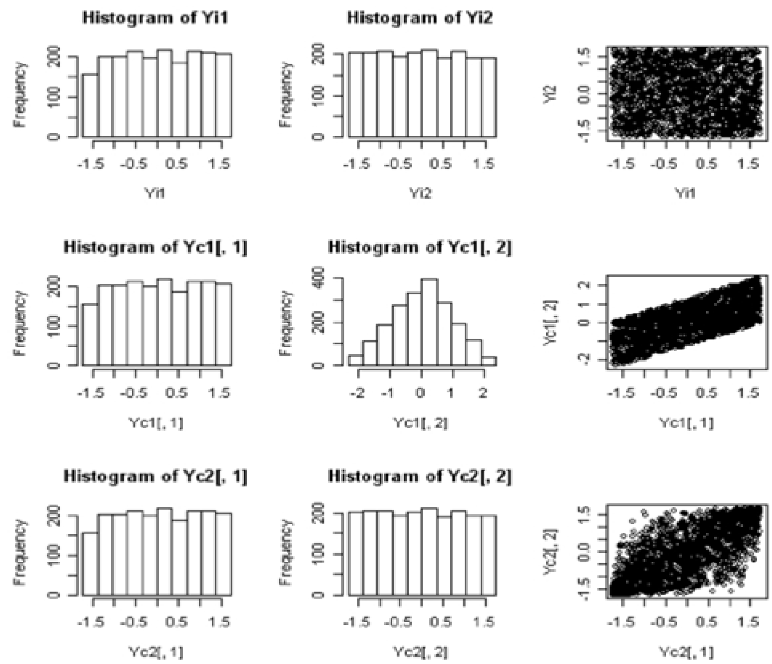


A.2 LINEAR COMBINATIONS OF NONREGENERATIVE DISTRIBUTIONS

The top three panels in Figure A-2 present histograms and a joint scatter plot from a 2,000 by 2 bivariate pseudo-sample Y_1 generated as two independent *uniform* $-\sqrt{3}, \sqrt{3}$ distributions with mean 0 and variance 1. The histograms and scatter plot of the marginal distributions indicate that the pseudo-samples appear to be uniformly and independently distributed over the $-\sqrt{3}, \sqrt{3}$ interval.

Assume that a correlated bivariate uniform distribution is desired with correlation 0.7. Because the uniform distribution is not additively regenerative, generating correlated variates using the Cholesky decomposition weighted-average procedure destroys the original marginal distributions. The middle three panels in Figure A-2 demonstrate this result. With a bivariate distribution, the Cholesky decomposition transformation leaves the first marginal unchanged. However, the second variate is reconstructed as a linear combination of both the original marginal samples. The second histogram in the middle set of panels clearly shows that the resulting variate is not uniformly

Figure A-2. Results of Generating Correlated Uniform Random Variates



distributed although the correlation between the two transformed random variates is 0.7. The scatter plot of the joint observations is presented in the third panel of Figure A-2.

The results of applying the Iman-Conover process to the uniform marginal samples are presented in the third panel of plots in Figure A-2.[1]

---

[1] As we indicate above, the Iman-Conover process can easily be implemented in Excel or other programming environments. Following is R code that can be used to compute the reordered correlated pseudo-sample. The user calls the function with the Y_I and SIGMA matrices. The function returns the correlated Y_C sample matrix.

```
ImanConover=function(yi,sigma) {
yc=yi
ydim=dim(yi)            # record the dimension of the Y_I matrix
zi=matrix(rnorm(ydim[1]*ydim[2]),ydim[1],ydim[2])   # populate the
   normal(0,1) Z_I matrix
zc=(zi %*% (solve(chol(cov(zi)))) %*% (chol(sigma))  # create the
   correlated Z_C matrix
for (j in 1:ncols) {
 ys=sort(yi[,j])
 yc[,j]=ys[rank(zc[,j])]              # create the correlated Y_C matrix
 }
yc
}
```

Because the Iman-Conover process merely involves reordering the original marginal pseudo-sample, the process has clearly not affected the histograms of the marginal distributions. The Pearson correlation of the transformed variates for this example is about 0.695. The third plot in panel three is a scatter plot of the joint distribution after the reordering process.

The Iman-Conover process can easily be used to generate correlated random variables over a wide range of possible functional forms for the marginal distributions in an economic policy simulation model.

A.3 GENERAL SIMULATION ISSUES

All simulations were conducted after selecting prior distributions for each of the elasticities used in the model. We apply nonstandard beta priors to the estimated demand and supply elasticities. The use of nonstandard beta distributions maintains original means and standard deviations for each elasticity. In addition, nonstandard beta distributions allow demand elasticities to be constrained to always be negative and supply elasticities to always be positive.

A sensitivity analysis of an equilibrium displacement model should consider both variations of elasticity estimates and correlations among these estimates (Davis and Espinoza, 1998). We assume that demand elasticities are uncorrelated with supply elasticities across the SUR block models. However, estimated correlations among the demand elasticities and among the supply elasticities are used in the simulation.

All of the Monte Carlo simulations conducted in Section 6 are the result of 1,000 iterations. Empirical distributions are generated for each endogenous variable and for all estimates of changes in consumer and producer surplus. We use these empirical distributions to develop reported means, confidence intervals, and P values for our results (Brester, Marsh, and Atwood, 2004).

January 2007

GIPSA Livestock and Meat Marketing Study

Contract No. 53-32KW-4-028

Volume 6: Meat Distribution and Sales
Final Report

Prepared for

Grain Inspection, Packers and Stockyard Administration
U.S. Department of Agriculture
Washington, DC 20250

Prepared by

RTI International
Health, Social, and Economics Research
Research Triangle Park, NC 27709

RTI Project Number 0209230

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RTI International is a trade name of Research Triangle Institute.

Abstract

Over time, the variety, complexity, and use of alternative marketing arrangements (AMAs) have increased in the livestock and meat industries. Marketing arrangements refer to the methods by which livestock and meat are transferred through successive stages of production and marketing. Increased use of AMAs raises a number of questions about their effects on economic efficiency and on the distribution of the benefits and costs of livestock and meat production and consumption between producers and consumers. This volume of the final report focuses on AMAs used in meat distribution and sales and addresses the following parts of the Grain Inspection, Packers and Stockyards Administration (GIPSA) Livestock and Meat Marketing Study:

- Part C. Determine extent of use, analyze price differences, and analyze short-run market price effects of AMAs.
- Part D. Measure and compare costs and benefits associated with spot marketing arrangements and AMAs.
- Part E. Analyze the implications of AMAs for the livestock and meat marketing system.

This final report follows the publication of an interim report for the study that used qualitative sources of information to identify and classify AMAs and to describe their terms, availability, and reasons for use. The portion of the study contained in this volume of the final report is based on analyses using industry survey data from meat processors, wholesalers, retailers, and food service operators and transactions data from meat processors.

This volume of the final report presents the results of analyses of the effects of AMAs on meat distribution and sales beyond the packing plant. The analyses are primarily descriptive and use a format different from the species-specific analyses

presented in previous volumes. Both beef and pork purchases and sales are examined. Because of the nature of the data maintained in the industry, we cannot identify a specific link between the use of specific AMAs for purchase of live animals and products bought and sold by meat processors.

The principal contributors to this volume of the final report are the following:

- Mary K. Muth, PhD, RTI International (Project Manager)
- John Lawrence, PhD, Iowa State University and AERC, LLC
- Sheryl C. Cates, RTI International (Data Collection Manager)
- Michaela Coglaiti, RTI International
- John Del Roccili, PhD, formerly with Econsult, West Chester University, and AERC, LLC (formerly Beef Team Leader; deceased)
- Shawn Karns, RTI International
- Nicholas Piggott, PhD, North Carolina State University
- Justin Taylor, MS, RTI International
- Catherine Viator, MS, RTI International

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This report and the study on which it is based were completed under a contract with GIPSA, U.S. Department of Agriculture (USDA). Any opinions, findings, and conclusions or recommendations expressed in this report are those of the authors and do not necessarily reflect the views of GIPSA or USDA.

Contents

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Tables

Executive Summary

As part of the congressionally mandated Livestock and Meat Marketing Study, this volume of the final report presents the results of analyses of the effects of alternative marketing arrangements (AMAs) on the distribution and sales of meat products downstream from the packer. This volume focuses on determining the extent of use of AMAs, describing the linkages between the stages of meat production, and describing the relationship between the use of AMAs and meat quality.

In this report, AMAs refer to all possible alternatives to the cash or spot market. AMAs in meat distribution and sales include arrangements such as forward contracts and marketing agreements. Cash or spot market transactions refer to transactions that occur immediately, or "on the spot." These include sales through dealers and brokers and direct trades.

The analyses include both beef and pork products, are descriptive, and focus on the relationships among industry participants involved in distributing meat products beyond the packing plant. The information used for this volume includes the results of the industry interviews, data from the industry surveys (described in Volume 2), and transactions data from meat processors. Analyses conducted for the Livestock and Meat Marketing Study are limited to economic factors associated with spot market and AMAs and do not analyze policy options or make policy recommendations.

Primary conclusions for this final report, as they relate to meat processing, distribution, and sales,[1] are as follows:

[1] Note that meat processors conduct meat processing but do not slaughter livestock. Meat packers slaughter livestock and may or may not conduct meat processing.

- **Meat processors differ greatly in the products they purchase and the products they sell.** Individual firms may have a dominant practice for purchases, sales, and pricing that is different from other competing firms. Although some processors' transactions data did reflect a mix of purchasing and/or pricing methods, many were all of one method. This dominant method approach was apparent in comparing the survey data with the transactions data. The survey includes more small firms, while the transactions data represent larger firms. Sixty-three percent of the processors surveyed indicated that they used the spot market exclusively. From the transactions records representing larger firms, 25% of records and 21% of the volume by weight for both beef and pork processors were in the spot market. Thus, based on the difference in the sample of processors that provided transactions data compared with those that responded to the survey, the results of the analysis differ.
- **Meat processors surveyed relied heavily on the spot market for meat purchases and sales but also used other methods.** An estimated 91% of the plants surveyed used the spot market for purchases, and 63% used it exclusively. Forward contracting was used by nearly 20% of plants, and marketing agreements and internal company transfers each were used by approximately 13% of the plants. The two most common pricing methods for purchases were price lists and individually negotiated prices (approximately 60% each). Formula pricing, typically tied to USDA-reported prices, was used by 32% of plants and 13% of plants used internal transfer. Approximately 60% of plants surveyed used the cash or spot market for meat sales as well. Forward contracts, marketing agreements, and internal transfers were approximately 10% each.
- **Transactions data indicate that meat processors often bought processed products and sold more highly processed products.** Transactions purchase data were 73% pork and 27% beef, by weight. Pork processors' purchase records were primarily for subprimal cuts (31%), ready-to-eat (RTE) product (24%), and ground pork and trimmings (19%). In contrast, beef processors' purchase transactions were primarily for processed RTE product (39%) and ground beef and trimmings (22%). The processors reporting sales produced only two product types—case ready and processed RTE.

- **Transactions data on meat processor purchases indicate a much larger use of AMAs than do the survey data.** Based on transactions data, only 21% of beef and pork products were purchased on the spot market. Internal transfers were a large factor for pork but were virtually nonexistent for beef. Forward contracts were 28% of beef purchases, but less than 1% of pork purchases. The type of purchase method used is either not important to meat processors or they did not understand the meaning of the categories, because 39% of beef and 32% of pork purchase methods were listed as “other or missing.”
- **Approximately 99% of pork and 55% of beef product pounds that were priced using formula pricing used a USDA-reported price as the base.** The other base used for purchased beef was a subscription service. Although nearly all pork pricing formulas are based on USDA-reported prices, it is worth noting that wholesale pork, while reported by USDA, is not covered under Mandatory Price Reporting (MPR).
- **Meat processors play an important distribution role in the meat value chain by purchasing large lots from a few sources and selling small lots to many firms.** Transaction purchase data included 53,831 records from 32 firms, averaging 22,800 pounds per transaction. Sales transactions from 11 firms included 848,295 records, averaging 771 pounds per transaction, and these were all case ready or RTE. A high percentage of these transactions did not identify the sales method, indicating that processors either did not understand the meaning of the categories that were listed or do not track this information.
- **When examining data specific to the beef industry, aggregate cattle purchase and beef sales transactions data suggest no relationship between cattle purchase methods and branded beef sales, although this relationship may be important to individual firms.** Plants that sold 0% to 20% of their beef as branded product purchased approximately the same percentage of their cattle on the spot market as did plants that sold 21% to 40% of their beef as branded product. Although the differences were small, the 21% to 40% plants used more forward contracts and less packer ownership than did the 0% to 20% plants. Shares of marketing agreement cattle were nearly identical across the two groups. In addition, 60% of the meat purchased on the spot market by processors

was branded product compared with none through marketing agreements and internal transfers.

- **Although potentially important to some beef industry firms, aggregate transactions data suggest that downstream marketing arrangements have no relationship to cattle purchase methods.** Beef plants were divided into two groups based on beef sales methods–0% to 50% and 51% to 100% cash or spot market beef sales. Transactions from both groups indicated that they each bought 60% of their cattle through the spot market and 40% using AMAs. The 0% to 50% cash sales group used more marketing agreements, and the 51% to 100% cash sales group had more packer-owned cattle.
- **Aggregate transactions data for the beef industry suggest some relationship between meat buyer type and cattle purchase methods.** Packers that sold more beef to meat processors bought fewer cattle on the spot market but about the same number of cattle through AMAs (with the difference resulting from a larger percentage of other purchases or missing information). Packers that sold a larger amount of beef to retailers and food service operators bought a larger percentage of their cattle on the spot market and a slightly lower percentage of cattle through AMAs.
- **The pork industry is more vertically integrated than is the beef industry.** Pork packers produce a higher percentage of the animals that they slaughter than do beef packers, and pork processors acquire much more of their product through internal transfer than do beef processors.
- **Meat processor buyers mix and match purchase and pricing methods.** Formula pricing was used as the pricing method for spot market, forward contracts, and marketing agreements. Likewise, individually negotiated prices were more common in forward contracts than in spot markets.

Decisions regarding methodologies, assumptions, and data sources used for the study had to be made in a short period of time. The analyses presented in this volume are based on the best available data, using methodologies developed to address the study requirements under the time constraints of the study. However, some analyses were limited because of the availability and quality of the transactions data.

1 Introduction and Background

Alternative marketing arrangements include all possible alternatives to the use of cash or spot markets for conducting transactions.

As part of the congressionally mandated Livestock and Meat Marketing Study, this volume of the final report presents the results of analyses of the effects of alternative marketing arrangements (AMAs) on meat distribution and sales. The types of questions posed by the Livestock and Meat Marketing Study include the following: What types of marketing arrangements are used? What is the extent of their use? Why do firms enter into the various arrangements? What are the terms and characteristics of these arrangements? What are the effects and implications of the arrangements on participants and on the livestock and meat marketing system?

The overall study comprises five parts based on the performance work statement in the contract with the Grain Inspection, Packers and Stockyards Administration (GIPSA). An interim report released in August 2005 addressed the first two parts, Parts A and B, of the study (Muth et al., 2005). It described marketing arrangements used in the livestock and meat industries and defined key terminology.[1] Results presented in the interim report were preliminary because they were based on assessments of the livestock and meat industries using published data, review of the relevant literature, and industry interviews.

This volume of the final report for meat processing, distribution, and sales uses a different format than the one used for each of the species because of differences in data availability and the

[1] A glossary of terms used in the study is included in a separate document.

nature of the research questions.[2] The analyses conducted for the species-specific volumes address Parts C, D, and E of the study as follows:

- Part C. Determine extent of use, analyze price differences, and analyze short-run market price effects of AMAs.
- Part D. Measure and compare costs and benefits associated with spot and AMAs.
- Part E. Analyze the implications of AMAs for the livestock and meat marketing system.

The interim report released in August 2005 addressed the first two parts of the study. This final report focuses on the final three parts of the study (Parts C, D, and E).

The analyses in this volume, which include both beef and pork products, are descriptive and focus on the relationships among industry participants involved in distributing meat products beyond the packing plant. Thus, the focus is on the role of AMAs in meat processing, distribution, and sales.

The information used for this volume includes the results of the industry interviews,[3] data from the industry surveys (described in Volume 2), and transactions data from meat processors and beef packers. Analyses conducted for the Livestock and Meat Marketing Study are limited to economic factors associated with spot and AMAs and do not analyze policy options or make policy recommendations.

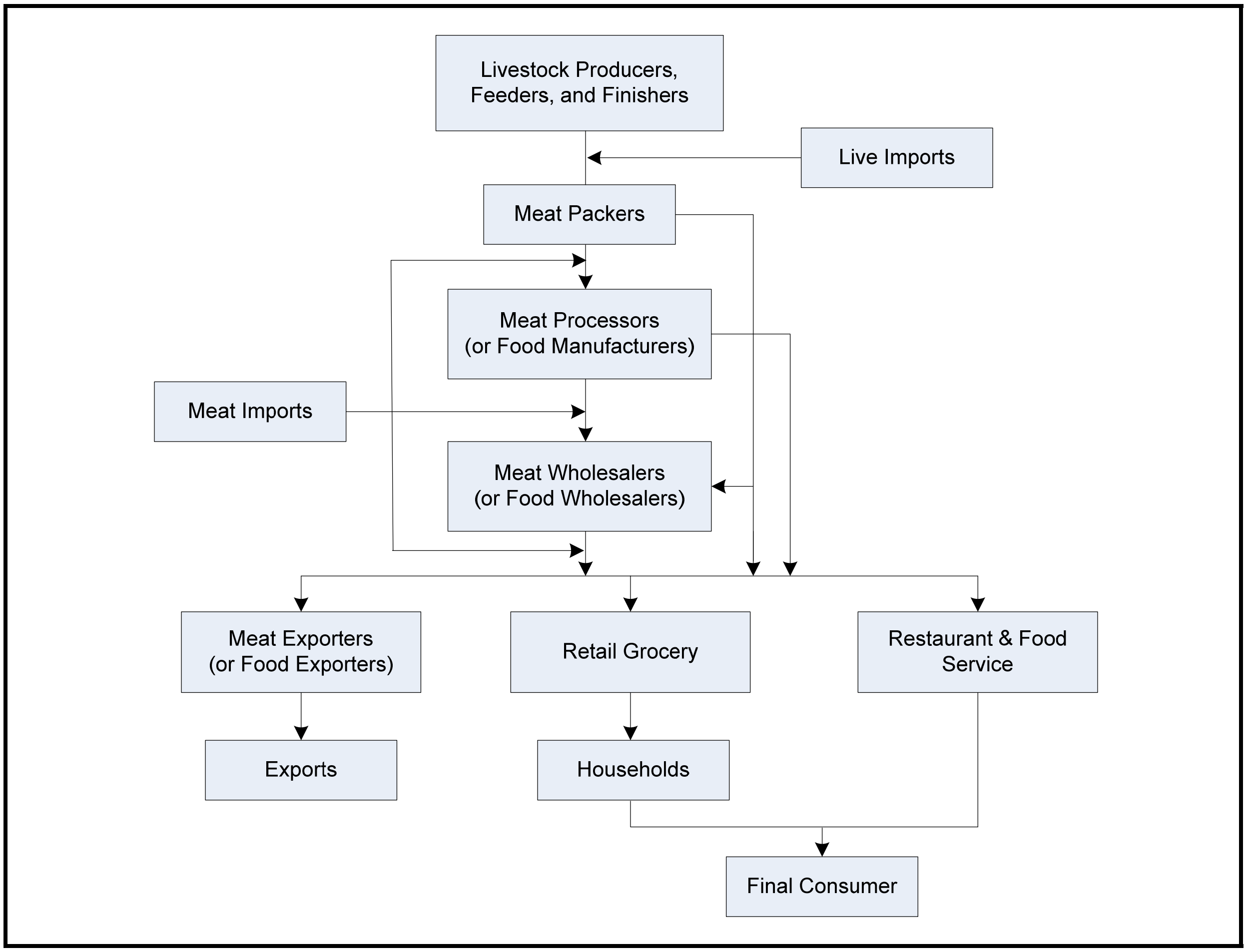
1.1 OVERVIEW OF MEAT DISTRIBUTION AND SALES

As indicated in Figure 1-1, meat distribution and sales occur through several successive stages. Livestock producers, feeders, and finishers sell live animals to meat packers. Some live animals are also imported and shipped directly to meat packing plants for slaughter. From the meat packing plant, carcasses, cuts, and processed meats are either shipped to a meat processor or directly to wholesalers, exporters, grocery retailers, or restaurants/food service operators. Based on the sales transactions data for beef packers and pork packers, approximately 15% of beef packer sales pounds and 21% of pork packer sales pounds are to meat processors and food

[2] Note that meat processors conduct meat processing but do not slaughter livestock. Packers slaughter livestock and may or may not conduct meat processing.

[3] A description of the process for conducting the interviews and the complete findings from the interviews is provided in the interim report (Muth et al., 2005).

Figure 1-1. General Overview of Meat Product Flows



manufacturers. The remainder of sales pounds represents product that has completed processing and is ready for final cooking or preparation before consumption. Meat products shipped to meat processors (or food manufacturers that use meat as an ingredient) for further processing are either shipped to a wholesaler or directly to any of the other types of downstream establishments. Finally, meat wholesalers (or food wholesalers) ship meat products to exporters, retailers, or restaurants/food service operators. In some cases, all of these stages occur at a single establishment that slaughters livestock and sells meat products directly to consumers. At the other extreme, meat products are traded through all of these individual stages. Note that imported meat products enter at various stages depending on the level of processing and intended use of the product.

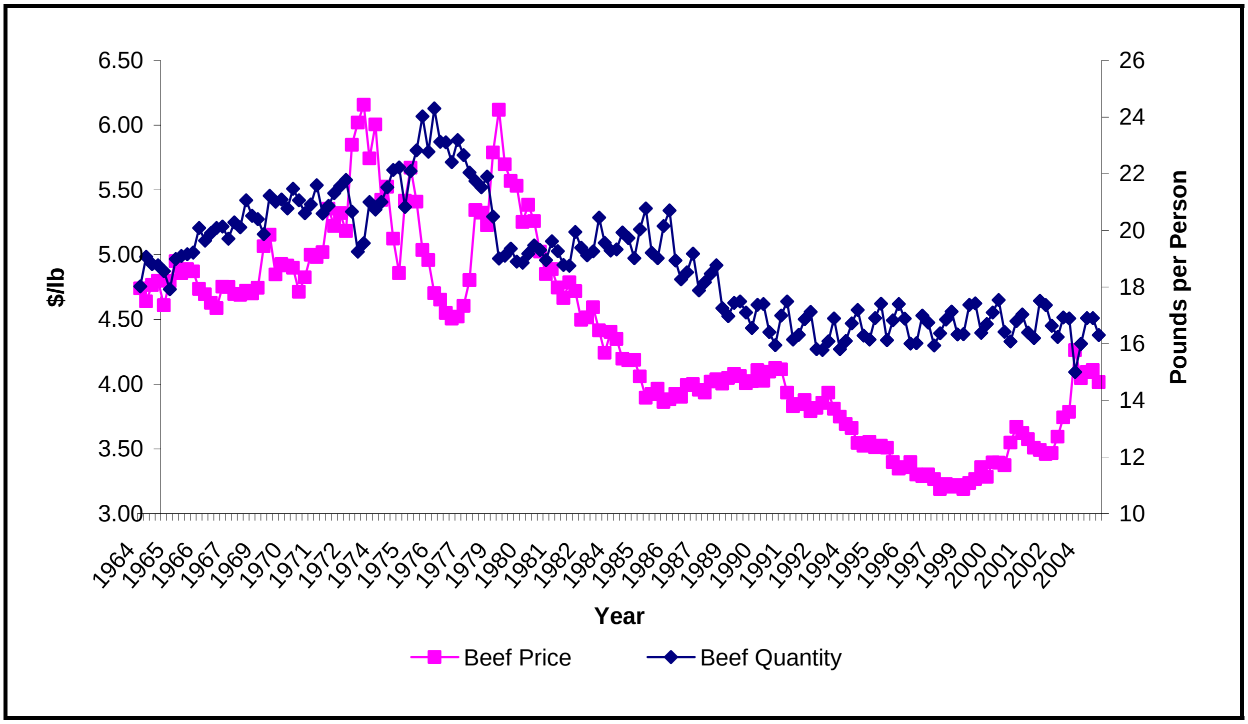
Over the past several decades, patterns of U.S. meat consumption have been affected by changes in relative prices for meat, consumer income levels, and tastes and preferences for meat and poultry. Changes in beef and pork consumption and prices relative to poultry are discussed below, before discussing changes in the location of meat consumption (e.g., food consumed at home versus away from home).

1.1.1 Comparisons of Consumption and Retail Prices for Beef, Pork, Lamb, and Poultry

Figure 1-2 reveals that U.S. beef consumption is quite seasonal—consumption in the second and third quarters is typically higher than consumption in the first and fourth quarters. Over the period 1964 to 2004, per capita beef consumption averaged around 18.8 pounds per quarter (approximately 75.3 pounds per capita annually). Per capita beef consumption levels have also been quite variable over this time period, ranging from as little as 15.0 pounds in the fourth quarter of 2003 to as much as 24.3 pounds in the third quarter of 1976 and have been decreasing generally. U.S. quarterly real retail beef prices measured in 2004 dollars have decreased over the entire period. During the mid- to late-1970s, real retail beef prices exceeded $6.00 per pound for several quarters, reaching a peak of $6.16 per pound (in 2004 dollars) in the third quarter of 1973. After this peak, real retail beef prices decreased dramatically for a period of 6 years to a level just below $4.00 per pound in the mid-1980s. Prices remained steady around this level for a period of approximately 6 additional years before declining significantly again, this time to as low as $3.20 per pound (in 2004 dollars) in the first quarter of 1999. Since then, real prices have risen and are back above $4.00 per pound.

Figure 1-2 also shows that the relationship between beef prices and consumption levels weakened between 1964 and 2004, as both real retail prices and per capita consumption trended downward. This inverse relationship was quite strong up to the early 1980s, and then consumption levels appear to have become less responsive to changes in real retail prices. For example, during the price declines from 1992 to 1999, consumption levels remained relatively stable, although still quite seasonal at around 17 pounds per capita per quarter. The seemingly weaker inverse price and quantity relationship appeared to

Figure 1-2. U.S. Quarterly Per Capita Beef Consumption (lbs per person) and Real Retail Beef Price ($/lb) (2004 dollars), 1964–2004
The inverse relationship between beef prices and beef consumption has weakened over time.



Sources: U.S. Department of Agriculture (USDA), Economic Research Service. 2004g. *Red Meat Yearbook*. Stock #94006. Washington, DC: USDA. <http://usda.mannlib.cornell.edu/data-sets/livestock/94006/>.

U.S. Department of Agriculture, Economic Research Service. 1994. “Livestock and Meat Statistics.” *Red Meat Yearbook*, Statistical Bulletin No. 885. Washington, DC: USDA.

U.S. Department of Agriculture, Economic Research Service. 2005. *Livestock, Dairy, & Poultry Outlook.* Washington, DC: USDA. <http://www.ers.usda.gov/publications/ldp/>.

U.S. Bureau of Labor Statistics. “Consumer Price Index—All Urban Consumers, U.S. All Items.” <http://data.bls.gov/cgi-bin/surveymost?cu>. Accessed April 18, 2005.

U.S. Department of Commerce, Bureau of Economic Analysis. National Income and Product Accounts Table, Table 2.6 Personal Income and Its Disposition, Monthly. Washington, DC: U.S. Department of Commerce. <http://www.bea.gov/bea/dn/nipaweb/SelectTable.asp?Selected=N>.

U.S. Department of Agriculture, Economic Research Service. 2004c. “Food Consumption (Per Capita) Data System, Food Availability.” Washington, DC. <http://www.ers.usda.gov/data/foodconsumption/FoodAvail Spreadsheets.htm#mtpcc>.

rebound when the significant price spike in the last quarter of 2003 coincided with a considerable, though temporary, decline in consumption levels. After the price spike tempered, consumption levels were reestablished at previous levels.

Figure 1-3 reveals that U.S. quarterly pork consumption is seasonal but has remained steady at 13 pounds per capita (approximately 51.5 pounds per capita annually) over the period 1964 to 2004. Per capita pork consumption declined to as little as 9.5 pounds in the third quarter of 1975 and was as much as 16.1 pounds in the fourth quarter of 1964. U.S.

Figure 1-3. U.S. Quarterly Per Capita Pork Consumption (lbs per person) and Real Retail Pork Price ($/lb) (2004 dollars), 1964–2004
As with beef, the inverse relationship between pork prices and pork consumption has weakened over time.

Sources: U.S. Department of Agriculture, Economic Research Service. 2004g. *Red Meat Yearbook*. Stock #94006. Washington, DC: USDA. <http://usda.mannlib.cornell.edu/data-sets/livestock/94006/>.

U.S. Department of Agriculture, Economic Research Service. 1994. “Livestock and Meat Statistics.” *Red Meat Yearbook*, Statistical Bulletin No. 885. Washington, DC: USDA.

U.S. Department of Agriculture, Economic Research Service. 2005. *Livestock, Dairy, & Poultry Outlook.* Washington, DC: USDA. <http://www.ers.usda.gov/publications/ldp/>.

U.S. Bureau of Labor Statistics. “Consumer Price Index—All Urban Consumers, U.S. All Items.” <http://data.bls.gov/cgi-bin/surveymost?cu.> Accessed April 18, 2005.

U.S. Department of Commerce, Bureau of Economic Analysis. National Income and Product Accounts Table, Table 2.6 Personal Income and Its Disposition, Monthly. Washington, DC: U.S. Department of Commerce. <http://www.bea.gov/bea/dn/nipaweb/SelectTable.asp?Selected=N>.

U.S. Department of Agriculture, Economic Research Service. 2004c. “Food Consumption (Per Capita) Data System, Food Availability.” Washington, DC. <http://www.ers.usda.gov/data/foodconsumption/FoodAvail Spreadsheets.htm#mtpcc>.

quarterly real retail pork prices measured in 2004 dollars have decreased over the entire period. During the mid-1970s, real retail pork prices exceeded $5.00 per pound, reaching a peak of $5.23 per pound (2004 dollars) in the fourth quarter of 1975. After this peak, real retail pork prices have been declining and have most recently stabilized at around $2.75 per pound.

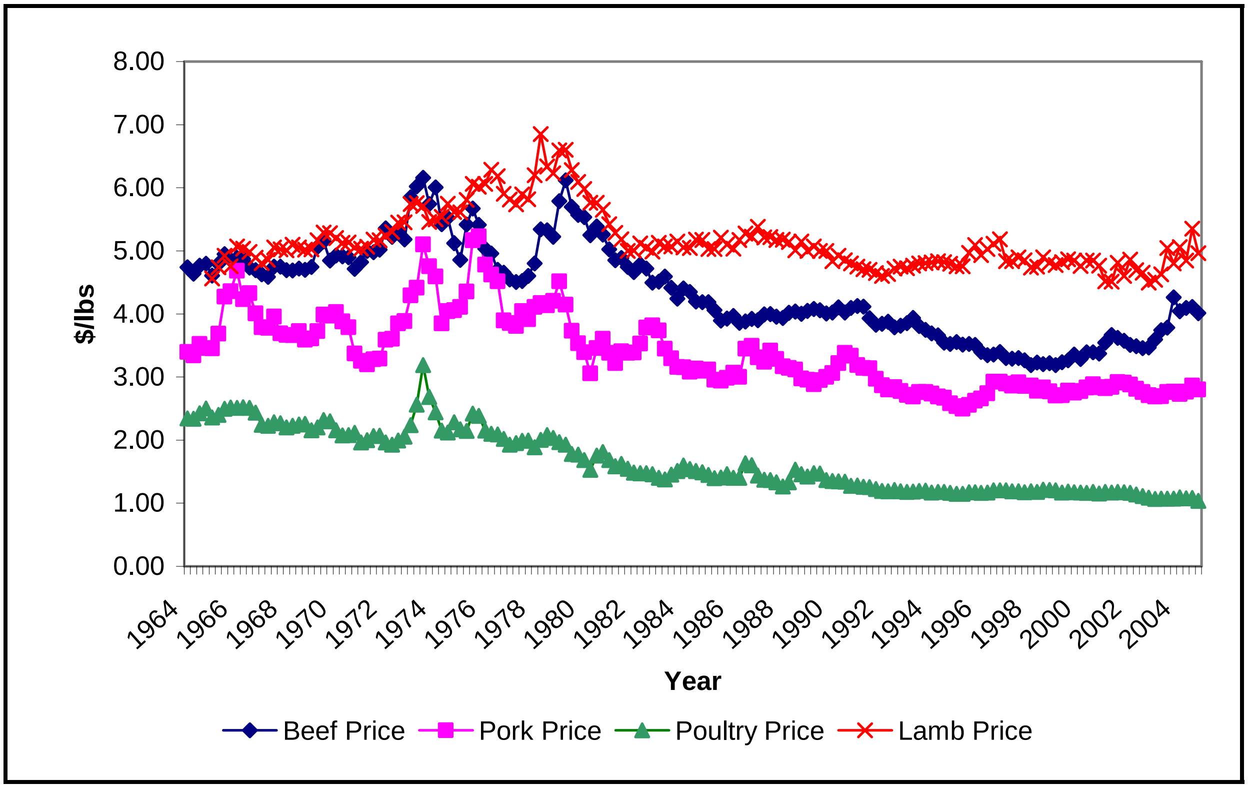
Figure 1-3 also shows that, similar to the beef industry, the inverse relationship between retail pork prices and consumption levels weakened between 1964 and 2004. This inverse relationship was quite strong up to about the early 1980s, and then consumption levels appear to have become less responsive to changes in real retail prices.

Figure 1-4 shows how relative real quarterly price levels for beef, pork, lamb, and poultry measured in 2004 dollars behaved over the period 1964 through 2004. During this period, the ranking of the most expensive to least expensive for the most part remains the same: lamb is the most expensive per pound, closely followed by beef and pork, and then poultry at a significantly lower price. However, in several periods prior to 1975, beef prices were slightly more expensive than lamb prices. During several periods, pork prices were almost as high as beef prices for a quarter or so (e.g., in the first quarter of 1966 and the fourth quarter of 1975), and in some periods, all three meats have experienced sharp rises (e.g., in 1974). Overall, the real prices of meat have declined steadily over the last several decades, and since the mid-1990s, prices have stabilized with an exception being the recent spike in beef prices.

Figure 1-5 shows how the composition of beef, pork, and poultry consumption has changed over the period 1964 through 2004. During this period, total meat (beef, pork, and poultry) per capita consumption on an annual basis has increased 27.8%. Specifically, in 1964 per capita consumption of beef, pork, and poultry combined was 171.2 pounds, and in 2004 it was 218.8 pounds (an increase of 47.6 pounds). Figure 1-5 illustrates that this increase can be attributed entirely to the substantial increase of poultry consumption, which averaged 9.7 pounds per quarter in 1964 compared with 25.4 pounds in 2004, an increase of 15.7 pounds per quarter (62.8 pounds on an annual basis). Poultry’s consumption level can be compared with beef and pork consumption levels, which averaged 18.7 and 14.5 pounds per quarter, respectively, in 1964 and were more recently 16.5 and 12.8 pounds per quarter, or 2.2 and 1.7 pounds less, respectively, in 2004. The increase in poultry consumption has been steady over the previous 4 decades, and the decline in beef consumption began in the mid-1970s. Pork consumption has remained relatively stable with only a slight downward trend.

Figure 1-4. U.S. Quarterly Retail Beef, Pork, Lamb, and Poultry Prices (2004 dollars), 1964–2004

The real prices for meat and poultry have been declining over time, but the relative ranking of beef, pork, lamb, and poultry prices has stayed the same.



Sources: U.S. Department of Agriculture, Economic Research Service. 2004g. *Red Meat Yearbook*. Stock #94006. Washington, DC: USDA. <http://usda.mannlib.cornell.edu/data-sets/livestock/94006/>.

U.S. Department of Agriculture, Economic Research Service. August 2004f. *Poultry Yearbook.* Washington, DC: USDA. <http://usda.mannlib.cornell.edu/data-sets/livestock/89007/>.

U.S. Department of Agriculture, Economic Research Service. 1973. "Livestock and Meat Statistics." Statistical Bulletin No. 522. Washington, DC: USDA.

U.S. Department of Agriculture, Economic Research Service. 1989. "Livestock and Meat Statistics." Statistical Bulletin No. 784. Washington, DC: USDA.

U.S. Department of Agriculture, Economic Research Service. 1994. "Livestock and Meat Statistics." *Red Meat Yearbook*, Statistical Bulletin No. 885. Washington, DC: USDA.

U.S. Department of Agriculture, Economic Research Service. 2005. *Livestock, Dairy, & Poultry Outlook.* Washington, DC: USDA. <http://www.ers.usda.gov/publications/ldp/>.

U.S. Bureau of Labor Statistics. "Consumer Price Index—All Urban Consumers, U.S. All Items." <http://data.bls.gov/cgi-bin/surveymost?cu>. Accessed April 18, 2005.

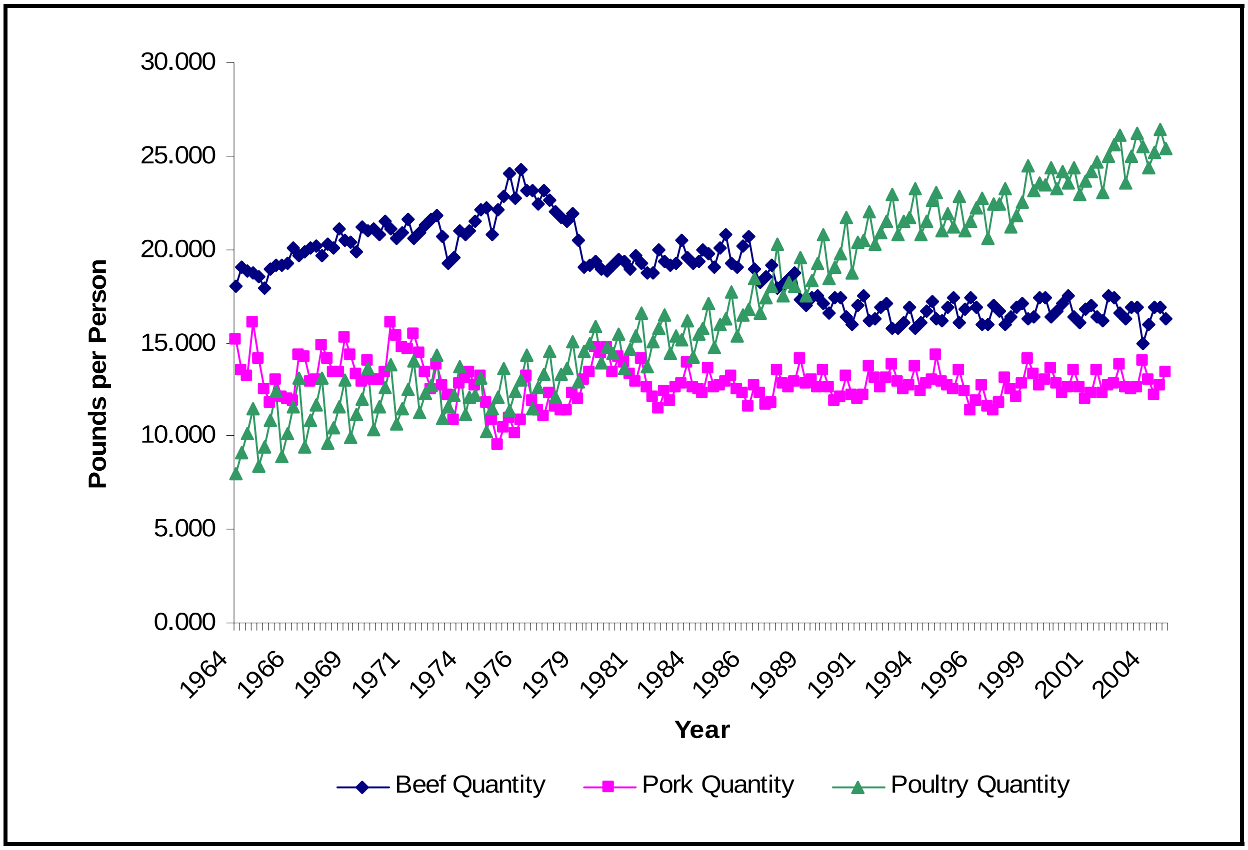
American Sheep Industry (ASI) Association. 2003/2004. "U.S. Sheep Industry Market Situation Report." Centennial, CO: ASI.

McDonnell, T., ASI. 2005. Personal communication with the study team.

Lamb consumption is not shown in Figure 1-5 because its scale compared with beef, pork, and poultry is extremely small. In the late-1960s, quarterly per capita lamb consumption was approximately 0.8 pounds, and consumption trended downward until 1980. Since then, lamb consumption has remained flat at approximately 0.3 pounds per person per quarter.

Figure 1-5. U.S. Quarterly Per Capita Beef, Pork, and Poultry Consumption (lbs per person), 1964–2004

Per capita meat and poultry consumption has increased over time, but the majority of the increase is due to increased poultry consumption. Lamb consumption is not included in the graph because it would appear only slightly above the horizontal axis.



Sources: U.S. Department of Agriculture, Economic Research Service. 2004g. *Red Meat Yearbook*. Stock #94006. Washington, DC: USDA. <http://usda.mannlib.cornell.edu/data-sets/livestock/94006/>.

U.S. Department of Agriculture, Economic Research Service. August 2004f. *Poultry Yearbook.* Washington, DC: USDA. <http://usda.mannlib.cornell.edu/data-sets/livestock/89007/>.

U.S. Department of Agriculture, Economic Research Service. 1994. “Livestock and Meat Statistics.” *Red Meat Yearbook*, Statistical Bulletin No. 885. Washington, DC: USDA.

U.S. Department of Agriculture, Economic Research Service. 2005. *Livestock, Dairy, & Poultry Outlook.* Washington, DC: USDA. <http://www.ers.usda.gov/publications/ldp/>.

U.S. Department of Commerce, Bureau of Economic Analysis. National Income and Product Accounts Table, Table 2.6 Personal Income and Its Disposition, Monthly. Washington, DC: U.S. Department of Commerce. <http://www.bea.gov/bea/dn/nipaweb/SelectTable.asp?Selected=N>.

U.S. Department of Agriculture, Economic Research Service. 2004c. “Food Consumption (Per Capita) Data System, Food Availability.” Washington, DC: USDA. <http://www.ers.usda.gov/data/foodconsumption/FoodAvailSpreadsheets.htm#mtpcc>.

1.1.2 Changes in Patterns of Meat Sales by Food Service Operators and Retailers

In 2003, U.S. consumers spent approximately $904 billion on food. These expenditures comprised $497 billion spent on food at home and $407 billion spent on food away from home (USDA/ERS, 2003, 2004a). Food expenditures by families and individuals accounted for 10.3% of disposable personal income in 2003, down from 12.5% in 1980. Food store sales reached $370 billion, accounting for over 74% of food-at-home sales. Food store sales have grown relatively slowly in recent years because of slow population growth and aggressive competition from other retailers, including mass merchandisers and warehouse club outlets.

Fresh meat, poultry, and fish sales comprised 13.3% of supermarket sales, making meat, poultry, and fish one of the highest selling categories in retail stores (Food Marketing Institute, 2004). The 2004 National Meat Case Study (NMCS) (2004) found that beef, pork, and chicken represented 90% of fresh meat in terms of linear feet. Beef's share was 43%, pork's share was 22%, and chicken's share was 25%. The study also found that lamb's meat case representation grew in 2004, while veal's declined.

Merchandising strategies for the total meat department appear to be shifting, resulting in a 6 percentage point decline for fresh meat and poultry's share of total linear feet and a corresponding increase in the share of linear feet for processed meats, ready-to-eat (RTE) products, and ready-to-cook products. Pork had the highest percentage of ready-to-eat packages, followed by turkey at 8%, chicken at 6%, and whole muscle beef at 4%.

The 2004 National Meat Case Study (NMCS) (2004) also found the following:

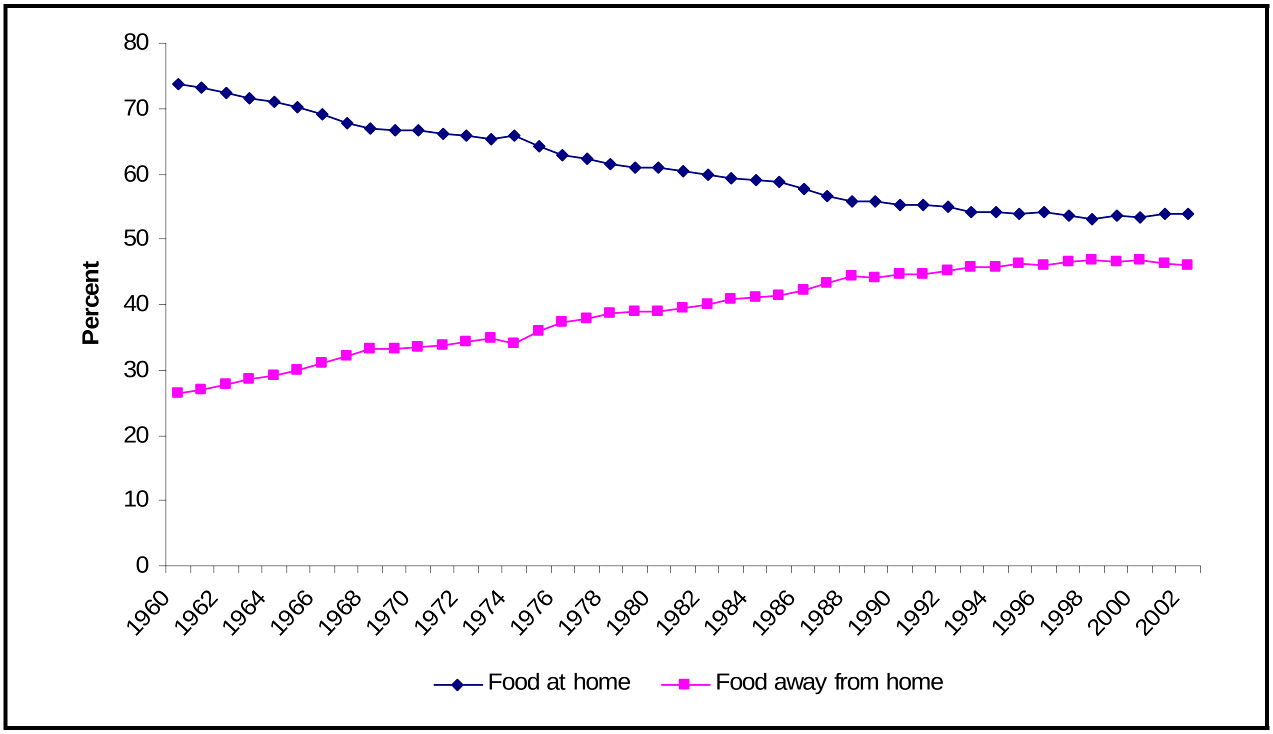
- Twenty-two percent of all meat packages carried a natural claim.
- Enhanced product represented 21% of all packages, with pork having the largest share at 45% followed by chicken with 23% and beef with 16%.
- A strong shift from in-store packaging of fresh meat products to packages prepared off site was evident (case-ready products increased from 49% in 2002 to 60% in 2004, with poultry having the largest share followed by ground beef, pork, lamb, veal, and whole muscle beef).
- Supplier-branded packages have become more prominent, with half of all self-serve packages carrying a supplier brand and 12% having a store brand (supplier-branded packages were most prominent in turkey with

86%, chicken with 77%, and pork with 56%, but the majority of beef packages were not branded).

Food service firms exhibited a similar pattern of slow growth and intense competition.

Food service firms exhibited a similar pattern of slow growth and intense competition. Restaurants accounted for almost $331 billion, or 81%, of total food service sales. As shown in Figure 1-6, consumers spent nearly half their food expenditures at restaurants and take-out establishments in 2002.

Figure 1-6. Expenditures for Food at Home and Food Away from Home, 1960–2002
Expenditures on food away from home have increased steadily, while expenditures on food consumed at home have decreased steadily.



Source: U.S. Department of Agriculture, Economic Research Service. 2004a. “Briefing Room-Food Market Structures: Food Service.” ERS Food Expenditure Series. <http://www.ers.usda.gov/Briefing/FoodMarket Structures/foodservice.asp>.

The relative expansion of the fast food market segment appears to have stalled in recent years. In 2002, sales at full-service restaurants accounted for a slightly larger share of total away-from-home food. Also, for meals eaten at home, an increasing number of those meals are fully prepared or partially prepared by outside sources. Supermarkets are attempting to regain food dollars lost to the food service industry by offering a menu of fully prepared meals. It is likely that the opportunity offered by food service for food retailing is quite large because demographic factors are changing the way people eat.

Large food service chains are continuing to gain market share. The top 50 U.S. restaurant franchisers accounted for 39% of separate eating place sales in 2000 compared with 28% in 1999 (Harris et al., 2002).

This consolidation has resulted in the emergence of very large retail groups, such as Kroger, Albertson's, Safeway, WalMart, and Ahold USA.

Competition in the retail sector from nontraditional retailers has been the catalyst for a wave of consolidation and transformation, which has seen the continued rise of supermarkets and hypermarkets and the steady decline of small traditional retail outlets.[4] For many food retailers, consolidation is driven by the competitive threat of WalMart and other discount retailers that have added retail food sales to their stores. This consolidation has resulted in the emergence of very large retail groups, such as Kroger, Albertson's, Safeway, WalMart, and Ahold USA. As shown in Figure 1-7, the top-four food retailers accounted for about 32% of U.S. retail food sales in 2001 compared with 19% for the top-four food retailers in 1997.[5]

The mergers among the large retailers are part of a strategy to seek additional growth opportunities and cost savings in the form of lower procurement costs and lower operating costs. Retailers are also attempting to gain sales by providing products that increase satisfaction to consumers who are characterized as time starved, nutrition conscious, quality conscious, and environmentally conscious. These efforts include introducing natural food products, expanding prepared food offerings, promoting store or private-label brands, expanding frequent shopper programs, and introducing self-service checkouts.

The changes in consumer expectations in terms of product quality, as well as the search for profitable niche markets, have led retailers to modify their merchandising and purchasing practices in the meat, fruit, and vegetable sectors.

The changes in consumer expectations in terms of product quality, as well as the search for profitable niche markets, have led retailers to modify their merchandising and purchasing practices in the meat, fruit, and vegetable sectors. These retailer initiatives have resulted in increased segmentation of product offerings on store shelves and in the meat case. Retailers now offer, in addition to standard products, differentiated products focusing on health, convenience, taste,

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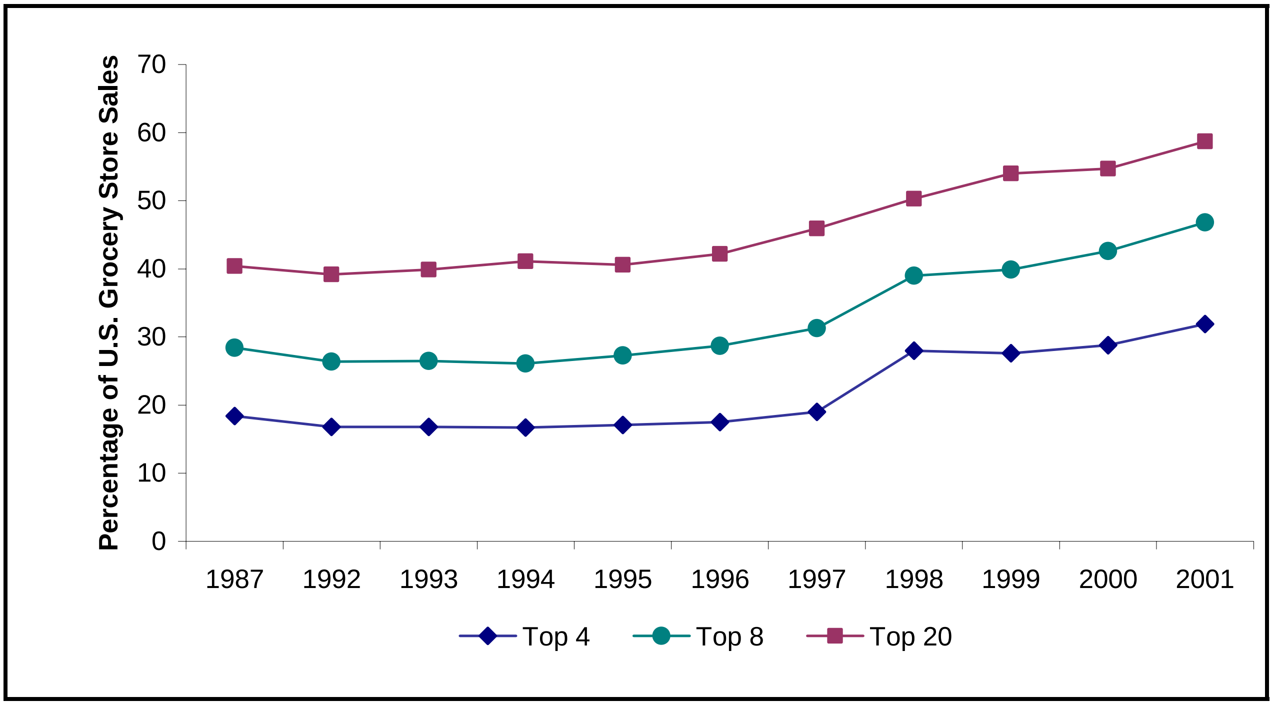
[4] A hypermarket is a store that combines a supermarket and a department store. In the United States, WalMart, Fred Meyer (part of the Kroger chain), Meijer, and Target operate hypermarkets.

[5] National concentration ratios may not reflect actual market power because supermarkets tend to compete on a local level.

Figure 1-7. Four-Firm Concentration Ratios (CR4s) for Grocery Retailers, 1987–2001[a]
The grocery retail sector has increased substantially since the mid-1990s.



[a] Ratios based on the North American Industry Classification System (NAICS), which reclassified some retail sales, resulting in higher concentration shares than under the previous Standard Industrial Code (SIC) classification system.

Source: U.S. Department of Agriculture, Economic Research Service. 2003. "Briefing Room-Food Market Structures: Food Retailing. ERS Food Expenditure Series." <http://www.ers.usda.gov/Briefing/FoodMarketStructures/foodretailing.htm>.

and information about how the food was produced. For example, several meat processors now offer case-ready branded meats to satisfy large retailers. As closer relationships are formed, processors are increasingly using AMAs to improve the quality of animal production and to ensure traceback capabilities.

New technologies, such as source verification (Meyer, 2001), are being developed to meet consumers' expectations for a healthy, safe product. Source verification systems allow the meat system to identify locations where problems exist and allow producers to track livestock as they move through the system, thereby providing information on quality. Producers can use this information to improve their decisions regarding production methods to better meet consumer demands.

1.2 OVERVIEW OF MARKETING ARRANGEMENTS IN MEAT DISTRIBUTION

Key dimensions that define a marketing arrangement in meat distribution and sales include

- procurement or sales method and
- pricing method (including formula pricing base and internal transfer pricing method).

In the context of the meat industry, as described above, we describe the types of marketing arrangements used in the sale of meat products from the packer downstream to different types of buyers. In this report, cash or spot market transactions refer to transactions that occur immediately or “on the spot.” These include auction barn sales; video or electronic auction sales; sales through order buyers, dealers, and brokers; and direct trades. The terms “cash market” and “spot market” are used interchangeably. “Alternative marketing arrangements” refer to all possible alternatives to the cash or spot market. In the distribution and sales of meat products downstream from the packer, alternatives to the spot market primarily include forward contracts and marketing agreements. In addition to the type of procurement or sales method, the other key dimension that defines a marketing arrangement is the pricing method, which is further defined by formula base, if formula pricing is used, and internal transfer pricing method, if the product is internally transferred within a single company.

Transactions may be for carcasses, single cuts, or a variety of processed products. Sales representatives usually start negotiations for individual products based on a price list and usually must meet sales quotas. Listed prices are discounted if inventories of that cut are plentiful. Other pricing practices used for meat products might include the following:

- two-part pricing—includes a fixed payment (e.g., slotting allowance) and a per-unit price;
- volume discounts—larger shipments have lower per-unit prices;
- exclusive dealings—the buyer is prohibited from buying and reselling the same products from another supplier; and
- bundling—the buyer must purchase other related products to receive a lower price.

In addition, the meat industry uses different types of supply chain structures to meet downstream customer needs. These include

- brand licensing programs,
- marketing alliances, and
- new-generation cooperatives.

Brand licensing programs are generally breed based (e.g., Certified Angus Beef, Certified Hereford Beef), although they need not be. These programs require livestock to meet a certain genetic "template," thereby creating value by centering the program around a branded product that uses breed to convey a certain level of quality. Licensing programs tend to be loosely coordinated, with the only obligation being the certification of participants (Anton, 2002).

Marketing alliances are programs initiated by processors and retailers. These programs are owned by operations that purchase finished livestock from livestock producers and/or feedlots using a quality-based grid that typically has quality, yield, and process requirements. Value is added by creating brand identification for niche products (such as Nolan Ryan's or Laura's Lean).

New generation cooperatives, such as Ranchers Renaissance or U.S. Premium Beef, typically limit membership, impose strict quality and delivery standards, and require a fairly substantial up-front investment. The structure is more formal than the vertical arrangements discussed above. Shares establish a two-way contract between the members and the cooperative, which requires members to sell a certain number of livestock through the cooperative and then the cooperative buys these livestock when ready for market. A grid-pricing system is generally used, thus providing members with a further incentive to comply with product specifications. In addition to premiums, dividends may be paid to members (Brocklebank and Hobbs, 2004).

1.3 DESCRIPTION OF THE MEAT PROCESSOR TRANSACTIONS DATA

Many of the analyses conducted for this volume were based on transactions data obtained from meat processors that receive meat inputs from packers and sell meat products to a variety of buyer types. We obtained usable meat purchase data from 32 meat processing plants (17 beef and 15 pork) and usable meat sales data from 11 meat processing plants (6 beef and 5 pork).[6] Data from lamb breaking plants were analyzed with the lamb packer data in Volume 5 of this report. We describe the data preparation process and content of the beef and pork records of the meat processor purchase data set and the sales data set below.

1.3.1 Meat Processor Purchase Transactions Data

For this volume of the report, we used meat product purchase records from 32 plants and meat product sales records from 11 plants in addition to other data sources.

Before tabulating and analyzing the meat processor purchase transactions data, we systematically examined the purchase data set to isolate and address data inconsistencies, data-reporting errors, or extraneous data. Specific data preparation procedures were as follows:

- **Meat type not identifiable.** Plants were asked to indicate whether their meat product was predominantly beef, pork, or lamb. For some data records, more than one meat type was chosen. After reviewing the product description, the predominant meat type could not be determined. These records were deleted (3 records).
- **Lamb products.** The meat product was predominantly lamb in fewer than 50 data records. Because these records represented an insignificant amount of the reported products, they were deleted (43 additional records).
- **Missing meat type.** Data records that did not indicate the type of meat predominantly used in the meat product were deleted (3,259 additional records).
- **Missing total cost.** Data records that did not contain total cost of the transaction were deleted (2,889 additional records).
- **Out-of-range prices.** Data records in which the cost per pound was greater than $50 per pound were deleted. Based on their product descriptions, these records were deemed to be erroneous (6 additional records).

Before data preparation, the data set included 60,031 meat processor purchase records. After data preparation, the final data set included 53,831 meat processor purchase records. Of these records, 73% of the pounds were pork products and 27% were beef products.

[6] Meat processing plants were asked to provide sales data only if the products they sold contained at least 50% meat by weight.

1.3.2 Meat Processor Sales Transactions Data

Fewer plants provided sales data than purchase data because we requested data only for products that were at least 50% meat. Thus, plants that use meat primarily as an ingredient in meat products were not required to provide sales data. Before tabulating the sales transactions data, we systematically examined the sales data set to isolate and address data inconsistencies, data-reporting errors, or extraneous data. Specific data preparation procedures were as follows:

- **Out-of-range weights.** Data records with a total weight less than or equal to 1 pound were deleted. Most of these records were either sales samples or erroneously reported (3,471 records).
- **Out-of-range list prices.** Data records for which the list price per pound was between $0.30 and $30 were retained. After reviewing the list prices of similar products, we determined that all prices outside this range were erroneously reported and were subsequently deleted (93 additional records).

Before data preparation, the data set included 851,859 meat sales records. After data preparation, the final data set included 848,295 meat sales records. Of these records, 64% were beef products and 36% were pork products.

1.4 ORGANIZATION OF THIS STUDY VOLUME

In Section 2 of this volume, we describe the role of AMAs in meat sales and distribution. The analyses are primarily descriptive and are based on the survey and transactions data. References follow in Section 3.

2 Volume and Quality Differences Associated with Alternative Marketing Arrangements

In this section, we present results on volume and quality differences associated with alternative marketing arrangements used by meat processors,[1] food wholesalers, food exporters, food service operators, and grocery retailers. The analyses in this section are based on the meat purchase and sales transactions data provided by meat processors and on the survey results for the industry surveys across all of these channels.

2.1 MEAT DISTRIBUTION VOLUMES BY TYPE OF MARKETING ARRANGEMENT

Volume 2 of this report discussed in detail the data collection methodology and the summaries of the surveys from downstream participants including processors, wholesalers, retailers, food service operators, and exporters. The results of the AMA use and pricing methods are summarized here followed by a summary of the transactions data from the meat processors.

[1] Meat processors are firms that process meat, but that do not slaughter livestock.

2.1.1 Summary of Downstream Survey Responses

We summarize the results of the downstream survey responses by each type of market participant below. Note that the survey responses represent a broad range of company sizes, including many small companies.

Meat Processors

Meat processors purchased most of their product on the spot market, but they also used other purchasing methods. The survey results indicated the following:

- An estimated 91% of the plants used the spot market for purchases, and 63% of plants used it exclusively.
- Forward contracting was used by nearly 20% of plants.
- Marketing agreements and internal company transfers were each used by approximately 13% of the plants.

The two most common methods used by meat processors to price meat purchases were price lists and individually negotiated prices. The specific survey results indicated the following:

- Approximately 60% of plants used each method.
- Formula pricing was used by 32% of plants and the most common base was a U.S. Department of Agriculture (USDA) publicly reported price (63%).
- Internal transfer pricing was used by 13% of plants.

Meat processors reported that 41% of sales were to wholesalers and distributors, 29% to food service operators, 21% to retailers, and 8% to other processors and food manufacturers. The specific survey results indicated the following results related to meat processor sales to downstream buyers:

- Approximately 60% of plants used the cash or spot market.
- Approximately 10% of plants used forward contracts.
- Approximately 10% or more of plants used marketing agreements.
- Approximately 9% of sales to other processors/manufacturers were internal transfers.

Wholesalers

The most common pricing methods for wholesaler purchases on a dollar basis were flat pricing[2] (56% of dollar purchases), formula pricing (27% of dollar purchases), and or-better pricing[3] (12% of dollar purchases). For companies using formula pricing, the most common base was a USDA reported price (61% of companies).

Flat pricing was the most common pricing method for meat sales as well (63% of meat dollar sales compared with 24% for formula pricing). Most formula pricing agreements were based on USDA reported prices (52% of companies) or retail prices (36%).

Exporters

The most common pricing methods to purchase meat employed by exporters were flat pricing (76% of dollar purchases) and to a lesser extent formula pricing, or-better pricing, and floor-and-ceiling pricing.[4] The most common base for formula pricing was a USDA reported price.

Retailers

The most common pricing methods for purchasing meat by retailers were flat pricing (53% of dollar purchases), formula pricing (21% of dollar purchases), or-better pricing (12% of dollar purchases), and floor-and-ceiling pricing (12% of dollar purchases). Formula-priced meat purchases were most often based on retail prices (62% of companies) or USDA reported prices (35% of companies).

Food Service Operators

The most common pricing methods to purchase meat for food service operators were flat pricing (48% of dollar purchases), or-better pricing (21% of dollar purchases), floor-and-ceiling pricing (16% of dollar purchases), and formula pricing (14% of

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[2] Under flat pricing, buyers and sellers agree to a specific dollar per pound for a specified period.

[3] Under or-better pricing, buyers and sellers agree to a specific dollar per pound for a specified period; however, if the market price decreases during that time, then the purchase (sales) price decreases as well.

[4] Under floor-and-ceiling pricing, agreed upon purchase (sales) price increases and decreases with market prices, but the price has a lower limit and an upper limit for a specified period.

dollar purchases). The formula base price was most often tied to a retail price (61% of companies).

2.1.2 Summary of Meat Processor Transactions Data

We summarize the meat processor transactions data for purchases and for sales below. Meat processors were required to provide sales data only for products that contained at least 50% meat by weight. Only the largest processing plants were asked to provide transactions data. Smaller processing plants would have faced a significant burden in providing transactions data and were thus excluded.

Meat Processor Purchases

Thirty-two meat processing plants provided transactions data on purchases of beef and pork between October 2002 and March 2005. These data included nearly 54,000 transactions or records representing 1.227 billion pounds of product (Table 2-1). The respondents included 17 beef processing plants (owned by 11 companies) representing 27% of the volume by weight and 15 pork processing plants (owned by 9 companies) representing 73% of the volume by weight.

Table 2-1. Summary of Available Data on Purchase of Meat Products by Processors, October 2002–March 2005

Type of Purchase	Number of Plants	Number of Transactions (Records)	Number of Pounds	Percentage of Pounds Purchased
Beef	17	11,726	331,068,124	27.0%
Pork	15	42,105	896,226,877	73.0%
Total	32	53,831	1,227,295,001	100.0%

Note: Plants that are lamb breakers are not included in this summary.

It is important to note that these processors varied greatly in final products produced and in the meat they purchased (Table 2-2). Of the beef processors' transactions, nearly half were highly processed, with 39% RTE. Another 22% of the records were ground beef and trimmings. Primal cuts and carcasses or sides were very small percentages. An additional 23% of the records were classified as other or missing. Pork processors had fewer transactions than beef with processed product. Ground pork and trimmings accounted for 19% of the records, and approximately a fourth of the purchase records

Table 2-2. Summary Statistics for Meat Purchase Lot Characteristics, October 2002–March 2005

Statistic	Number of Records	Mean	St. Dev.
Total weight (lbs)	53,831	22,799	43,331
Total cost ($)	41,595	1.14	0.58
Meat cost ($)	53,088	1.06	0.55
Shipping cost ($)	18,953	0.01	0.02
Miscellaneous cost ($)	21,595	0.00	0.01
Statistic	**Number of Records**	**Percentage of Records**	
Branded	15,648	29.1	
Certification	0	0.0	
Beef product classification			
Carcass or side	D	D	
Primal cut	D	D	
Subprimal cut	0	0.0	
Ground and trimmings	3,783	22.4	
Portion cut	D	D	
Case Ready	0	0.0	
Processed RTE	6,516	38.6	
Processed NRTE	D	D	
Other or missing	3,861	22.9	
Pork product classification			
Carcass or side	D	D	
Primal cut	D	D	
Subprimal cut	13,034	31.0	
Ground and trimmings	8,171	19.4	
Portion cut	0	0.0	
Case ready	0	0.0	
Processed RTE	9,893	23.5	
Processed NRTE	D	D	
Other or missing	6,798	16.2	
Tenderized/marinated	D	D	
Added ingredients	11,069	20.6	
Refrigeration			
Chilled/fresh	32,906	61.1	
Frozen	8,879	16.5	
Other or missing	12,046	22.4	

D = Results suppressed.

were RTE or NRTE. However, 31% of pork records were subprimal cuts and a very small percentage were primal cuts and whole or sides of carcasses.

Twenty-nine percent of the transactions were identified as branded product. Twenty-one percent had added ingredients and a smaller percentage were tenderized or marinated. Over half of the purchase transactions were for chilled/fresh product (61%), and 17% were for frozen product.

The meat processors providing transactions data were asked to identify the purchase method used for each record (Table 2-3). Beef processors purchased a moderate percentage of their beef tonnage on the spot market. A similar share by weight was purchased with forward contracts (28%), but it was a smaller number of transactions, indicating that each transaction was larger. The average size of a forward contract transaction was nearly 48,000 pounds compared with 18,200 pounds for spot market purchases. Marketing agreement trades made up 17% of records, but only 7% of product, and internal transfers were virtually nonexistent for beef. However, 39% of the product and 26% of the records were listed as other or were missing, indicating that the processors contacted either did not identify with the categories provided or do not track this information.

Pork processors acquired much more of their product through internal transfer than did beef processors. Marketing agreements accounted for nearly half of the records (48%), but 23% of the product. The spot market represented a smaller percentage of the product and records. Forward contracts were less than 1% of either product or transactions, and other or missing was 32% of product and 24% of transactions.

Based on the totals in Table 2-3, spot market, marketing agreement, and internal transfer arrangements had nearly equal shares of combined product traded. However, this average is not very meaningful because pork purchase methods were quite different from beef.

The meat processors were also asked to identify the pricing method used for each record (Table 2-4). Other than price list, which was used only rarely for beef, the pricing methods differed substantially. As with purchase method, a moderate percentage of pork products and no beef products were acquired through internal transfer. Thirty-nine percent of beef

Table 2-3. Summary of Meat Purchase Methods by Meat Type, October 2002–March 2005

Product Type	Cash or Spot Market	Forward Contract	Marketing Agreement	Internal Company Transfer	Other or Missing	Total
Beef products						
No. of records	D	1,920	1,975	D	3,050	11,726
% of records		16.4%	16.8%		26.0%	100.0%
No. of pounds	D	91,822,289	24,367,462	D	127,761,734	331,068,124
% of pounds		27.7%	7.4%		38.6%	100.0%
Pork products						
No. of records	D	175	20,024	D	10,139	42,105
% of records		0.4%	47.6%		24.1%	100.0%
No. of pounds	D	6,003,967	204,342,874	D	282,539,920	896,226,877
% of pounds		0.7%	22.8%		31.5%	100.0%
All products						
No. of records	13,457	2,095	21,999	3,091	13,189	53,831
% of records	25.0%	3.9%	40.9%	5.7%	24.5%	100.0%
No. of pounds	253,653,755	97,826,256	228,710,335	236,803,000	410,301,654	1,227,295,002
% of pounds	20.7%	8.0%	18.6%	19.3%	33.4%	100.0%

D = Results suppressed.

Table 2-4. Summary of Meat Purchase Pricing Methods by Meat Type, October 2002–March 2005

Product Type	Price List	Negotiated	Formula Pricing	Internal Transfer Pricing	Other or Missing	Total
Beef products						
No. of records	D	6,013	2,793	D	D	11,726
% of records		51.3%	23.8%			100.0%
No. of pounds	D	129,742,790	76,895,605	D	D	331,068,124
% of pounds		39.2%	23.2%			100.0%
Pork products						
No. of records	0	1,130	31,992	D	D	42,105
% of records	0.0%	2.7%	76.0%			100.0%
No. of pounds	0	3,845,502	501,624,750	D	D	896,226,877
% of pounds	0.0%	0.4%	56.0%			100.0%
All products						
No. of records	D	7,143	34,785	D	8,758	53,831
% of records		13.3%	64.6%		16.3%	100.0%
No. of pounds	D	133,588,292	578,520,356	D	277,727,796	1,227,295,002
% of pounds		10.9%	47.1%		22.6%	100.0%

D = Results suppressed.

pounds and 51% of beef transactions were negotiated pricing compared with 0.4% and 3% of pork pounds and transactions that were negotiated. Formula pricing represented 76% of transactions and 56% of product weight for pork. For beef, formula pricing was approximately 23% of both transactions and weight. Other or missing represented 23% of product pounds and 16% of the records overall.

The most common base for pricing formulas was the USDA reported price, covering 99% of pork and 55% of beef product that was priced by formula (Table 2-5). The other base often used for purchased beef was a subscription service. Although nearly all pork pricing formulas are based on USDA reported prices, it is worth noting that wholesale pork, while reported by USDA, is not covered under MPR.

Table 2-5. Summary of Types of Formula Bases Used for Meat Purchases by Meat Type, October 2002–March 2005

Product Type	USDA-Reported Price	Subscription Service Price	Other Market Price	Other or Missing	Total
Beef products					
No. of records	1,443	D	0	D	2,793
% of records	51.7%		0.0%		100.0%
No. of pounds	42,072,923	D	0	D	76,895,605
% of pounds	54.7%		0.0%		100.0%
Pork products					
No. of records	31,316	0	D	D	31,992
% of records	97.9%	0.0%			100.0%
No. of pounds	494,521,517	0	D	D	501,624,750
% of pounds	98.6%	0.0%			100.0%
All products					
No. of records	32,759	D	D	D	34,785
% of records	94.2%				100.0%
No. of pounds	536,594,440	D	D	D	578,520,356
% of pounds	92.8%				100.0%

D = Results suppressed.

Branded meat purchases by beef and pork processors accounted for 37% of product pounds reported by participants (Table 2-6). Sixty percent of the spot market product purchased was branded, while 25% of the forward contract product was branded.

Table 2-6. Meat Branding by Purchase Method, October 2002–March 2005

Quality Measure	Cash or Spot Market	Forward Contract	Marketing Agreement	Internal Company Transfer	Other or Missing	Total
Branded						
No. of pounds	153,155,971	24,037,197	0	D	D	454,920,965
% of pounds	60.4%	24.6%	0.0%			37.1%

D = Results suppressed.

The type of product purchased by processors was somewhat related to purchase methods (Table 2-7). Those buying unprocessed meat were much more likely to use internal transfer than other methods. Those buying processed meat were more likely to use a marketing agreement (31%) than forward contracts or internal transfers. Virtually no processed product was purchased on the spot market. The internal transfer of unprocessed meat was predominately pork.

Meat Processor Sales

Eleven processors (six beef and five pork processors) provided sales transactions data (Table 2-8). Part of the decrease in reporting between meat purchases and meat sales is that the product must be at least 50% meat to be included in the study. Many products that processors prepared had less than 50% meat in the final product. Unlike the purchase data that had 53,831 records averaging 22,800 pounds per transaction, there were 848,295 sales records that averaged 771 pounds per transaction. Thus, processors play a distribution role in the value chain by purchasing large lots from a few firms and selling small lots to many small downstream buyers.

Sixty-eight percent of the transactions and 64% of the product sold was beef compared with pork (Table 2-8). Ninety percent of purchases were by retailers and 39% of transactions were of branded product (Table 2-9). The processors reporting produced only two products—case ready and processed RTE.

Table 2-7. Type of Alternative Marketing Arrangements Used for Meat Purchases by Meat Processors, by Level of Processing, October 2002–March 2005

		Meat Purchase Method					
Level of Processing	Type	Cash or Spot Market	Forward Contract	Marketing Agreement	Internal Company Transfer	Other or Missing	Total
Unprocessed meat	No. of records	4,022	1,630	D	D	D	29,659
	% of records	13.6%	5.5%				100.0%
	No. of lbs	74,548,393	73,546,089	D	D	D	671,698,640
	% of lbs	11.1%	10.9%				100.0%
Processed meat	No. of records	D	D	5,702	D	6,990	13,510
	% of records			42.2%		51.7%	100.0%
	No. of lbs	D	D	111,040,210	D	222,990,846	363,477,646
	% of lbs			30.5%		61.3%	100.0%
Other	No. of records	D	D	D	0	D	10,662
	% of records				0.0%		100.0%
	No. of lbs	D	D	D	0	D	192,118,716
	% of lbs				0.0%		100.0%
Total	No. of records	13,457	2,095	21,999	3,091	13,189	53,831
	% of records	25.0%	3.9%	40.9%	5.7%	24.5%	100.0%
	No. of lbs	253,653,755	97,826,256	228,710,335	236,803,000	410,301,654	1,227,295,002
	% of lbs	20.7%	8.0%	18.6%	19.3%	33.4%	100.0%

D = Results suppressed.

Table 2-8. Summary of Available Data on Sales of Meat Products by Processors, October 2002–March 2005

Type of Purchase	Number of Plants	Number of Transactions (Records)	Number of Pounds	Percentage of Pounds Purchased
Beef	6	574,286	417,846,936	64.0%
Pork	5	274,009	236,383,627	36.0%
Total	11	848,295	654,230,563	100.0%

Note: Plants that are lamb breakers are not included in this summary.

For beef, a higher percentage of product was case ready than processed RTE; for pork the opposite was true. Twenty-three percent of transactions were for products that were tenderized or marinated, and 100% had added ingredients. Approximately 97% of the product records were for fresh chilled product as opposed to frozen.

A high percentage of records and pounds did not identify the sales method, indicating that processors either do not identify the categories that were listed or do not track this information. Likewise, only a few beef sales transactions by meat processors reported being on negotiated pricing, and the vast majority were other or missing. Pork processors reported that approximately half of their transactions used negotiated pricing, and approximately one-fourth of their sales used formula pricing.

In summary, the meat processor purchases were heavily weighted by pork as 73% of the weight, and 78% of the transactions were by pork processors. The purchased product ranged from carcasses to RTE meats. Purchase and pricing methods differed by type of meat; pork had more internal transfers and marketing agreements, while beef had more spot market and forward contract usage. Buyers mix and match purchase and pricing methods as formula pricing was used as the pricing method for spot market, forward contracts, and marketing agreements. Likewise, individually negotiated prices were more common in forward contracts than spot markets. Finally, branded product was the majority of the spot market product and one-fourth of forward contracts and was not reported in marketing agreements or internal transfers. Thus,

Table 2-9. Summary Statistics for Meat Sales Characteristics, October 2002–March 2005

Statistic	Number of Records	Mean	St. Dev.
Total weight (lbs)	848,295	771	2,563
List price ($)	848,295	1,911	6,269
Gross price ($)	848,295	1,925	6,275
Price adjustments ($)	821,968	10	98
Net price ($)	848,295	1,901	6,266
Shipping cost ($)	841,922	24	66
Commission cost ($)	191,981	21	47
Statistic	**Number of Records**	**Percentage of Records**	
Buyer type			
Meat processor/food manufacturer	D	D	
Wholesaler/broker/distributor	26,583	3.1	
Retailer	766,350	90.3	
Food service operator	D	D	
Foreign buyer	0	0.0	
Other or missing	53,743	6.3	
Branded	329,097	38.8	
Other certification	0	0.0	
Beef product type			
Primal cut	0	0.0	
Subprimal cut	0	0.0	
Ground and trimmings	0	0.0	
Portion cut	0	0.0	
Case ready	D	D	
Processed RTE	D	D	
Processed NRTE	0	0.0	
Other or missing	0	0.0	
Pork product type			
Primal cut	0	0.0	
Subprimal cut	0	0.0	
Ground and trimmings	0	0.0	
Portion cut	0	0.0	
Case ready	D	D	
Processed RTE	D	D	
Processed NRTE	0	0.0	
Other or missing	0	0.0	

(continued)

Table 2-9. Summary Statistics for Meat Sales Characteristics, October 2002–March 2005 (continued)

Statistic	Number of Records	Percentage of Records
Tenderized/marinated	195,442	23.0
Added ingredients	848,295	100.0
Refrigeration		
Chilled/fresh	824,800	97.2
Frozen	D	D
Other or missing	D	D

D = Results suppressed.

for these processors providing transactions data, AMAs are not a necessary condition for branded programs.

The sales data from meat processors showed that they produced case ready and RTE beef and pork that was sold primarily to retailers. Very little product was sold on the spot market. Over one-third of the pork was priced by negotiation and nearly one-fourth was priced by formula. A few beef sales were priced by negotiation or formula, but more were listed under other or missing.

Comparison of Survey Results and Transactions Data

The survey includes a broad cross section of meat processors while the transactions data comes from the largest meat processors. These two sources of information provide more information that either source alone. However, we note some differences between the meat processor survey results and transactions-level data analyzed from meat processors. Much of this difference can be attributed to samples that represent different companies. The difference is most apparent by looking at the meat products purchased and sold. The survey included 63 firms selling an average of $15 million of beef and 77 firms selling $5.5 million of pork. The transactions data included 17 beef firms representing 27% of transactions and 15 pork firms representing 73% of transactions. The survey also included firms processing lamb and combination meat products. In both analyses, beef and pork processors' largest purchases were ground meat and trimmings and RTE products. Firms in the survey certified 30% of their product compared with no certification of product in the transactions data.

The two samples differed by who the customer was. Ninety percent of the transactions records were to retailers. However, the survey results indicate that 41% of sales were to wholesalers and distributors, 29% to food service operators, 21% to retailers, and 8% to other processors and manufacturers.

There is a large difference in purchasing methods between the two samples. The survey indicated that 91% of firms used the spot market to purchase product and 63% used it exclusively. Yet only 25% of the transactions records and 21% of the volume by weight for both beef and pork processors were in the spot market. In turn, the transactions data show more firms use AMAs than the survey indicates, particularly marketing agreements and internal transfers. The methods used by pork processors were dominant in the transactions data because they represented three-fourths of the observations.

The two most common methods used to price meat purchases by processors surveyed were price lists and individually negotiated prices, with approximately 60% of plants using each method. Formula pricing was used by 32% of plants, and 13% of plants used internal transfers. This compares with 11% of transactions records by negotiated pricing and virtually none by price list. Formula pricing was used for 47% of transactions, and internal transfer was used for a much smaller percentage. As with purchasing methods, pricing methods were weighted heavily by pork processors' transactions that had much fewer negotiated and much more internal transfers than did beef processors. Sixty-three percent of surveyed plants using formula pricing reported using a USDA publicly reported price. However, 93% of the transactions data using a formula based it on USDA-reported prices.

Transactions data for product sales were from an even smaller number of firms, 11 in total. The requirement that products must include at least 50% meat to be included in this analysis excluded firms and records. The survey reported that the spot market was used by 60% or more of plants and 10% of plants used forward contracts. The transactions records rarely indicated the sales method used.

Understanding Downstream Linkages

It is important to recognize that individual firms may have a dominant practice for purchases, sales, and pricing that is different from other competing firms. Averaging such firms together may provide an overview of the sector but does not represent any one firm. For example, some processors are wholly owned by a packer, and 100% of their product purchases are internal transfers. Another processor reported 100% of purchases in the spot market using USDA-reported prices in a formula purchase. Still other processors reported all marketing agreement or all forward contract. Although some processors transactions data did reflect a mix of purchasing and/or pricing methods, many were all of one method. This dominant method approach was apparent in the survey data as well. Sixty-three percent of the processors surveyed indicated they used the spot market exclusively. Thus, depending on which processor provided transactions data for purchases or sales, it is not surprising that the data do not match the survey results.

Another explanation for differences between the survey and transactions data besides sampling may be due to human perception versus actual data. The transactions data are factual records of the number and size of actual trades. The data were sent to and summarized by researchers on the project. The survey was mailed to firms to complete on site and return to researchers on the project. We do not know who within the plant completed the survey or what information he or she used to answer the questions. It is possible that a higher level of spot market use reported in the survey is due to the level of activity or work associated with the spot market compared with an ongoing AMA with a customer. Other possible perception versus actual data differences may exist.

2.2 QUALITY DIFFERENCES ASSOCIATED WITH MARKETING ARRANGEMENTS IN THE BEEF INDUSTRY

In this section, we present the results of descriptive analyses on beef quality differences and branded products for different marketing arrangements used by beef packers. The analysis focuses on beef packer purchases of cattle and sales of beef in the production and sale of branded products. Because the beef branded programs often rely on quality grades, (i.e., CAB), the beef data provides a vehicle to evaluate the relationship between live animal purchases and product sales and the role of AMAs.

One measure of beef quality is the percentage of product that is branded meat products. Presumably, product that represents a company's brand is of higher quality or at least more consistent quality than commodity product. The transactions data were sorted into two categories: plants that sell little branded product (0% to 20%) and plants that sell a moderate amount of branded product (21% to 40%).[5] No plants reported selling more than 40% of product as branded product. We then compared the cattle-purchasing methods for these two groups of plants. The hypothesis is that AMAs are necessary to secure the higher quality cattle needed for branded product. If so, plants selling more branded product would have a higher percentage of AMAs.

The results are summarized in Tables 2-10 and 2-11. Seventeen plants in the 0% to 20% branded product category purchased 32.4 million cattle in 357,000 lots during the data period. The seven plants in the 21% to 40% branded product category purchased 21.5 million cattle in 178,000 lots.

Table 2-10. Fed Cattle Purchase Transactions Based on Beef Product Branding Categories, October 2002–March 2005

		Steers and Heifers		
Percentage of Branded Products	**Number of Plants**	**Number of Lots**	**Number of Cattle**	**Hot Weight (lbs)**
0%–20% branded	17	356,948	32,382,229	25,190,641,373
21%–40% branded	7	177,881	21,493,892	16,892,303,828
Total	24	534,829	53,876,121	42,082,945,201

[5] Matching the timing of cattle slaughter by purchase method with beef sales by sales method at the plant level was not feasible because plants do not maintain their data in such a way that a purchase transaction can be matched to the subsequent multiple sales transactions. The cross-tab analysis provides an aggregate comparison.

Table 2-11. Beef Sales Product Branding, by Type of Cattle Purchase Method (No. of Plants = 24), October 2002–March 2005

Percentage of Branded Products	Type	Fed Cattle Purchase Method							
		Auction Barns	Dealers/ Brokers	Direct Trade	Forward Contract	Marketing Agreement	Packer Fed Owned	Other or Missing	Total
0%–20% branded	No. of lots	D	5,345	186,600	9,003	95,415	D	7,952	356,948
	% of lots		1.5%	52.3%	2.5%	26.7%		2.2%	100.0%
	No. of lbs	D	359,324,298	13,552,944,116	784,573,212	7,318,432,004	D	400,011,106	25,190,641,373
	% of lbs		1.4%	53.8%	3.1%	29.1%		1.6%	100.0%
21%–40% branded	No. of lots	D	0	115,364	9,117	48,229	D	484	177,881
	% of lots		0.0%	64.9%	5.1%	27.1%		0.3%	100.0%
	No. of lbs	D	0	10,444,169,384	936,042,161	4,902,547,745	D	44,624,345	16,892,303,828
	% of lbs			61.8%	5.5%	29.0%		0.3%	100.0%
Total	No. of lots	43,968		301,964	18,120	143,644	27,133		534,829
	% of lots	8.2%		56.5%	3.4%	26.9%	5.0%		100.0%
	No. of lbs	1,864,571,565		23,997,113,500	1,720,615,373	12,220,979,749	2,279,665,014		42,082,945,201
	% of lbs	4.5%		57.0%	4.1%	29.0%	5.4%		100.0%

D = Results suppressed.

The 0% to 20% plants bought a higher percentage of their cattle through auctions and dealers than did the 21% to 40% plants, and they bought a smaller percentage of cattle through direct trade. However, when we combine these three spot market methods and compare them with the three AMA methods, we see no difference in the use of AMAs related to the level of branded product sold. Both types of plants purchased a majority of their cattle on the spot market.

Although the differences were small, the 21% to 40% plants used more forward contracts and less packer ownership than did the 0% to 20% plants. Shares of marketing agreement cattle were nearly identical across the two groups.

Another argument made for using AMAs to buy cattle is to fulfill downstream agreements with customers. To evaluate this claim, we compared cattle purchase methods with beef sales methods (Tables 2-12 and 2-13). Beef plants that specified sales methods were divided into two groups: 0% to 50% cash or spot market beef sales and 51% to 100% cash or spot market beef sales. The 0% to 50% cash group had five plants, 129,000 lots, and 16.0 million cattle purchased. The 51% to 100% group represented nine plants, 169,000 lots, and 18.8 million cattle purchased. Although the 0% to 50% cash group bought a smaller percentage of their needs through auctions and dealers than did the 51% to 100% cash group, they purchased more direct trade cattle. Transactions from both groups indicated they bought equal percentages of their cattle through the spot market. The 0% to 50% cash group used more marketing agreements, and the 51% to 100% cash group had more packer owned cattle. Thus, there was no substantial difference in the use of AMAs compared with spot market purchases based on beef sales methods for the transactions data reviewed.

Table 2-12. Fed Cattle Purchase Transactions Based on Sales Transactions Categories, October 2002–March 2005

% Cash Market Sales	Number of Plants	Steers and Heifers: Number of Lots	Steers and Heifers: Number of Cattle	Hot Weight (lbs)
0%–50% cash market	5	128,943	15,980,944	12,584,269,659
51%–100% cash market	9	169,100	18,784,484	14,624,122,186
Not specified	10	236,786	19,110,693	14,874,553,355
Total	24	534,829	53,876,121	42,082,945,201

Table 2-13. Use of AMAs for Cattle Purchases Based on Use of Marketing Arrangements for Beef Sales (No. of Plants = 24), October 2002–March 2005

Percentage of Cash Market Sales	Type	Fed Cattle Purchase Method							
		Auction Barns	Dealers/ Brokers	Direct Trade	Forward Contract	Marketing Agreement	Packer Fed Owned	Other or Missing	Total
0%–50% cash market	No. of lots	D	0	83,463	4,878	39,579	0	D	128,943
	% of lots		0.0%	64.7%	3.8%	30.7%	0.0%		100.0%
	No. of lbs	D	0	7,527,523,134	516,449,199	4,445,851,118	0	D	12,584,269,659
	% of lbs		0.0%	59.8%	4.1%	35.3%	0.0%		100.0%
51%–100% cash market	No. of lots	7,868	D	89,019	6,750	41,712	D	D	169,100
	% of lots	4.7%		52.6%	4.0%	24.7%			100.0%
	No. of lbs	664,458,515	D	8,110,288,479	727,017,575	3,139,671,080	D	D	14,624,122,186
	% of lbs	4.5%		55.5%	5.0%	21.5%			100.0%
Not specified	No. of lots	D	D	129,482	6,492	62,353	3,892	0	236,786
	% of lots			54.7%	2.7%	26.3%	1.6%	0.0%	100.0%
	No. of lbs	D	D	8,359,301,887	477,148,599	4,635,457,551	307,776,269	0	14,874,553,355
	% of lbs			56.2%	3.2%	31.2%	2.1%	0.0%	100.0%
Total	No. of lots	43,968		301,964	18,120	143,644	27,133		534,829
	% of lots	8.2%		56.5%	3.4%	26.9%	5.0%		100.0%
	No. of lbs	1,864,571,565		23,997,113,500	1,720,615,373	12,220,979,749	2,279,665,014		42,082,945,201
	% of lbs	4.5%		57.0%	4.1%	29.0%	5.4%		100.0%

D = Results suppressed.

Finally, the packer transaction data were sorted by beef sales type to determine whether the market outlet influenced the choice of cattle procurement methods. Three categories of beef buyers were identified as low or high volume purchases of beef from packers. These buyer types are meat processors, retailers, and food services. While the differences in the use of spot market and AMA purchases of fed cattle by packers in each buyer type category were not large, they did exist. Packers that sold more beef to meat processors bought fewer cattle on the spot market, but about the same number of cattle through AMAs (with the difference resulting from a larger percentage of other purchases or missing information). Packers that sold a larger amount of beef to retailers bought a larger percentage of their cattle on the spot market and a slightly lower percentage of cattle through AMAs. Finally, packers that sold more beef to food service bought a higher percentage of cattle in the spot market and lower percentage through AMAs. The differences in purchase volumes were approximately 10 percentage points more in the spot market and 10 percentage points less through AMAs. In summary, comparing cattle purchase methods across types of buyers for beef products did not reveal substantial differences. Spot market purchases were near 60% of cattle bought and AMAs represented 35% to 40% of cattle purchased regardless of buyer type.

The cross-tab analysis of aggregate cattle purchase and beef sales data suggests little correlation between quality measures and downstream commitments and the use of AMAs. The motivation and use may be stronger for an individual firm or marketing program. A possible explanation for this weak relationship in the aggregate data may be the nature of the beef industry and the relative size of these programs compared with the total market. For example, the widely recognized Certified Angus Beef (CAB) program is based on product specifications determined at slaughter rather than on process specifications during the animal's lifetime. Only 5 of 43 USDA branded beef programs[6] have standards beyond what can be determined via visual inspection of the animal or carcass at slaughter. Thus, regardless of how the animal is procured, as long as it and its carcass meet the CAB specifications, it

[6] See USDA's Agricultural Marketing Service's "Comparison of Certified Beef Programs," updated June 8, 2006, at http://www.ams.usda.gov/lsg/certprog/industry.htm.

qualifies for the program. The market share of branded beef is also relatively small. Only 14% to 15% of cattle qualify for CAB, widely recognized as the most successful branded beef. Given the measurable carcass specifications that define a brand and the relatively small portion of beef in branded programs compared with commodity beef, it is more efficient for packers and processors to sort carcasses than it is to produce cattle to meet the specifications.

It should also be noted that most packers sell to a variety of markets. That is, carcasses produce many different products (from steaks to hamburger) and packers buy cattle that vary in levels of quality that cannot be determined until after slaughter. Grid marketing, in AMAs or spot markets, sends price signals to sellers regarding quality and yield grade differences and shares the risk of off-specification carcasses between buyers and sellers. AMAs may help packers narrow the distribution of cattle purchased and more accurately meet the specifications of particular downstream markets, but AMAs cannot predict with certainty the quality grade of cattle. Thus, as long as quality grades and not credence attributes are primary determinants of brand or other downstream market specifications, AMAs will likely not be a necessary condition for quality.

2.3 SUMMARY

We analyzed and compared meat purchase and sales transactions data from meat processors with survey data from downstream users. Seventy-three percent of the product represented in the transactions records was pork and the remainder was beef. Over 40% of the pork and 60% of the beef purchased by these processors was ground (including trimmings) or RTE product, and 100% of the sales were either case-ready or RTE product.

Processors purchased a smaller percentage of their beef and pork on the spot market compared to AMAs. These transactions results have less spot market purchases than was reflected in the survey where 91% of processors used the spot market to purchase meat and 63% used it exclusively.

It was also apparent that processors either do not keep track of the purchase method or do not identify with the categories listed because 39% of the beef processors and 32% of the pork processors recorded the purchase method as “other” or it was missing. Even fewer processing plants provided usable meat sales data and it represented more beef than pork. Even fewer sales transactions were identified by selling method. Formula pricing, most often based on USDA reported prices, was used in spot market purchases as well as AMAs. Likewise, individually negotiated prices were more common in forward contracts than in spot market transactions.

It was difficult to assess the impact of AMAs on beef quality based on matching beef cattle purchase to beef sales transactions data. However, there appears not to be a relationship between branded product, a measure of quality, and AMA use. Two examples illustrate this point. First, 60% of the beef purchased on the spot market by processors was branded product compared with none through marketing agreements. Second, comparing beef packer cattle purchase methods with beef sales methods shows no difference in spot market use between plants with under 20% or over 20% branded product sales. Thus, AMAs do not appear to be a necessary condition for a branded beef product.

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