PRICE DETERMINATION IN SLAUGHTER CATTLE PROCUREMENT

by

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PREFACE

Congress included $500,000 in the U.S. Department of Agriculture's (USDA) Packers and Stockyards Administration (now Grain Inspection, Packers and Stockyards Administration (GIPSA)) 1992 fiscal-year appropriation to conduct a study of concentration in the red meat packing industry. GIPSA solicited public comments on how to conduct the study and formed an interagency working group to advise the Agency on the study. Based on the public input and comments of the working group, GIPSA selected seven projects and contracted with university researchers for six of them.

The findings of the study are summarized in Packers and Stockyards Programs, GIPSA, USDA, *Concentration in the Red Meat Packing Industry*, February 1996. The technical reports of the contractors are published as a series of Grain Inspection, Packers and Stockyards Administration Research Reports (GIPSA-RR). The technical reports of the contractors are:

GIPSA-RR 96-1 Marvin L. Hayenga, Stephen R. Koontz, and Ted C. Schroeder, *Definition of Regional Cattle Procurement Markets*.

GIPSA-RR 96-2 Slaughter Cattle Procurement and Pricing Team, Texas A&M Agricultural Market Research Center, *Price Determination in Slaughter Cattle Procurement*.

GIPSA-RR 96-3 Clement E. Ward, Ted C. Schroeder, Andrew P. Barkley, and Stephen R. Koontz, *Role of Captive Supplies in Beef Packing*.

GIPSA-RR 96-4 S. Murthy Kambhampaty, Paul Driscoll, Wayne D. Purcell, and Everett D. Peterson, *Effects of Concentration on Prices Paid for Cattle*.

GIPSA-RR 96-5 Marvin L. Hayenga, V.J. Rhodes, Glenn A. Grimes, and John D. Lawrence, *Vertical Coordination in Hog Production*.

GIPSA-RR 96-6 Azzeddine Azzam and Dale Anderson, *Assessing Competition in Meatpacking: Economic History, Theory, and Evidence*. This project reviewed relevant research literature.

The seventh project analyzed hog procurement in the eastern Corn Belt, and was conducted by the Economic Research Service, U.S. Department of Agriculture. The findings of this project are included in the summary report on the study referenced above and are not published in a separate technical report.

This report is based on work performed under contract for GIPSA, USDA. The views expressed in this report are those of the authors and are not necessarily those of GIPSA or USDA.

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Texas Agricultural Market Research Center (TAMRC) Contract Report, Contract No. 53-6395-2-126 with the Packers and Stockyards Program of the Grain Inspection, Packers and Stockyards Administration, U.S. Department of Agriculture, by the TAMRC Slaughter Cattle Procurement and Pricing Study Team, Texas Agricultural Market Research Center, Department of Agricultural Economics, Texas A&M University, College Station, Texas 77843-2124, June 1996.

ABSTRACT: This report identifies and assesses the effects of the primary factors affecting procurement and pricing practices in the slaughter cattle market through an analysis of the daily transactions records of the top 43 steer and heifer beef packing plants, and the top 5 cow and bull beef packing plants over the period of April 1992 to March 1993. Also, those same steer and heifer packing plants and a random sample of feedlots of over 4,000-head capacity were asked to respond to surveys regarding information not available from the transactions data. The analysis and conclusions focus particularly on the effects of concentration and economies of size on the procurement and pricing behavior of packers.

ACKNOWLEDGEMENTS

This report was prepared by the Slaughter Cattle Procurement and Pricing Study Team of the Texas Agricultural Market Research Center (TAMRC) in the Department of Agricultural Economics at Texas A&M University. Team members included the following:

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A number of student workers also provided crucial assistance to the project, including Lisa Milligan, Amy Milligan, Hope Bay, and Karen DeFrehn. Dr. Nichols provided administrative support and assistance in helping conceptualize and design the project particularly during the early phases of the project. Mr. Richard Dulas provided important computer support and analytical assistance particularly for section 3 of the report. Mr. Ward supervised the management and handling of the transactions database, provided crucial analytical support and assistance particularly for sections 2 and 3 of the report, was responsible for all computer work and interface with the statistical and computer support staff of the Packers and Stockyards Programs at the U.S. Department of Agriculture, and served as the project's security officer. Dr. Raymond Dietrich provided information and insights that greatly improved the quality the project. Ms. Schiller supervised the typing and manuscript preparation for the various drafts of this report. Ms. Johnson did much of the original work for section 6 of this project as part of her Master of Agriculture requirements under the supervision of Dr. Davis. That section was later expanded and substantially rewritten by other team members. Mr. Fred Mesler of the Texas A&M University Research Foundation served as the contract officer for this project. Dr. Williams served as editor for the report. The team members owe a debt of gratitude to several anonymous reviewers for helping to greatly improve the quality of the final report. Any errors or omissions, however, are solely the responsibility of the team members.

Principal authors of the various sections of this report were:

Executive Summary	Dr. Williams
Section 1	Dr. Williams
Section 2	Dr. Williams
Section 3	Dr. Goodwin and Dr. Williams
Section 4	Dr. Capps, Dr. Love, Dr. Williams, Ms. Adams
Section 5	Dr. Capps, Dr. Love, Dr. Williams, Ms. Adams
Section 6	Dr. Goodwin, Dr. Williams, Dr. Davis, and Ms. Johnson
Appendices A & B	Mr. Ward

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EXECUTIVE SUMMARY

Competitive markets with many buyers and sellers have long been viewed as ideal environments for healthy and fair trade. A competitive environment provides consumers with a quality product at reasonable cost. As a particular market sector becomes more concentrated (fewer buyers or sellers), there is concern that the larger operations will gain market control and manipulate it for their own benefit. Concentrated market power may provide buyers in a market like that of slaughter cattle with the upper hand in procuring and pricing the commodities sold to them for processing. On the other hand, concentration of buyers in a market may be primarily the result of the necessity to gain economies of size in order to survive. An analysis of the pricing and procurement behavior in such a concentrated market, therefore, is necessary to identify, isolate, and measure the effects of the many factors affecting buyer pricing and procurement behavior.

The primary objective of this project was to identify and assess the effects of the primary factors affecting procurement and pricing practices in the slaughter cattle market through an analysis of the daily transactions records of the top 43 steer and heifer beef packing plants, and the top 5 cow and bull beef packing plants (i.e., the transactions data) over a period of a year. These transactions data were collected by the Packers and Stockyards Programs (PSP), Grain Inspection, Packers and Stockyards Administration (GIPSA), U.S. Department of Agriculture (USDA) for the period of April 1992 to March 1993. Also, those same steer and heifer packing plants and a random sample of feedlots of over 4,000-head capacity were asked to respond to surveys regarding information not available from the transactions data (i.e., the packer and feedlot survey data).

Section 1 of the report reviews the methods and procedures followed in the project. Sections 2 through 5 make use of the transactions data for various types of analyses. Section 2 provides a broad overview of the transactions data used in the analyses. Section 3 provides the results of a non-parametric analysis of the transactions data. Section 4 presents the results of an analysis of factors affecting the choice of procurement and pricing methods by the top U.S. beef packers. Section 5 lays out the results of an analysis of the factors affecting slaughter cattle prices. Finally, section 6 summarizes the results of the packer and feeder survey.

Section 1: Project Description

In general, the analysis of the packer transactions records included defining, characterizing, and quantifying the slaughter cattle pricing and procurement behavior of packers to the extent allowed by the individual transaction data collected from the packers. The results are provided in sections 2

through 5 of the report. The information gleaned from the packer and feeder surveys, on the other hand, was intended to provide insight into *why* particular procurement practices and pricing methods have been followed by packers, and *why* there have been differences in those practices and methods among packers and between packers and the various slaughter cattle suppliers. The results of the packer and feeder survey are provided in section 6 of the report. Thus, the transaction data provided information on *what* packer procurement and pricing practices were during a particular period of time while the packer and feeder surveys provided insight into *why* such practices were followed.

The Transactions Data Analysis

The transactions data collected and cleaned by PSP for each of the 43 steer and heifer plants included individual transactions records involving lots of 35 or more head of cattle slaughtered over the period of April 5, 1992, to April 3, 1993. The transactions data included information on purchasing plants, cattle sellers, pricing and procurement methods, characteristics and costs of the cattle purchased, and the slaughter of the corresponding kill lots. Two other sets of data were collected from all plants and made available by PSP for this project: (1) daily totals over a subset of the transactions data elements for each of the 43 steer and heifer plants, and 5 cow and bull slaughter plants and (2) "non-transactions" data items from the Beef Packer Costs and Returns Survey (BPCRS), including a measure of slaughter capacity for each plant, and the volume and value of beef outputs shipped from each plant.

The specific objective of the transactions data analysis was to address the following three general questions to the extent that the data allowed:

(1) What were the characteristics, nature, and patterns of the slaughter cattle procurement activities of the top 43 steer and heifer plants, and of the top 5 cow and bull plants during the period of the data?

(2) Did some statistically significant relationships exist among the slaughter cattle procurement activities of the top 43 steer and heifer packing plants and the key characteristics of the transactions between those plants and the sellers from which they purchased cattle during the period of the data?

(3) What major factors affected the choice of slaughter cattle procurement and pricing methods and the costs of cattle slaughtered by the top 43 steer and heifer packing plants during the period of the data?

The analysis of each of these three general questions required different approaches. The first general question required a simple descriptive analysis of packer procurement and pricing practices, including the characteristics, dimensions, and patterns of packer behavior as revealed by the data. The results of this examination of the data established the basis for the subsequent empirical examination related to general questions 2 and 3. The descriptive data analysis involved the calculation of standard summary statistics (totals, means, variances, standard deviations, maximums,

minimums, etc.). Also, cross tabulations were done to calculate frequency distributions by various relevant combinations of the characteristics of cattle transactions provided by the data.

The descriptive analysis of the data defined by the first general question suggested possible relationships among the characteristics, dimensions, and patterns of the slaughter cattle procurement and pricing practices of the top 43 steer and heifer packing plants. In analyzing the second general question, therefore, statistical procedures were used to determine whether any such relationships were statistically significant. Two types of non-parametric tests were used to explore the potential statistical relationships between and among the variables of analysis: (1) those used to identify possible *correlation* between/among the variables of analysis and the transactions data characteristics (Pearson correlation test and the Spearman rank correlation test) and (2) those used to test for *statistical differences* between/among the variables of analysis and each transaction data characteristic or sets of those characteristics (the Analysis of Variance (ANOVA) procedure and the Student-Newman-Kuhls (SNK) procedure).

To answer the last general question, the most important factors affecting the choice of pricing/procurement methods by packers and the delivered cost of slaughter cattle to packing plants were identified and the extent of the relationships measured. The results of the preceding descriptive and non-parametric analyses helped determine the existence of any relationship between the key transactions data characteristics and both the pricing/procurement methods and the costs of fed cattle paid by packers. A Polychotomous Choice Model was used to determine which transactions characteristics affected either the *choice* of cattle procurement method or the *choice* of lot pricing method. Section 4 of this report provides details on the theoretical properties, specification, and use of this model for the analysis of the factors affecting packers' choices of procurement and pricing methods. A hedonic technique was used in a multivariate regression analysis to quantify the relationship between the delivered costs of cattle to packers and the transactions data characteristics. The analysis was done over the period of the data for individual plants, for packer firms, and for all packing plants across geographic location, slaughter capacity, and other relevant characteristics as allowed by the data. Section 5 of this report presents more detail on the method used and the results of the hedonic regression analysis.

The Packer and Feedlot Survey Data Analysis

Both packer buyers and feedlot sellers were surveyed to determine the actual and preferred methods and arrangements involved in feedlot-packer trading relationships, perceptions regarding factors affecting the net price for fed cattle paid by packers to feedlots, and perceptions regarding non-price factors affecting feedlot-packer trading relations. The packer survey went to the same steer and heifer slaughter plants that provided the transactions data. The feedlot survey was administered to a randomly selected sample of U.S. cattle feedlots having a one-time capacity of 4,000 head or more.

Cross tabulation contingency tables were produced for the responses to all questions on both surveys as appropriate to generate frequency distributions and relevant summary statistics such as means. An Analysis of Variance (ANOVA) was done for many questions as well to identify statistically significant differences within and between or among multiple classifications of packer and feedlot

responses to the same questions. The Student-Newman-Kuhls (SNK) procedure was utilized to account for differences in the number of observations within and among groups. Questions regarding ranked preferences for purchase behavior were analyzed using various ranked-sum procedures of the Wilcoxon type. The results are presented in section 6 of this report.

Section 2: Description of the Transactions Data

The transactions dataset included a total of 200,616 individual transactions (cattle lots purchased) by the 43 steer and heifer plants for the period April 5, 1992, through April 3, 1993. Those 43 steer and heifer plants were associated with 20 separate firms. The 5 cow and bull plants were owned by 5 different firms. Together, the top three firms (ConAgra, Excel Corp., and IBP, Inc.) accounted for 75.1% of all lots purchased and 81.0% of all steers and heifers purchased.

The 43 steer and heifer plants purchased 23,113,362 head of steers and heifers from 19,396 individual sellers for slaughter during the one year period of the data for an average of 1,191.7 head per seller. Although the increasing concentration of packers is the primary concern of this study, the transactions data indicate a high degree of concentration among cattle sellers as well. Only 11.2% of the sellers sold more than 1,000 head of steers during the year but accounted for 86.1% of all slaughter steer and heifers sold. Also, only 11% of the sellers sold more than 12 lots of steers and heifers to packers during the year but accounted for over 94% of the steers and heifers slaughtered.

By far the largest number of lots were purchased through the open (spot) market (82.3%). Marketing agreements and forward contracting were used for most of the remainder of the transactions (8% and 7%, respectively). Packer-fed or owned cattle were reported to account for only 2.7% of the transactions. Two pricing methods were used for most of the transactions -- carcass weight (37.6%) and liveweight (45.6%). Formula pricing accounted for the remainder (16.8%). Consequently, liveweight or carcass weight pricing with procurement through the open market accounted for the bulk of the transactions (74.7%).

The principal pricing method used, however, varied somewhat over the different procurement methods. Those lots procured through forward contracting tended to be priced on a carcass weight basis. About half the packer fed/owned cattle were priced on a carcass basis. However, nearly half of the cattle priced on a formula basis were purchased through the spot market. For lots purchased on the spot market, liveweight and carcass weight were the principal pricing methods used.

Nearly all lots included steers and heifers of more than one quality and yield grade. Over 80% of the lots included at least some choice yield grade 2 steers and heifers. At the same time, over 80% included at least some choice yield grade 3 steers and heifers. Likewise, nearly 80% of the lots included some select yield grade 2 steers and heifers and nearly 80% included some select yield grade 3 steers and heifers. Choice yield grade 4 steers and heifers were included in 57.1% of the lots while select yield grade 4 steers and heifers were included in 53.5% of the lots. Yield grade 2 and 3 steers and heifers were the most common across all quality grades. Yield grade 5 steers and heifers were least common across all quality grades.

The slaughter of steers and heifers was distributed fairly evenly throughout the period. About 25% of all steers and heifers were slaughtered during each quarter of the April 1992 through April 1993 period. The elapsed time between purchase and slaughter ranged from 1 day to 240 days with a mean of 14 days from purchase to slaughter. The average per hundred weight (cwt) rail cost per lot of steers and heifers slaughtered was $120.14/cwt. Despite a rather wide variation in the size, quality, and yield grade of the lots, the variation in the average per hundred weight cost of the lots was relatively small.

Section 3: Non-Parametric Analysis

Pricing and procurement activities between and among various types and locations of sellers and packers are the focus of the analysis presented in this section of the report. By and large, no difference was found across pricing methods in their effects on any cost or yield measure. Little difference was found across procurement methods either, except that the cost of lots procured by forward contracting was generally lower than that of lots procured by any other method. The three largest firms (ConAgra, Excel, and IBP) operated plants with the largest throughput capacities and higher capacity utilization ratios over the period of the data. The lots of cattle procured by those three firms also were significantly higher in cost and generally higher in quality and uniformity than lots purchased by smaller firms. Lots originating from sellers and/or those slaughtered by plants in the regions in which those three large firms have a major presence (West North Central and South Plains) showed similar cost relationships.

Perhaps the most interesting and important conclusion to evolve from the analysis in this section relates to the cost relationships of large firms that have large throughput capacity and high capacity utilization ratios. In general, firms with plants of generally larger capacities were found to have paid more than plants with smaller capacities for the cattle they slaughtered, both in terms of liveweight and hotweights. Additionally, percentage yields of lots slaughtered and the number of head per lot increased with firm size. The same relationships held true for capacity utilization ratios. There are two plausible explanations for these results. One is that the large firms possess a sufficient degree of market power to bid away lots from smaller competing firms in the market with the potential of so-called "sweetheart" deals between packing firms and sellers. Another plausible explanation is that large firms with high capacity utilization ratio plants are willing to pay higher amounts (or incur higher costs) so that adequate numbers of cattle are made available to the plant to maintain a throughput which minimizes average costs of all head slaughtered. The increased costs of these cattle would be more than offset by the cost efficiencies gained by maintaining a high plant throughput. In a product market characterized by declining demand and production plants which utilize divergent levels of technology, it is reasonable to expect larger, more efficient plants to continue to drive down production costs. As efficiencies increase, it becomes even more important for slaughter plants to obtain sufficient numbers of cattle to maintain economically efficient operations, which may result in these same plants incurring higher delivered costs for the animals slaughtered. Smaller, less efficient firms may be unable to respond adequately to this behavior and, therefore, lose their competitive position relative to the larger firms. Unless these smaller plants are geographically isolated or supply a niche product market, they will operate only until a short-run shutdown point is reached, at which time they must choose to add technology or, alternatively, go

out of business. The latter alternative results in further concentration of the industry. Sections 4 and 5 provide further analysis and testing of these alternative hypotheses.

Some specific observations relating to the analysis in this section include the following:

- In general, plants with larger capacities paid more than plants with smaller capacities for the cattle they procured. Also, the largest firms in terms of numbers of steers and heifers slaughtered clearly paid the highest amount per animal slaughtered relative to smaller firms. The largest three firms paid the highest average cost/cwt of all cattle procured by all firms. Additionally, the percentage yields of lots slaughtered and the number of head per lot increased as the size of the plant and the firm increased. The same relationships held true for capacity utilization ratios. Gains from processing efficiency and economies of size in processing likely enabled these plants and firms to pay more for higher quality, more uniform animals as inputs into their operations. The larger-throughput, higher-capacity-utilization- ratio plants are owned primarily by the large national firms with dominant market shares; whereas smaller-throughput, lower-capacity-utilization firms are owned by small local or regional firms with small market shares. These results reinforce the concept of size and efficiency advantage for larger firms and suggest that the larger firms may be most concerned with their plants operating at full capacity to minimize final product costs.

- The cost of cattle was lowest for lots sold by sellers in the largest-size categories on a per head basis and was the highest on a per cwt, liveweight basis. This implies that the cattle from the largest-sized seller categories are physically smaller than the cattle sold by sellers in the smaller size categories.

- There does not appear to be a relationship between size of seller and size of packing firm. While the three largest packers purchased nearly one-half of their cattle from the largest sellers (annual sales in excess of 16,000 head), nearly 40% of their purchases were from the smallest sellers (annual sales less than 4,000 head). In fact nearly 25% of all cattle purchased by the three largest packers were from sellers with sales of less than 1,000 head per year. On the other hand, although the smallest packers had a tendency to purchase cattle from small sellers, they purchased nearly one-third of their cattle from the largest sellers.

- Packing plants in the two largest volume regions (West North Central and South Plains) paid the most per cwt, liveweight, and hotweight for the cattle they procured. Plants in the lower volume regions were likely older and smaller than those in the West North Central and South Plains regions and, therefore, may not have experienced the efficiency nor size advantages of the newer, larger, more technologically up-to-date plants in the higher volume regions.

- The statistical relationship between the several cost/cwt measures and seller location was much the same as between those cost measures and packer location, primarily due to the concentration of feeders near packing plants. The larger volume seller regions exhibited higher costs/cwt than the smaller volume seller regions.

- Lots sold by feeders cost significantly more (and represented the majority of cattle marketed) than those sold by any other seller type among those lots for which seller type was indicated.

- The procurement method also had some effect on the cost/cwt (liveweight and hotweight) of the cattle procured for slaughter. Lots procured through forward contracting had the lowest cost/cwt (liveweight and hotweight) of any procurement method. The most probable explanation for these results involves the concept of shared risk by the packer, whereby the feeder "locks in" a price for the cattle, thus forfeiting potential increases in the market to ensure no exposure to price decreases.

- There were no statistically significant differences in any cost or yield measure based upon pricing method. The lack of statistically significant differences in costs among pricing methods suggests that pricing method may not be a reasonable explanation for often "observed" lower prices for so-called captive supplies. If this were truly the case, the cost of cattle priced on a liveweight basis would be expected to be significantly higher than the cost of those cattle procured and priced as "captive supplies". This analysis provides no evidence consistent with that expectation.

- Generally speaking, larger firms and predominant selling and packing regions had average lot sizes larger than those of other firms and regions.

- No statistically significant differences were found to exist between lots that were predominantly choice, select, and prime grade quality (in that order) and those that were predominantly select, choice, and prime grade quality (in that order) with respect to any cost or yield attribute. These results likely reflect that the historical market preference for choice grade beef is giving way to the rising importance of select grade beef in the marketplace as stimulated by consumer desire for leaner beef cuts.

- During the period of analysis, packers paid more for lots with predominant yield grade characteristics of yield grades 2 and 3; and those types of lots accounted for over 70% of all lot transactions and were generally larger in size than lots of alternative yield grade combinations. For the largest packers, yield grades 2 and 3 dominated as the leading classifications of lots. The desire by those packers for uniformity in the cattle they process was most likely driven by the need to maximize capacity utilization and throughput by processing highly uniform lots. An overall desire for uniformity in cattle slaughtered with respect to their yield grade characteristics and a desire for less heavily finished cattle or poor carcass yielding cattle (yield grades 4 or 5) also was evidenced.

- No statistically significant differences were found to exist for lot yields across either procurement methods or pricing methods. Some significant differences in lot yields across seller and packer geographic regions, however, were evident. Percentage lot yields were highest and lot sizes largest for plants in the South Plains. Also, percentage lot yields and the cost/cwt of cattle paid by packing plants in the North Atlantic and East North Central regions were lower than in all other regions. Typically, those latter plants were older and

smaller than those in other regions and, therefore, may not have experienced the efficiency nor size advantages of the newer, larger, more technologically up-to-date plants in the West North Central and South Plains regions.

Section 4: Analysis of Factors Affecting Packer Choices of Slaughter Cattle Procurement and Pricing Methods

In obtaining fed cattle for slaughter, packers choose among several alternative methods of both procurement and pricing. The most common procurement methods include: (1) the open or spot market, (2) marketing agreements, i.e., long-term purchase arrangements in which the packer agrees to purchase a specified number of cattle in a specified time period, (3) forward contracting, and (4) packer fed/owned. The most common pricing methods include: (1) liveweight, (2) carcass weight, and (3) formula, e.g., pricing based on a packer's weekly-average prices paid or on an average of two or more price reports, etc. A number of factors likely affect the procurement and pricing methods chosen for different lots of cattle including key characteristics related to the purchasing plant or firm, the fed cattle seller, the particular lots of fed cattle purchased, and the slaughter and sale of beef by packers. A number of those factors are represented in the daily fed cattle purchase transactions records collected by PSP from the top 43 steer and heifer beef packing plants. In this section, the transactions data were analyzed to identify those characteristics that significantly affected the *choices* of fed cattle procurement and pricing methods by the top steer and heifer packing plants during the period of the data, and to measure the extent of their effects.

The empirical analysis conducted involved the estimation of multinomial logit models for procurement and pricing methods across all firms and regions. For procurement methods, the multinomial logit model correctly classifies nearly 87% of all transactions. This success in classification is unequivocally the result of the ability of the model to correctly predict procurement transactions conducted through the spot market and by forward contracting. The model correctly predicted over 78% of those lots procured through forward contracting and over 99% of those procured through the spot market. As a predictive device, the model does extremely well in predicting the selection of the forward contract and spot market procurement methods. The pricing method multinomial logit model correctly classifies about 60% of the set of transactions as to pricing methods. This success is largely attributable to the ability of the model to correctly predict the transactions which used the liveweight pricing method. The model correctly classified 80% of the lots using liveweight pricing but only 43% and 51% of the lots using carcass weight and formula pricing methods, respectively.

The empirical results confirm that a large number of factors play a significant role in the determination of the methods of procurement and pricing chosen by packers for the cattle lots they purchase. Although the level of concentration in the beef packing industry and the size (i.e., processing capacity) of a firm were shown to have an effect on the particular cattle procurement and pricing methods chosen, a number of other factors were shown to be equally or more important, such as the characteristics of the lots purchased by packers (i.e., number of head per lot, average weight per head, cattle type, yield grade, and quality grade) and seasonality (i.e., the quarter in which cattle are slaughtered). Also, the method chosen by packers to procure fed cattle was found to affect the

probability that a given pricing method would be chosen. Procurement through the spot market was found to increase the tendency to use liveweight as the pricing method while procurement through forward contracting, packer fed cattle, and/or marketing agreements was found to increase the probability that packers will choose the carcass weight or formula pricing methods to price cattle.

More specifically, major conclusions that can be drawn from the results of this study include the following:

- Increases in slaughter capacity tend to increase the use of forward contracts but decrease the use of packer feeding as cattle procurement methods. Increases in regional concentration, as measured by the regional Herfindahl-Hirschman Index (RHHI), however, lead to increases in the use of packer feeding and decreases in the use of all other procurement methods. The elasticity of the probability of using packer feeding due to a change in the RHHI is nearly 3, by far the largest elasticity of any of the procurement methods.

- Also, as regional concentration increases (as measured by the RHHI), packers tend to choose the carcass weight pricing method. With increases in slaughter capacity (an indicator of size economies), however, packers tend to gravitate toward pricing on a carcass weight and formula basis.

- As the number of days that elapses between purchase and slaughter increases, so does the tendency of packers to rely on forward contracts, packer fed cattle, and marketing agreements as procurement methods. Packers are less likely, however, to use the spot market as a procurement method as the time between purchase and slaughter increases. Changes in probabilities associated with lot pricing methods are not highly sensitive to changes in the elapsed time between purchase and slaughter.

- Increases in wholesale beef demand, as reflected by increases in the output price of beef (i.e., the weighted average revenue received for beef sales) result in decreases in the choice of forward contracts as the procurement method but result in increases in the choice of marketing agreements and packer feeding. At the same time, as the output price rises, packers tend to move toward formula-based pricing methods or toward liveweight pricing. Carcass weight as a pricing method is negatively related to increases in wholesale beef demand.

- The procurement of cattle from within 300 miles of packing plants is likely to be done through marketing arrangements or as packer fed cattle. Procurement of cattle outside a radius of 300 miles of a packing plant is likely to be done by forward contacts and the use of the spot market. Also, lots of cattle from sellers within 300 miles are less likely to be priced on a formula or a carcass weight basis.

- The probability of choosing to procure through the spot market and forward contracts increases for lots that are predominantly yield grade 1 relative to those that are predominantly yield grade 2, while the probability of choosing packer fed arrangements or

marketing agreements decreases. The probability of choosing to procure through forward contracting, packer fed arrangements, and the spot market rises for lots that are predominantly yield grade 3 or higher relative to those that are predominantly yield grade 2, while the probability of choosing marketing agreements declines with respect to this yield grade comparison. In lots that are graded select, the probability of choosing packer fed arrangements and the spot market increases but the probability of using forward contracts or marketing agreements declines. For cattle yield grade 2, packers tend to use the carcass weight and formula pricing methods. They move away from the liveweight pricing method under these yield grade conditions. For prime or choice cattle, packers tend to use liveweight and formula pricing methods

- Changes in factors that positively affect the probability of choosing liveweight as the pricing method negatively affect the probability of choosing carcass weight as the pricing method and vice versa.

Section 5: Analysis of Factors Affecting Slaughter Cattle Prices

In this section, the factors affecting the prices paid for the cattle slaughtered by the top steer and heifer packing plants during the April 5, 1992, to April 3, 1993 period are identified and analyzed. Two sets of regression analyses using a hedonic price model are done to quantify the relationships between the delivered cost of fed cattle paid by packers and transactions data characteristics. First, a set of parameters were derived using all transaction observations across all firms and regions. Next, to facilitate a regional comparison of the factors affecting the average delivered liveweight cost/pound of fed cattle paid by packers, parameters were derived for three regions: (1) the Midwest (Texas, Kansas, Nebraska, and Colorado); (2) the Upper Midwest (Illinois, Iowa, Wisconsin, and Minnesota); and (3) the Far West (California, Arizona, Idaho, Utah, and Washington).

For each set of regression analyses, the estimation of the model tests hypotheses concerning the effects of several factors on the price paid by a packing plant for a lot of cattle, including: (1) characteristics of the lot; (2) price of the final product(s); (3) plant capacity; (4) distance from the seller to the packer; (5) seasonality; (6) exercise of market power on the buying side of the market; and (7) methods chosen for procuring and pricing the lot. The regression results from the model provide a measure of the marginal effects of the characteristics of the cattle procured on the price paid for them.

The empirical results do not provide support for the hypothesis that packers are generally exerting spatial monopsony market power and pay less per pound for cattle from nearby feeders. In fact, the results indicate that, on average nationally, packers pay a small premium for nearby cattle, probably because cattle shipped shorter distances arrive in better condition than cattle shipped longer distances, and because the transactions costs associated with purchasing cattle from more distant sellers may be higher. The possibility of monopsony power leading to a lower delivered cost of cattle was found only in the Upper Midwest region where packers were estimated to be paying an average of $0.09/cwt less for cattle purchased within 100 miles and $0.29/cwt less for cattle purchased between 100 to 300 miles of the plant. In all other regions, however, packers were found

to be paying small *premiums* for locally purchased fed cattle. This is the opposite the opposite of what would be expected under monopsony conditions.

The empirical results lead to a number of other conclusions regarding price determination in slaughter cattle procurement, including the following:

- While statistically affected by the output price of beef for most firms and regions, the average delivered cost/pound of fed cattle paid by packers is almost completely insensitive to changes in output price. This is due primarily to the lack of variability in the largely cross-sectional transactions data as discussed in the study limitations section.

- Increases in slaughter capacity have only a small positive effect on the average delivered cost of fed cattle paid by packers. Again, as with the output beef price, the lack of variability in the data helps explain the limited magnitude of the measured effect. Thus, even though the dominant firm strategy hypothesis cannot be rejected, this result does not support a conclusion that increases in slaughter capacity lead to lower prices paid by packers for fed cattle.

- Increases in the average weight per head result in a lower average delivered cost of fed cattle paid by packers. A 100-pound increase in the average weight per head results in a $0.75/cwt decline in the average delivered cost paid by packers for fed cattle.

- As slaughter cattle procurement within a region becomes more concentrated, as indicated by increasing values of the RHHI, the average delivered cost of fed cattle paid by packers falls. To put this result in perspective, if the region is captured by a single firm, the average delivered cost of fed cattle would be expected to fall by only 3%. However, this result is conditional on estimates using data for a single year, where most of the variation in fed cattle prices and RHHI results from cross-sectional differences. In addition, while concentration results in a tendency for lower prices to be paid for fed cattle, the competition among the few large packers for available supplies to maintain maximum utilization of their installed capacities tends to mitigate those price effects to some extent. Only in the Far West region do increases in capacity and regional concentration work together to lower average delivered costs paid by packers for fed cattle. In contrast, only in the Upper Midwest region do increases in capacity and regional concentration work together to raise average delivered costs paid by packers for fed cattle.

- Each of the procurement and pricing methods associated with captive supplies (defined as cattle owned by packers, forward contracted cattle, and/or formula-priced cattle bought by packers) is associated with a discount in the average delivered cost of fed cattle paid by packers compared to cattle procured through the spot market and priced on a liveweight basis. The highest discount of $1.74/cwt is associated with forward contracting followed by packer-fed cattle (a discount of $0.57/cwt) and formula pricing (a discount of $0.25/cwt).

- Cattle procured through marketing agreements receive premiums of $0.54/cwt while those priced on a carcass weight basis receive discounts of $0.18/cwt compared to cattle purchased in the spot market and priced on a liveweight basis.

- Regionally, the effect of pricing on a carcass weight basis on the average cost paid by packers for fed cattle was less than that of pricing on a liveweight basis only for the upper and lower Midwest regions. Only in the Far West region did packers pay higher average cost for formula priced cattle.

- Few differences in the effect of procurement methods on the average cost paid by packers for fed cattle were found across regions. However, packer fed cattle procurement had a positive effect on the average cost paid by packers for fed cattle compared to cattle procurement through the spot market in the Far West and Upper Midwest regions.

Section 6: Trading Relationships in the Slaughter Cattle Market

To supplement the analysis of the individual transactions records of the top beef packers, an independent survey of packers and feedlots was conducted to obtain insight into *why* particular procurement practices and pricing methods have been followed by packers and *why* there have been differences in those practices and methods among packers and between packers and the various slaughter cattle suppliers. Because the perspectives of packers and feeders concerning not only the practices followed but also the factors affecting them were potentially quite different, the surveys asked both packers and feeders many of the same questions.

The packer buyer sample included the 42 largest steer and heifer slaughter plants in the United States, which accounted for 93% of total commercial steer and heifer slaughter in 1992. The feedlot sample, however, was randomly drawn from a sampling frame of all U.S. feedlots with a one-time capacity of 4,000 head or greater. The sampling frame was proportionately stratified by geographic location and feedlot capacity. The geographic stratum included the PSP regions having cattle feedlots with a one-time capacity of 4,000 head or greater. The feedlot capacity stratum included 4 feedlot capacity size groups of over 4,000 head: (1) 4,000-7,999 head, (2) 8,000-15,999 head, (3)16,000-31,999 head and (4) 32,000 head or over.

The surveys were mailed to a contact individual at each feedlot and packing plant. Of the 195 feedlots in the feedlot sample, 116 returned completed surveys for a 59.5% total response rate. Completed surveys were also returned by 26 of the packing plants for a 62% total response rate. The questions on each survey were organized into four sections: (1) descriptive information, (2) the actual and preferred methods and arrangements involved in feedlot-packer trading relationships, (3) perceptions regarding factors affecting the net price for fed cattle paid by packers to feedlots, and (4) perceptions regarding non-price factors affecting feedlot-packer trading relations.

Cross tabulation contingency tables were produced for the responses to all questions on both surveys, as appropriate, to generate frequency distributions and relevant summary statistics. An Analysis of Variance (ANOVA) was also done for many questions to identify statistically significant

differences within and between or among multiple classifications of packer and feedlot responses to the same questions. Packer responses were classified into two groups: (1) single vs. multiple plant firms and (2) geographic regions. Feedlot responses were classified into four groups: (1) feedlot capacity, (2) single vs. multiple feedlot firms, (3) feedlot regions, and (4) the number of packer buyers purchasing from each feedlot. To account for differences in the number of observations within and among groups, the Student-Newman-Kuhls (SNK) procedure was utilized to identify statistically significant differences. Packer and feedlot responses were compared using a paired *t*-test procedure assuming unequal variances. Questions regarding ranked preferences for purchase behavior were analyzed using various ranked-sum procedures of the Wilcoxon type.

Some of the major conclusions from the packer and feedlot survey results include the following:

- Feedlots reported that the fed cattle they sold in 1993 were priced primarily on a liveweight basis. Packers reported more uniform use of the various pricing methods. Nevertheless, both the feedlots and the packers prefer the liveweight pricing method.

- Although forward pricing was used by about half of both the packer and feedlot respondents, relatively few cattle were purchased on forward contact in 1993. Forward contracts were used for less than 10% of the cattle sold or purchased in 1993.

- More feedlots reported selling contract cattle priced on a liveweight basis than on any other basis. Packer respondents again reported more uniform use of the various pricing methods for contract cattle. As before, both feedlots and packers tend to prefer liveweight pricing for contract cattle.

- Feedlots reported that the bulk of their contract sales were for delivery either within 10 days or in 30 days or more in 1993. The largest percentage of packers indicated that most of the contract cattle they purchased were for delivery in more than 30 days. The delivery period preferred most by feedlots is preferred least by packers. The packers reported a clear preference for a delivery period of more than 30 days while feedlots clearly preferred a delivery period of 10 days or less.

- According to both feedlot and packer respondents, feedlots were more likely than packers to pay the transportation costs in 1993. Not surprisingly, the feedlots tend to prefer that packers pay the transportation costs. The packers tend to prefer the opposite.

- "High quality grade" is the only characteristic associated with fed cattle for which a majority of either packers or feedlots perceive that a premium is paid.

- A majority of packers perceive that prices are discounted for a larger number of characteristics associated with the fed cattle they buy than is the case for a majority of the feedlots. A majority of feedlots perceive that fed cattle prices are discounted for only 2 characteristics: "dark cutters" and "muddy coats." A majority of packers perceive that prices are discounted for those and seven other of the characteristics listed on the survey.

- Packers and feedlots rate the same three feedlot services/characteristics the highest in importance in purchases/sales of fed cattle and in the same rank order: (1) "honesty," (2) "reliability," and (3) dependable delivery dates. Even though both feedlots and packers tend to rate "reliability" and "honesty" high in terms of importance, packers rate those characteristics significantly higher than do feedlots.

- Regarding other feedlot services/characteristics, packers rate the importance of the feedlot feeding primarily steers, heifers, or non-Brahman cattle, being dependable in delivering cattle on schedule, and sorting pens to finish their cattle evenly as more important than do feedlots.

- Feedlots perceive that having a feedlot of capacity greater than 20,000 head, having a scales at the feedlot, and having the ability to determine proper finish to be significantly more important in their ability to make sales to packers than do the packers themselves. Packers perceive feedlot size to be of little importance.

- Packers and feedlots also rate the same three reasons for lost sales as highest in importance but in different rank order. The packers perceive that the type of cattle offered by the feedlot is the primary reason for lost sales. In contrast, feedlots perceive that cattle often being priced too high is the primary reason.

- Packers place a statistically higher level of importance than do feedlots on the following five reasons that some feedlots lose sales to other feedlots: (1) the type of cattle offered, (2) the weighing method desired, (3) the delivery practices of the feedlot, (4) inconsistent quality of the cattle offered, and (5) the overall quality of the cattle offered.

- There are no statistically significant differences in the preferences between feedlots and packers for any of the methods or arrangements involved in selling/buying fed cattle.

PRICE DETERMINATION IN SLAUGHTER CATTLE PROCUREMENT

SECTION 1
PROJECT DESCRIPTION

Competitive markets with many buyers and sellers have long been viewed as ideal environments for healthy and fair trade. A competitive environment provides consumers with a quality product at reasonable cost. As a particular market sector becomes more concentrated (fewer buyers or sellers), there is concern that the larger operations will gain market control and manipulate them for their own benefit. Concentrated market power may provide buyers in a market like that of slaughter cattle with the upper hand in procuring and pricing the commodities sold to them for processing. On the other hand, concentration of buyers in a market may be primarily the result of the necessity to gain economies of size in order to survive. An analysis of the pricing and procurement behavior in such a concentrated market, therefore, is necessary to identify, isolate, and measure the effects of the many factors affecting buyer pricing and procurement behavior.

Understanding how prices are determined in an industry and isolating all the specific factors determining pricing and procurement behavior is complicated for several reasons. First, in addition to the market forces of supply and demand, a vast array of non-market forces, ranging from the characterisitics of the cattle slaughtered to the procurement practices of the packing plants, affect prices in a market like that for slaughter cattle. Also, there is not simply one market and one market price for cattle. There are many, and they are influenced by numerous, distinct forces. Cattle prices and markets differ by geographic region of the country, time period (daily, weekly, monthly, yearly, seasonal), market functions (buying or selling with various delivery specifications), and so on. Unfortunately, such price and other data required for an analysis of price behavior in the slaughter cattle have been largely unavailable. As a consequence, research on the pricing and procurement of slaughter cattle has been difficult at best.

The primary objective of this project was to identify and assess the effects of the primary factors affecting procurement and pricing practices in the slaughter cattle market through an analysis of the daily transactions records of the top 43 steer and heifer beef packing plants and the top 5 cow and bull beef packing plants (i.e., the transactions data) over a period of a year. These transactions data were collected by the Packers and Stockyards Programs (PSP), Grain Inspection, Packers and Stockyards Administration (GIPSA), U.S. Department of Agriculture, for the period of April 1992 to March 1993. Those steer and heifer packing plants and a random sample of feedlots of over 4,000 head capacity also were asked to respond to surveys regarding qualitative and other information not available from the transactions data (i.e., the packer and feedlot survey data).

In general, the analysis of the packer transactions records included defining, characterizing, and quantifying the slaughter cattle pricing and procurement behavior of packers to the extent allowed

by the information on individual transactions collected from packers. The information gleaned from the packer and feeder surveys, on the other hand, were intended to provide insight into *why* particular procurement practices and pricing methods have been followed by packers and *why* there have been differences in those practices and methods among packers and between packers and the various slaughter cattle suppliers. Because the perspectives of packers and feeders, not only on what practices are followed but also the factors affecting them, were potentially likely quite different, the surveys asked many of the same questions to both packers and feeders. Thus, in general, the transaction data provided information on *what* packer procurement and pricing practices were during a particular period of time, while the packer and feeder surveys provided insight into *why* such practices were followed.

The project formally commenced in the fall of 1992. Because of delays faced by PSP/GIPSA/USDA in obtaining the transactions data from the packers and because of the time required for cleaning and preparing the data, actual analysis of the data did not begin until January 1995. Timelines for the work performed on this project by the contractor for both the transactions data analysis and the packer and feeder survey are provided in Tables 1.1 and 1.2.

The Transactions Data Analysis

The more specific objective of the transactions data analysis was to address the following three questions to the extent that the data allowed:

(1) What were the characteristics, nature, and patterns of the slaughter cattle procurement activities of the top 43 steer and heifer plants and of the top 5 cow and bull plants during the period of the data?

(2) Did some statistically significant relationships exist among the slaughter cattle procurement activities of the top 43 steer and heifer packing plants and the key characteristics of the transactions between those plants and the sellers from which they purchased cattle during the period of the data?

(3) What major factors affected the choice of slaughter cattle procurement and pricing methods and the costs of cattle slaughtered by the top 43 steer and heifer packing plants during the period of the data?

The Transactions and Related Data

As indicated, the transactions and related data utilized in this study were collected and cleaned by the Packers and Stockyards Program (PSP) of the Grain Inspection, Packers, and Stockyards Administration (GIPSA), U.S. Department of Agriculture. Appendices A and B of this report include details provided by PSP on their data collection and cleaning process. Data were collected

from 43 steer and heifer plants and 5 cow and bull slaughter plants (Table 1.3). For each of the steer and heifer plants, data were collected by PSP for individual transactions involving lots of 35 or more head of cattle slaughtered over the period of April 5, 1992, to April 3, 1993[1]. The transactions data included information on purchasing plants, cattle sellers, pricing and procurement methods, characteristics and costs of the cattle purchased, and the slaughter of the corresponding kill lots (Table 1.4).

Two other sets of data were collected from all plants and made available for this research by the PSP. First, transactions data involving daily totals over a subset of the transactions data elements were collected from each plant (Table 1.5). Whereas the individual transactions data (listed in Table 1.4) were collected from each plant only for transactions involving steers and heifers, the daily totals also included cows, bulls, other, and totals over all cattle types in addition to steers and heifers. Consequently, the daily totals for steers and heifers should reflect the sums of the individual transactions of the same dates. Because individual transactions data were not collected from any plant for cows and bulls, and because only limited data were provided for cows and bulls even in the form of daily totals, many of the statistical analyses and the conclusions reached in this report refer only to steers and heifers.

The other set of data provided by PSP was "non-transactions" data items from the Beef Packer Costs and Returns Survey (BPCRS) upon request of the contractor (Texas A&M University), including a measure of slaughter capacity for each plant, and the volume and value of beef outputs shipped from each plant (Table 1.6). Two observations on slaughter capacity were provided for each plant, one for the first day of the data period (April 5, 1992) and the other for the last day of the period (April 3, 1993). If the capacity was different on the two dates, no information was provided to determine when during the data period the capacity changed. Consequently, when the capacity variable was used in the research reported here, the maximum of the two capacity observations was used. The beef output shipment data included weekly totals of the value and volume of the following beef products shipped from each plant: (1) fabricated whole carcass equivalents, (2) fabricated beef primals, (3) fabricated beef sub-primals, (4) other fabricated cuts, (5) trimmings, boneless beef, or grinding material, (6) carcass beef (whole, halves, quarters), and (7) beef by-products, variety meats, and kill floor grinding material. See section 4 for more details on the characteristics and use of the BPCRS data used in this study.

Most of the transactions data were received from PSP in June 1994. Some information on sellers arrived in August 1994. Additional cleaning and preparation of the huge datasets as received from PSP were required through December of 1994 before analysis of the data could begin. The BPCRS data which was requested and received in April 1995 also required some preparation, including

[1] Note that the transactions data relate to lots of cattle slaughtered (not purchased) between these dates. As discussed in section 2 of this report, some of the cattle slaughtered during that period were purchased in preceding months.

integration of the annual and weekly data with the daily transactions data into a common dataset for analysis. Appendix B of this report provides details of the cleaning, preparation, and transformations required before the transactions and BPCRS data could be used for analysis. Section 2 of this report details the dimensions and statistical characteristics of the transactions dataset. Section 4 of this report provides details on the BPCRS data.

Methods of Analysis

Each of the three general questions addressed in the analysis of the transactions data required different analytical approaches. The specific sub-questions of the three general questions addressed and the corresponding analytical methods used to answer those questions are briefly discussed below. More details on the specific questions addressed and the methods of analysis utilized can be found in sections 3 through 5 of this report.

General Question I: What were the characteristics, nature, and patterns of the slaughter cattle procurement activities of the top 43 steer and heifer packing plants and of the top 5 cow and bull packing plants for the period April 5, 1992, through April 3, 1993?

This general question implies a simple descriptive analysis of packer procurement and pricing practices, including the characteristics, dimensions, and patterns of packer behavior as revealed by the data. No particular underlying hypotheses or tests of hypotheses are implied. The results of this examination of the data provided the basis for the subsequent empirical examination related to general questions 2 and 3.

1. Specific questions addressed:

   The following specific questions indicate the particular transaction data items considered in the descriptive analysis. Each question relates to one or more of the transactions data items in Tables 1.4, 1.5, or 1.6. Letters in parentheses refer to the cattle type for which transactions data were provided and, thus, for which the questions are relevant: SH for *steers and heifers;* CB for *cows and bulls*; and AC for *all cattle*. For steers and heifers, the questions relate to individual transactions. For cows and bulls and all cattle, however, the questions relate only to daily totals.

   Purchasing plant and firm characteristics questions
   Question 1.1 What were the names of the plants? (AC, SH, CB)
   Question 1.2 With what firms were the plants associated? (AC, SH, CB)
   Question 1.3 What were the locations of the plants? (AC, SH, CB)
   Question 1.4 What were the slaughter capacities of the plants? (AC, SH, CB)

Cattle seller characteristics questions

Question 1.5 What were the names of the sellers? (SH)
Question 1.6 From what types of sellers were cattle purchased? (SH)
Question 1.7 What were the locations of the sellers? (SH)
Question 1.8 What were the firms with which the cattle sellers were associated? (SH)

Pricing/procurement characteristics questions

Question 1.9 What were the lot procurement methods used? (SH)
Question 1.10 What were the lot pricing methods used? (SH)

Purchase lot characteristics questions

Question 1.11 What were the seasonal patterns of purchases? (SH)
Question 1.12 What were the net live or actual purchase weights of the cattle lots purchased? (SH)
Question 1.13 What type of cattle were purchased? (AC, SH,CB)
Question 1.14 What were the quality grades of the cattle lots purchased? (SH)
Question 1.15 What were the yield grades of the cattle lots purchased? (SH)
Question 1.16 What were the dressing yields of the cattle lots purchased? (SH)
Question 1.17 What were the total delivered costs of the purchased lots? (AC, SH, CB)
Question 1.18 What were the transportation costs of the cattle lots purchased? (AC, SH, CB)
Question 1.19 What were the commissions paid for the cattle lots purchased? (AC, SH, CB)

Packing plant slaughter characteristic questions

Question 1.20 How much time elapsed between the purchase and slaughter of the cattle lots? (SH)
Question 1.21 How many head were slaughtered? (AC, SH, CB)
Question 1.22 What were the hot weights of the cattle lots slaughtered? (AC, SH, CB)
Question 1.23 What was the average rail cost of the cattle lots slaughtered? (AC, SH, CB)

2. Analytical Methodology

Cross tabulations were done to calculate frequency distributions of the transactions data pertaining to each of the questions identified above. In general, *n*-way cross tabulation contingency tables were produced for each question (i.e., for each transactions data item) by relevant characteristics among the five categories of transactions characteristics variables as listed in Tables 1.4 and 1.5. In essence, the cross tabulation analysis generated standard summary statistics (totals, means, variances, standard deviations, maximums, minimums, etc.) as appropriate for each of the questions above by the relevant characteristics listed in Table 1.4 (i.e., the BY variables in 2-way contingency tables) and by various relevant combinations of those characteristics (i.e., the BY variables in 3-or-more-way contingency tables).

For example, the 2-way cross tabulation analysis of question 1.9 ("What were the procurement methods used?) by purchasing plant characteristics (individual plants, firms, plant locations) provided some indication of which packing plants and firms used what kind of procurement method and what procurement methods were used at different geographical locations. Note that this analysis could only be done for steers and heifers because data on procurement method was not collected for cow and bull slaughter plants (see Table 1.5). To determine whether a given plant or firm used different procurement methods for different types of cattle (not including cows and bulls), for example, required a 3-way analysis of the same question 1.9 by plant name or firm by cattle type. As many "by" variables as needed can be added to address the relevant question. Following this example, 2-way, 3-way, and higher order analyses, as appropriate, were conducted for each of the questions 1.1-1.23. The results are reported in sections 2 and 3 of this report.

General Question II: Did any statistically significant relationships exist among the slaughter cattle procurement activities of the top 43 steer and heifer packing plants and the key characteristics of the transactions between those plants and the sellers from which they purchased cattle during the period of the data?

The descriptive analysis of the data defined by the first general question above suggested possible relationships among the characteristics, dimensions, and patterns of the slaughter cattle procurement and pricing practices of the top 43 steer and heifer packing plants. In this phase of the analysis, statistical procedures were used to determine whether any such relationships were statistically significant. The specific questions to be addressed regarding such statistical relationships and the methodology planned for use in the analysis are discussed below.

1. Specific questions addressed:

The following specific questions indicate, in general terms, the relationships that were tested statistically. Each question focuses on the relationship between a particular transactions data item (i.e., the variable of analysis for each question) and the characteristics of the transactions between packing plants and sellers (see Table 1.4).

Purchasing plant and firm characteristics questions

Question 2.1 Did some statistically significant relationship exist between the slaughter capacities of individual plants or firms and key transactions characteristics?

Question 2.2 Did some statistically significant relationship exist between the geographical location of individual plants and key transactions characteristics?

Question 2.3 Did some statistically significant relationship exist between individual plants and the firms with which the plants were associated and key transactions characteristics?

Cattle seller characteristics questions

Question 2.4 Did some statistically significant relationship exist between individual sellers and firms with which those sellers were associated grouped by size of feedlot and key transactions characteristics?

Question 2.5 Did some statistically significant relationship exist between the types of sellers and key transactions characteristics?

Question 2.6 Did some statistically significant relationship exist between the geographical locations of sellers and key transactions characteristics?

Pricing/procurement characteristics questions

Question 2.7 Did some statistically significant relationship exist between the lot procurement methods used and key transactions characteristics?

Question 2.8 Did some statistically significant relationship exist between the lot pricing methods used and key transactions characteristics?

Purchase lot characteristics questions

Question 2.9 Did some statistically significant relationship exist between the net live or actual weights of the lots purchased and key transactions characteristics?

Question 2.10 Did some statistically significant relationship exist between the type of cattle purchased and key transactions characteristics?

Question 2.11 Did some statistically significant relationship exist between the quality grades of the cattle lots purchased and key transactions characteristics?

Question 2.12 Did some statistically significant relationship exist between the yield grades of the cattle lots purchased and key transactions characteristics?

Question 2.13 Did some statistically significant relationship exist between the dressing yields of the cattle lots purchased and key transactions characteristics?

Question 2.14 Did some statistically significant relationship exist between the total delivered costs of the purchased lots and key transactions characteristics?

Question 2.15 Did some statistically significant relationship exist between size of the lots and key transactions characteristics?

Question 2.16 Did some statistically significant relationship exist between the transportation costs of the cattle lots purchased and key transactions characteristics?

Question 2.17 Did some statistically significant relationship exist between the commissions paid for the cattle lots purchased and key transactions characteristics?

Packing plant slaughter characteristic questions

Question 2.18 Did some statistically significant relationship exist between the number of head slaughtered and key transactions characteristics?

Question 2.19 Did some statistically significant relationship exist between the hot weights of the cattle lots slaughtered and key transactions characteristics?

Question 2.20 Did some statistically significant relationship exist between the cost per pound of the cattle slaughtered and key transactions characteristics?

2. Analytical Methodology:

Non-parametric analyses were done to determine the existence or strength of any association between the variables of analysis in each of the 20 questions above and the transactions data characteristics (see Table 1.4). The non-parametric tests used to explore the potential statistical relationships between and among the variables of analysis can be grouped into two major categories: (1) those used to identify possible *correlation* between/among the variables of analysis and the transactions data characteristics or (2) those used to test for *statistical differences* between/among the variables of analysis and each transaction data characteristic or sets of those characteristics.

a. Tests for Correlation
This category of statistical tests was used to investigate possible relatedness among variables. Correlation tests, including the Pearson correlation test and the Spearman rank correlation test, were used to test for relatedness between two variables in one or more strata. That is, do changes in a particular variable of analysis and one or more transaction data characteristic move in the same direction or in opposite directions and, if so, what is the magnitude of relatedness?

b. Tests for Statistical Difference
The Analysis of Variance (ANOVA) procedure was used to test for differences in the means of variables both within and between or among groups. The existence of statistical differences in continuous variables such as prices paid, for example, based upon dichotomous variables such as size classification, region, or other groupings of transactions data characteristics can also be tested. ANOVA can be used to test for equality of the mean scores of one or more continuous variables in one or more stratam of dichotomous variables. ANOVA is not appropriate, however, for analyses utilizing dichotomous variables (such as pricing and procurement methods) as the dependent variables because no true means or variances exist for such variables. To account for differences in the number of observations within and among groups, the Student-Newman-Kuhls (SNK) procedure was used to identify statistically significant differences.

General Question III: What major factors affected the choice of slaughter cattle procurement and pricing methods and the costs of cattle slaughtered by the top 43 steer and heifer packing plants during the period of the data?

This question lays out the third major task of this project which was to: (1) use the transactions data provided by PSP to identify factors that affected the choice of slaughter cattle procurement and pricing methods, and the costs of the cattle slaughtered by the top 43 steer and heifer packing plants

over the period of the data and (2) quantify the magnitude of the relationship between the identified factors and the choice of pricing/procurement methods of the packing plants and the levels of purchased cattle costs to those plants. The descriptive and non-parametric analyses discussed above helped determine whether a relationship existed between these methods, and costs and the key transactions data characteristics. In this part of the project, the most important factors affecting the choice of pricing/procurement methods and costs to packing plants were identified, and the extent of the relationships were measured. The specific questions addressed and the analytical procedures followed are discussed in this section in some detail below.

1. Specific questions addressed:

Question 3.1 Which, if any, of the transactions data characteristics (as defined in Table 1.4) significantly affected the choice of *cattle procurement method* by the top 43 steer and heifer packing plants and to what extent?

Question 3.2 Which, if any, of the transactions data characteristics (as defined in Table 1.4) significantly affected the choice of *lot pricing method* by the top 43 steer and heifer packing plants and to what extent?

Question 3.3 Which, if any, of the transactions data characteristics (as defined in Table 1.4) significantly affected the *delivered cost* of cattle purchased by the top 43 steer and heifer packing plants and to what extent?

2. Analytical Methodologies:

a. Factors Affecting Choice of Procurement/Pricing Methods

A Polychotomous Choice Model was used to determine which transactions characteristics affected either the *choice* of cattle procurement method or the *choice* of lot pricing method. The dependent variables in these situations correspond to discrete values. The simplest case is that in which the dependent variable is binary (i.e., can be only two values), which for convenience and without any loss of generality can be denoted by 0 and 1. The number of possible types of cattle procurement methods and possible types of lot pricing methods, however, was more than two for each method. The dependent variables in this case, therefore, took on discrete values from 1 to k, where k refers to the maximum number of procurement or pricing methods. At the same time, cattle procurement and lot pricing methods are examples of *unordered* categorical variables. That is, they are dependent variables whose values may be defined according to any order desired.

Because the dependent variables correspond to discrete values, the probability that the ith procurement or pricing method is chosen, conditional on the given transactions characteristics, was investigated. Because the two methods are unordered variables and because there are more than two types for each method, the analysis of the factors

affecting the choice of procurement and lot pricing methods required the use of the *multinomial logit model*. Section 4 of this report provides details on the theoretical properties, specification, and use of this model for the analysis of the factors affecting packers' choices of procurement and pricing methods. Estimation of the multinomial logit model required the use of a specialized computer software package called LIMDEP.

b. Factors Affecting the Delivered Cost of Fed Cattle

Multivariate Regression Analysis was used to quantify the relationship between the packer costs of cattle and the transactions data characteristics (see Table 1.4). The non-parametric analysis discussed in the preceding section (i.e., analysis of general question II) helped identify and describe any relationship that may exist between cattle costs and one or more transactions data characteristics such as plant size, plant location, type of cattle purchased, etc. The objective of the regression analysis was to provide quantitative measures of the extent to which changes in the costs of cattle to packers are related to changes in statistically significant transactions data characteristics. This analysis was done over the period of the data for individual plants, for packer firms, and for all packing plants across geographic location, slaughter capacity, and other relevant characteristics as allowed by the data. A *hedonic technique* was used in the regression analysis, the results of which are presented in section 5 of this report. Previous empirical applications of the hedonic technique generally have regressed price or logs of prices of different varieties of good on various specification variables such as quality characteristics or more readily measurable variables such as size and performance. The hedonic technique as used in this study required the use of cross section data over the period of the data to regress delivered costs per pound of liveweight paid by packers for fed cattle against the transactions data characteristics (see Table 1.4). The estimated coefficients of these equations provide some notion of the "shadow" or marginal prices of the characteristics of the cattle procured and slaughtered by individual plants, plants in a given region of the country, plants in given capacity categories, packer firms, or all plants in the sample over the period of the data.

Packer and Feedlot Survey Data Analysis

Both packer buyers and feedlot sellers were surveyed to determine actual and preferred transactions methods, arrangements and pricing methods for contracted cattle, delivery arrangements, weighing conditions, pencil shrink arrangements, packer buyer preferred feedlot characteristics and services, packer buyer reasons for not buying from feedlots, and conditions in which packer buyers pay price premiums and discounts. The results are discussed in detail in section 6 of this report.

The Packer and Feedlot Survey Data

The packer and feedlot surveys were designed and administered directly by the contractor. A first survey was sent to the 42 top steer and heifer packing plants from a list provided by PSP. These were the same steer and heifer slaughter plants from which the PSP collected transactions data[2]. Although the PSP provided the names and addresses of those steer and heifer packing plants, the contractor was responsible for identifying the packer buyer or other appropriate individual in each plant to respond to the survey.

The feedlot survey was administered to a sample of U.S. cattle feedlots having a one-time capacity of 4,000 head or more. The sample was randomly drawn from a sampling frame of all U.S. feedlots with a one-time capacity of 4,000 head or more as given in *CF Resources Cattle Industry Reference Guide 1992* published by CF Resources, Inc. The sampling frame was proportionately stratified by geographical location and feedlot capacity in a two-way stratification. The geographical stratum included the 6 PSP geographical regions having cattle feedlots with a one-time capacity of 4,000 head or more (East North Central, West North Central, South Atlantic, South Plains, Mountain, and Pacific). The capacity stratum included 4 feedlot capacity size groups of over 4,000 head (4,000-7,999 head, 8,000-15,999 head, 16,000-31,999 head, and 32,000 head or more).

The proportions used for stratifying the sampling frame were the number of fed cattle in each region and feedlot capacity group during 1992. Two of the PSP regions (East North Central and South Atlantic) only had one feedlot each of 4,000 head capacity or more. Because the capacities of those two lots represented less than 1% of the total capacity of all feedlots in the sample, they were excluded from the sampling frame and the sample was adjusted by recalculating the proportions among the remaining four PSP regions so that two more feedlots were assigned to the appropriate size categories. The procedure maintained the integrity of both the size and location strata of the sample. The final result of the sampling procedure was a two-way stratified sample of 195 feedlots from the population of 598 total feedlots to permit a 95% confidence interval with a ±7% error in response (Table 1.7). Alternate feedlots also were drawn for each feedlot capacity group within each region should some feedlots refuse to participate. The alternate feedlots were drawn at a 20% rate of the original sample and were drawn for each capacity size group within each region.

A pre-survey letter was sent to each of the packers on the list provided by PSP to solicit the name and address of the primary fed cattle buyer for each plant and to determine the willingness of the plant to participate in the survey. Each letter included a self-addressed and stamped card on which the plant could respond. The plants were given 10 days in which to respond, after which each non-responding plant was contacted directly by phone to elicit the requested information. Because the feedlot sampling frame included only the name, city and state, and telephone number for each

[2] The list provided by the PSP included only one of the two Beef America plants in Omaha, Nebraska. Thus, although PSP collected transactions data from 43 plants, the packer survey was sent to only 42 plants.

feedlot, addresses of the feedlots in the final sample were obtained from the Beef Spotter book or through telephone calls.

A survey was sent to the identified contact individual at each packing plant and feedlot along with a cover letter requesting their assistance in filling out and returning the surveys. Two weeks response time plus 3 days for mail service was allowed. A reminder letter and another questionnaire was sent to all nonrespondents again asking for their assistance. Another 2 weeks response time for all nonrespondents to return their surveys was again allowed. Then all contact individuals at the packing plants and feedlots who had not responded by that time were contacted by phone to again request their assistance in filling out and returning the surveys. The cutoff date for accepting surveys from the original sample was two weeks after the remaining nonrespondents were contacted by telephone. Any remaining nonrespondent feedlots were replaced from the alternate list drawn from the sampling frame. Surveys were sent to that list and the same process of reminder letters and phone calls to non-respondents from that list was followed. This process required approximately another 7 weeks. A follow-up attempt was made to estimate the nonresponse error and determine the effects of nonresponse on the results.

Method of Analysis

Cross tabulation contingency tables were produced for the responses to all questions on both surveys, as appropriate, to generate frequency distributions and relevant summary statistics such as means. An Analysis of Variance (ANOVA) was done for many questions as well to identify statistically significant differences within and between or among multiple classifications of packer and feedlot responses to the same questions. Packer responses were classified into two groups: (1) single vs. multiple plant firms and (2) geographic regions. Feedlot responses were classified into four groups: (1) feedlot capacity, (2) single vs. multiple feedlot firms, (3) feedlot regions, and (4) the number of packer buyers purchasing from each feedlot. To account for differences in the number of observations within and among groups, the Student-Newman-Kuhls (SNK) procedure was utilized to identify statistically significant differences.

A comparison of mean responses by packers and feedlots for cattle purchase behavior often was not meaningful due to the nature of the samples. That is, packers did not buy exclusively from the feedlots included in the feedlot sample nor did the feedlots sell exclusively to the packers included in the packer sample. Comparisons of rating responses between packers and feeders surveyed, however, are provided. Ratings for importance of feedlot services and characteristics, and reasons for lost sales for packers and feedlots were compared using a paired *t*-test procedure assuming unequal variances.

Questions regarding ranked preferences for purchase behavior were analyzed using various ranked-sum procedures of the Wilcoxon type. Based upon the data limitations, the most appropriate analytic techniques for assessing potential statistically significant differences was judged to be the Kruskal-Wallis χ^2. This technique utilizes a type of χ^2-statistic to detect differences in ranked preferences between/among groups. The classifications used for both feedlots and packers were the same as for the previously discussed analyses.

Table 1.1: Transactions Data Analysis Timeline

Tasks	Time Required
Development of the computer programs needed to download transactions data and convert into Statistical Analysis System (SAS) datasets, and to perform the data analyses[1]	From beginning of project through December 1994
Development of models and analytical techniques, including extensive review of literature on appropriate analytical models and procedures	From beginning of project through December 1994
Preparation of transactions data for analysis	July 1994 - December 1994
Analysis of data as described in plan of work	December 1994 - August 1995
Deliver final report to PSA	November 1, 1995

[1] SAS is a registered trademark of the SAS Institute, Inc., Cary, North Carolina.

Table 1.2: Packer and Feedlot Survey Timeline

Tasks	Time Required
All preliminary work in preparation to mail surveys to packers and feedlots, including designing survey instrument, developing survey sample, etc.	12 months[1]
Pre-survey letter mailed and enclosed response card from beef packers received back	January - February 1994
Non-respondent packers contacted by phone to acquire names/addresses of head packer buyer	February 1994
Cover letters and surveys sent to packers and feedlots. Began receiving completed surveys	February - March 1994
Follow-up letter sent to non-respondent packers and feedlots. Receipt of completed surveys	mid-March 1994
Follow-up phone calls made to all packer buyers and feedlot managers who still had not responded Continued receiving completed surveys	late-March - April 1994
Last date for receiving surveys from original sample	May 2, 1994
Replacement of non-respondents with alternate respondents, mail survey, follow-up, etc	May - June 1994
Analysis of survey results	July 1994 - June 1995

[1] Much of the preparatory work had been done by the time PSP obtained OMB approval for the surveys. However, we were asked by PSP not to send out the surveys until after difficulties concerning PSP collection of transactions and cost data from packers were cleared up. We were given approval to proceed with the surveys in January 1994.

Table 1.3: Packing Plants from which Transactions Data were Collected

Plant Name[1]	Firm Name	Plant Location	Plant Type[2]
1. Aurora Packing Co., Inc	Aurora Packing Co., Inc	North Aurora, Illinois	S&H
2. Beef America	Beef America	Norfolk, Nebraska	S&H
3. Beef America	Beef America	Omaha, Nebraska	S&H
4. Beef America	Beef America	Omaha, Nebraska	S&H
5. Booker Custom Packing Co.	Booker Custom Packing Co.	Booker, Texas	S&H
6. Caldwell Packing Co.	Caldwell Packing Co.	Windom, Minnesota	S&H
7. ConAgra Fresh Meats	Conagra	Nampa, Idaho	C&B
8. Excel Corp.	Excel Corp.	Fort Morgan, Colorado	S&H
9. Excel Corp.	Excel Corp.	Sterling, Colorado	S&H
10. Excel Corp.	Excel Corp.	Dodge City, Kansas	S&H
11. Excel Corp.	Excel Corp.	Schuyler, Nebraska	S&H
12. Excel Corp.	Excel Corp.	Friona, Texas	S&H
13. Excel Corp.	Excel Corp.	Plainview, Texas	S&H
14. Gibbon Packing, Inc.	Gibbon Packing, Inc.	Gibbon, Nebraska	C&B
15. Greater Omaha Packing Co., Inc.	Greater Omaha Packing Co., Inc.	Omaha, Nebraska	S&H
* 16. Green Bay Dressed Beef, Inc.	Green Bay Dressed Beef, Inc.	Green Bay, Wisconsin	S&H
17. Harris Ranch Beef Co.	Harris Ranch Beef Co.	Selma, California	S&H
18. Hyplains Dressed Beef	Hyplains Dressed Beef	Dodge City, Kansas	S&H
19. IBP, Inc.	IBP, Inc.	Denison, Iowa	S&H
20. IBP, Inc.	IBP, Inc.	Boise, Idaho	S&H
21. IBP, Inc.	IBP, Inc.	Geneseo, Illinois	S&H
22. IBP, Inc.	IBP, Inc.	Emporia, Kansas	S&H
23. IBP, Inc.	IBP, Inc.	Holcomb, Kansas	S&H
24. IBP, Inc.	IBP, Inc.	Luverne, Minnesota	S&H
25. IBP, Inc.	IBP, Inc.	Dakota City, Nebraska	S&H
26. IBP, Inc.	IBP, Inc.	Lexington, Nebraska	S&H
27. IBP, Inc.	IBP, Inc.	West Point, Nebraska	S&H
28. IBP, Inc.	IBP, Inc.	Amarillo, Texas	S&H
29. IBP, Inc.	IBP, Inc.	Pasco, Washington	S&H
30. Leonard & Harral Packing Co.	Leonard & Harral Packing Co.	San Antonio, Texas	C&B
31. E A Miller Co.	ConAgra	Hyrum, Utah	S&H
32. Monfort, Inc.	ConAgra	Greeley, Colorado	S&H
33. Monfort, Inc.	ConAgra	Des Moines, Iowa	S&H
34. Monfort, Inc.	ConAgra	Garden City, Kansas	S&H
35. Monfort, Inc.	ConAgra	Grand Island, Nebraska	S&H
36. Monfort, Inc.	ConAgra	Dumas, Texas	S&H
37. Moyer Packing Co.	Moyer Packing Co.	Souderton, Pennsylvania	S&H
* 38. Murco, Inc.	Murco, Inc.	Plainwell, Michigan	S&H
39. National Beef Packing	National Beef Packing	Liberal, Kansas	S&H
40. Packerland Packing Co., Inc.	Packerland Packing Co., Inc.	Hospers, Iowa	S&H
41. Packerland Packing Co., Inc.	Packerland Packing Co., Inc.	Green Bay, Wisconsin	S&H
42. Peck Foods Corp.	Peck Foods Corp.	Milwaukee, Wisconsin	C&B
43. Sam Kane Beef Processors, Inc.	Sam Kane Beef Processors, Inc.	Corpus Christi, Texas	S&H
* 44. Shamrock Meats, Inc.	Shamrock Meats, Inc.	Vernon, California	S&H
45. Shapiro Packing Co., Inc.	Shapiro Packing Co., Inc.	Augusta, Georgia	C&B
46. Sunland Beef Co.	Sunland Beef Co.	Tolleson, Arizona	S&H
* 47. Taylor Packing Co., Inc.	Taylor Packing Co., Inc.	Wyalusing, Pennsylvania	S&H
48. Washington Beef, Inc.	Washington Beef, Inc.	Toppenish, Washington	S&H

[1] For those plants marked with an asterisk (*), an incomplete set of transactions data was provided. See section 2.
[2] S&H = steer and heifer plant and C&B = cow and bull plant.

Table 1.4: Transactions Data: Individual Transactions for each Lot of 35 Head or More Slaughtered by Each Steer & Heifer Plant

Data Collected By Lot Characteristics	Data Description
PURCHASING PLANT/FIRM CHARACTERISTICS	
1. Plant ID	Code uniquely identifying the plant
2. Plant firm	Name of firm that operates, owns, or controls packer, as appropriate
3. Plant name	Name of plant
4. Plant location	City, county, state, FIPS code
CATTLE SELLER CHARACTERISTICS	
5. Seller ID	Code uniquely identifying the seller
6. Seller type	Types: (1) auction, (2) dealer, (3) feed lot/farmer feeder, 4) unknown
7. Seller location	City, county, state, FIPS code
8. Seller firm	Name of firm that operates, owns, or controls seller, as appropriate
PRICING AND PROCUREMENT CHARACTERISTICS	
9. Procurement method	Types: (1) open (spot) market, (2) forward contract, (3) marketing agreement, (4) packer-fed/owned, (5) other, and (6) unknown.
10. Pricing method[1]	Types: (1) live weight, (2) carcass weight (hot or dressed) including carcass grade/yield, (3) carcass weight, fixed price (not grade/yield), (4) formula, (5) grade/yield and formula, (6) custom kill and railers, (7) unknown.
CATTLE PURCHASE LOT CHARACTERISTICS	
11. Purchase date	Date lot was purchased by the packer
12. Number of head	Number of head in the kill lot
13. Net live or actual purchase weight	Generally equal to gross liveweight minus pencil shrink.
14. Cattle type	Types: (1) steers, (2) heifers, (3) dairy and fed Holsteins, (4) mixed (steers and heifers), (5) other (not including cows and bulls), (6) unknown.
15. Quality grade	Categories: (1) prime, (2) choice, (3) select, (4) other
16. Yield grade	Yield grades no. 1, 2, 3, 4, and 5
17. Lot yield	As recorded by packers
18. Total delivered cost ($)	Cost of cattle, transportation, commission, feed (feed charged to packer by seller)
19. Transportation cost	Total cost for transporting the lot
20. Commissions paid	Total commissions paid for the lot
SLAUGHTER CHARACTERISTICS	
21. Kill date	Date cattle recorded as slaughtered
22. Total hot weight of lot (lbs)	Same as carcass weight or dressed weight
23. Cost per hundredweight ($/cwt)	Average rail cost as provided by packer or calculated by PSP using delivered cost and hot weight

[1] Although each transaction was identified by one of the seven pricing methods listed here, pricing methods (2) and (3) were not treated as mutually exclusive when the data was collected by PSP. The same was the case for pricing methods (4) and (5). Consequently, in the analyses presented in this report, only 3 mutually exclusive pricing methods could be utilized: live weight, carcass weight, and formula.

Table 1.5: Transactions Data: Daily Totals for Steers & Heifers, Cows & Bulls, and All Cattle Collected from All Plants

Daily Data Collected	Daily Data Description
PURCHASING PLANT/FIRM CHARACTERISTICS	
1. Plant ID	Code uniquely identifying the plant
2. Plant firm	Name of firm that operates, owns or controls packer as appropriate
3. Plant name	Name of plant
4. Plant location	City, county, state, FIPS code
CATTLE SELLER CHARACTERISTICS	
NOT INCLUDED	
PRICING AND PROCUREMENT CHARACTERISTICS	
NOT INCLUDED	
PURCHASED CATTLE CHARACTERISTICS (DAILY TOTALS)	
5. Cattle type	Types: (1) all cattle, (2) bulls, (3) cows, (4) cows and bulls, (5) steers, (6) heifers, (7) steer and heifers, (8) dairy cows, (9) fed Holsteins, and (10) other
6. Daily total delivered cost ($)	Cost of cattle slaughtered this day, including transportation, commission, and feed costs charged to packer by seller
7. Daily transportation cost	Total cost for transporting the cattle this day
8. Daily commissions paid	Total commissions paid for the cattle purchased this day
SLAUGHTER CHARACTERISTICS (DAILY TOTALS)	
9. Kill date	Date of slaughter for totals recorded this day
10. Daily Number of head	Number of head slaughtered this day
11. Daily Total hot weight of lot (lbs)	Total hot weight of cattle slaughtered this day. Same as carcass weight or dressed weight.
12. Daily Average rail cost ($/cwt)	Calculated by PSP as: Delivered cost ÷ Hot weight x 100

Table 1.6: Non-Transactions Data Items from the Beef Packer Costs and Returns Survey (BPCRS) Provided by the Packers and Stockyards Programs, GIPSA, USDA

Data Provided	Data Description
1. Plant Capacity	Maximum combined slaughter rate (head per hour) as designed and engineered for all beef slaughter lines at each plant per hour provided at two points in time: (1) the beginning of the period (April 5, 1992) and (2) the end of the period (April 3, 1993) with no indication of when any change from the beginning to the end of the period might have occurred. Part A, item 1b from the BPCRS.
2. Fabricated beef shipped in whole carcass equivalents	Weekly shipments by plant, quantity (lbs) and value ($1,000). Part C, item 8A from the BPCRS.
3. Fabricated beef shipped as primals	Weekly shipments by plant, quantity (lbs) and value ($1,000). Part C, item 8B from the BPCRS.
4. Fabricated beef shipped as sub-primals	Weekly shipments by plant, quantity (lbs) and value ($1,000). Part C, item 8C from the BPCRS.
5. Fabricated beef shipped as other fabricated cuts	Weekly shipments by plant, quantity (lbs) and value ($1,000). Part C, item 8D from the BPCRS.
6. Fabricated beef shipped as trimmings, boneless beef, or grinding material from fabrication operations item 8E	Weekly shipments by plant, quantity (lbs)and value ($1,000). Part C, from the BPCRS.
7. Shipments of carcass beef (whole, halves, quarters)	Weekly shipments by plant, quantity (lbs) and value ($1,000). Part C, item 9 from the BPCRS.
8. Shipments of beef by-products, variety meats, and (lbs) kill floor grinding material 10 from	Weekly shipments by plant, quantity and value ($1,000). Part C, item the BPCRS.

Table 1.7: Number of Feedlots in Survey Sample Stratified by Capacity and Region[1]

Region	One-Time Feedlot Capacity Categories (Head)				
	4,000-7,999	8,000-15,999	16,000-31,999	≥ 32,000	Total
	number of feedlots				
Mountain	5	8	15	14	42
Pacific	2	3	9	8	22
East North Central	0	0	0	0	0
West North Central	9	20	22	18	69
Southern Plains	3	9	14	36	62
South Atlantic	0	0	0	0	0
TOTAL	19	40	60	76	195

[1] States included in each region are as follows: (1) Mountain - Arizona, Colorado, Idaho, Montana, New Mexico, Nevada, Utah, and Wyoming, (2) Pacific - California, Oregon, and Washington, (3) East North Central - Illinois, Indiana, Michigan, Ohio, and Wisconsin, (4) West North Central - Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota, (5) Southern Plains - Oklahoma and Texas, (6) and South Atlantic - Delaware, Maryland, Florida, Georgia, North Carolina, South Carolina, Virginia, and West Virginia.

PRICE DETERMINATION IN SLAUGHTER CATTLE PROCUREMENT

SECTION 2
TRANSACTIONS DATA: GENERAL DESCRIPTION

This section provides an overview of the transactions data used in the analysis of packer pricing and procurement behavior in this study. Data on individual transactions related to lots of steer and heifer slaughter cattle slaughtered by the top 43 plants were collected for the period April 5, 1992, through April 3, 1993 (see Table 1.3 for a list of the packing plants). The dataset included a total of 200,616 individual transactions. Data for daily totals of individual transactions ("the daily data") also were provided for those same 43 steer and heifer plants as well as for five cow and bull slaughter plants (see Table 1.3). Data on individual transactions were not provided for the five cow and bull plants. In essence, the daily data involved daily totals over a subset of the transactions data elements collected from each plant. Whereas the individual transactions data were collected from each plant only for transactions involving steers and heifers, the daily totals also included cows, bulls, other, and totals over all cattle types in addition to steers and heifers. Consequently, the daily totals for steers and heifers should reflect the sums of the individual transactions of the same dates. Because individual transactions data were not collected from any plant for cows and bulls, and because only limited data were provided for cows and bulls even in the form of daily totals, many of the statistical analyses and the conclusions reached in subsequent sections of this report refer only to steers and heifers. This section reports primarily the summary statistics for the individual steer and heifer and the daily transactions data (counts, frequency distributions, sums, means, variances, standard deviations, maximums, minimums, etc.) as appropriate. Most of the 2-way and 3-way crosstabulations of interest as related to the non-parametric analysis reported in that section are presented in section 3.

Individual Steer and Heifer Transactions Data

The order of presentation in this part follows the order of the variables as provided in Table 1.4 of section 1 of this report organized into five sections: (1) purchasing plant and firm characteristics, (2) cattle seller characteristics, (3) pricing and procurement characteristics, (4) cattle purchase lot characteristics, and (5) packing plant slaughter characteristics.

Purchasing Plant and Firm Characteristics

The 43 steer and heifer plants were associated with 20 separate firms (see Table 1.3). The five cow and bull plants were owned by five different firms. The owner of one of the cow and bull plant,

however, also was the owner of steer and heifer plants. Together, the top three firms accounted for 75.1% of all steer and heifer lots purchased and 81.0% of all steers and heifers purchased.

Because five of the 48 plants were primarily cow and bull slaughter plants, they were not included in the individual steer and heifer transactions dataset. The five plants were: (1) ConAgra Fresh Meats, (2) Gibbon Packing, Inc., (3) Leonard and Harral Packing Co., (4) Peck Foods Corp., and (5) Shapiro Packing Co., Inc. These plants were included in the daily totals transactions dataset, however, and are discussed later in this section. The steer and heifer slaughter of two other primarily cow and bull slaughtering plants (Murco, Inc. and Taylor Packing Co., Inc.) were included in the individual steer and heifer transactions dataset. Because the data for steer and heifer slaughter for those two plants were so sparse, however, they could not be included in some of the analyses conducted (see sections 4 and 5 of this report). At the same time, the steer and heifer transactions of two other plants (Shamrock Meats, Inc. and Green Bay Dressed Beef, Inc.) also were too sparse to allow them to be included in those same analyses. Consequently, even though the transactions data for all 43 steer and heifer packing plants are included in this section and used in the non-parametric analyses presented in section 3 of this report, the steer and heifer transactions for 4 of the plants included in the individual steer and heifer transactions dataset (i.e., Murco, Inc.; Taylor Packing; Co. Inc.; Shamrock Meats, Inc.; and Green Bay Dressed Beef, Inc.) were not useable for the more rigorous, quantitative analyses presented in sections 4 and 5. More discussion on this point can be found in those sections.

The regional distribution of the 43 steer and heifer packing plants was roughly the same as the regional distributions of both the lots and the steers and heifers purchased during the period of the data. The largest percentage of the plants were in the West North Central region (46%) which accounted for 56% of both the lots and the steers and heifers purchased (Table 2.1). The South Plains region included 14% of the plants and accounted for 15% of the lots and 20% of the steers and heifers purchased. The Mountain region accounted for 14% of the plants, 13% of the lots, and 15% of the steers and heifers purchased. The East North Central region included 12% of the plants and accounted for 10% of the lots but only 5% of the steers and heifers purchased. Although deleted from Table 2.1 and subsequent tables to avoid disclosure, the North Atlantic packer region was still included in the totals. Also, a collateral deletion of the Pacific region was also necessary for this and some other tables to avoid disclosure with respect to the North Atlantic region.

If "captive supplies" are defined as cattle owned by packers, forward contracted by them, and/or formula priced cattle bought by packers, then 24.6% of the cattle lots reported to be slaughtered would be classified as captive supplies. This includes all lots in the transactions dataset procured through forward contracts or packer fed (19,537 lots) plus all lots priced on a formula basis, other than those procured by forward contracting or as packer fed cattle (29,847 lots).

Cattle Seller Characteristics

The 43 steer and heifer plants purchased 23,113,362 head of slaughter cattle from 19,396 individual sellers for slaughter during the 1-year period of the data for an average of 1,191.7 head per seller (Table 2.2). The largest number of sellers (76.0%) were located in the West North Central region.

Sellers in that region also accounted for the largest share of total lots purchased (53.1%) and steer and heifer purchases (51.9%) for slaughter during the one year period of the data. Sellers in the South Plains, the East North Central, and the Mountain regions made up another 19.6% of all sellers and accounted for 37.8% of the lots purchased and 42% of all steers and heifers purchased. The only other regions with a substantial number of sellers were the Pacific region (1.0%) and Canada (1.2%). All other regions accounted for less than 1% of all sellers (Table 2.2).

Although the increasing concentration of packers is the primary concern of this study, the transactions data indicate a high degree of concentration among slaughter steer and heifer sellers as well. Only 11.2% of the sellers accounted for 86.1% of all slaughter steer and heifer sales (Table 2.3). About 89% of the sellers sold less than 1,000 head of slaughter steers and heifers, accounting for 14% of all steers and heifers slaughtered during the period of the data. Two-thirds of the steers and heifers were purchased from large sellers who sold 8,000 head or more during the year. Less than 1% of the sellers sold more than 32,000 head to packers during that year but accounted for 43% of all steers and heifers slaughtered. Looking at the seller concentration issue from another perspective, only 11% of the sellers sold more than 12 lots of steers and heifers to packers during the year but accounted for over 94% of the steers and heifers slaughtered (Table 2.4). Over 74% of the sellers sold less than 4 lots of steers and heifers to packers during the year.

Only 1,677 (8.6%) of the sellers, however, were identified by type (i.e., dealer, auction, or feedlot/farmer feeder). Feedlot/farmer feeders accounted for 41% of those sellers identified by type and 59.1% of the lots sold by all type-identified sellers. Only 7.9% of the identified sellers were auctions, which accounted for only 8.6% of the transactions of type-identified sellers. The remaining identified sellers (51.5%) were designated as "dealers" and accounted for 32.3% of the transactions of type-identified sellers. The sellers of the remaining transactions (82.1%) were not identified by type.

Pricing and Procurement Characteristics

Four types of pricing methods and four types of procurement methods were reported to have been used by steer and heifer packers over the period of the data. The four pricing methods included: (1) carcass weight, (2) formula, e.g., pricing based on a packer's weekly average prices paid or an average of two or more price reports, etc., (3) live weight, and (4) custom kill and railers. The four procurement methods included: (1) forward contracting, (2) packer fed/owned, (3) marketing agreements, i.e., long-term purchase arrangements in which the packer agrees to purchase a specified number of cattle per specified time period, and (4) the open or spot market.

By far the largest number of procurement transactions (lot purchases) were conducted through the open (spot) market (82.3%) (Table 2.5). Marketing agreements and forward contracting were used for most of the remainder of the transactions (8% and 7%, respectively). Packer-fed or owned cattle were reported to account for only 2.7% of the transactions. Two pricing methods were used for most of the transactions: carcass weight (37.6%) and liveweight (45.6%). Formula pricing accounted for the rest (16.8%). Consequently, liveweight or carcass weight pricing with procurement through the open market accounted for the bulk of the transactions (74.7%).

The principal pricing method used, however, varied somewhat over the different procurement methods. Those lots procured through forward contracting tended to be priced on a carcass weight basis (Table 2.5). About half the packer fed/owned cattle were priced on a carcass basis. However, nearly half of the cattle priced on a formula basis were purchased through the spot market. For lots purchased on the spot market, liveweight and carcass weight were the principal pricing methods used.

Cattle Purchase Lot Characteristics

Each transaction record provided information on the characteristics of the respective steer and heifer lots purchased and slaughtered (see Table 1.3). Summary statistics on each of those characteristics are presented here.

Liveweight and Lot Size

The reported liveweight of each lot ranged from 0 pounds (lb) to 1,676,098 lb over 198,587 transactions for an average lot liveweight of 134,618.4 lb (Table 2.6). The reported number of head in a lot ranged from 1 to 1,916 for an average over 200,615 transactions of 115.2 head. Virtually all lots contained less than 1,000 head (Table 2.7). Consequently, the average weight per slaughter steer and heifer purchased for slaughter by packers over the period of the data was 1,156.7 lb. Over half (52.6%) of the lots weighed less than 100,000 lb. About 80% of all lots weighed less than 200,000 lb.

Quality Grade of the Lot

While many of the transaction records reported the quality and yield grades of the lots purchased, many either did not report grades or reported combinations of grades for the lot (e.g., prime/choice, select/other). PSP made decisions on which quality and yield grades to assign to lots in the latter case (see Appendix A for details).

Only 40,914 transaction records (20.4%) indicated that the respective lots of steers and heifers contained at least some prime grade steers and heifers (Table 2.6). Another 49,973 lots (24.9%) were reported to contain no prime grade cattle (Table 2.8). Unfortunately, 54.7% of the records (109,729 lots) failed to report the percentage of the lots accounted for by prime grade cattle. On average, prime grade steers and heifers accounted for 3.4% of the cattle in the lots which were reported to contain at least some prime grade steers and heifers (Table 2.6).

In contrast, only 60 lots (0.0%) were reported to contain no choice steers and heifers (Table 2.8). Another 7,383 lots (3.7%) failed to report the percentage of the lot accounted for by choice cattle. On average, choice grade steers and heifers accounted for 57.2% of the steers and heifers in the lots which were reported to contain at least some choice grade steers and heifers (Table 2.6).

About 83% of the lots (167,093) were reported to contain at least some select quality cattle (Table 2.6). Another 0.6% of the records (1,115 lots) reported that the respective lots contained no select

cattle while 16.2% (32,408 lots) failed to report the percentage of the lot accounted for by select quality cattle (Table 2.8). On average, select grade steers and heifers accounted for 35.2% of the steers and heifers in the lots reported to contain at least some select grade steers and heifers (Table 2.6).

About 65% of the lots (130,386) were reported to contain at least some "other" grade steers and heifers (Table 2.6). "Other" grade cattle were defined as those graded as other than prime, choice, or select; these were primarily ungraded, not recorded or known, or recorded by the packer as "other" grade. For most lots containing at least some other grade steers and heifers (78%), other grade steers and heifers made up less than 10% of the lots (Table 2.8). On average, other grade steers and heifers accounted for 8.9% of the steers and heifers in the lots reported to contain at least some other grade steers and heifers (Table 2.6).

Yield Grade of the Lot

Only 30% of the lots (60,240 lots) were reported to include at least some yield grade 1 steers and heifers (Table 2.8). The percentage of a lot that was yield grade 1, however, was reported for only 41.7% of the lots (83,697 lots) (Table 2.9). Thus, 72% of the lots for which a yield grade 1 percentage was reported included some yield grade 1 steers and heifers (Table 2.11). Also, yield grade 1 steers and heifers made up less than 10% of the lot for 70% of the lots reported to contain some yield grade 1 steers and heifers. On average, yield grade 1 steers and heifers accounted for only 8% of the steers and heifers in the lots reported to contain at least some yield grade 1 steers and heifers (Table 2.6).

In contrast, 83.4% of all lots (167,279 lots) were reported to include at least some yield grade 2 steers and heifers (Table 2.6). The percentage of the lots that were yield grade 2 was not reported for 15.6% of all transactions (Table 2.9). Over 98% of the lots for which a grade 2 percentage was reported included at least some yield grade 2 steers and heifers. On average, yield grade 2 steers and heifers accounted for 49.4% of the steers and heifers in lots reported to contain at least some yield grade 2 steers and heifers (Table 2.6).

At the same time, 82.4% of all lots (165,330 lots) included at least some yield grade 3 steers and heifers (Table 2.6). The percentage of the lots purchased made up by yield grade 3 steers and heifers was not indicated for 17.4% of the lots (Table 2.9). Thus, 99.2% of the lots for which a yield grade 3 percentage was reported included at least some yield grade 3 steers and heifers. On average, yield grade 3 steers and heifers accounted for 42.1% of the steers and heifers in lots reported to contain at least some yield grade 3 steers and heifers (Table 2.6).

Yield grade 4 steers and heifers were reported to be included in 62.5% of all lots (125,450 lots) or 74.2% of the lots for which a yield grade 4 percentage was reported (Tables 2.6 and 2.9). The yield grade 4 percentage was not reported for nearly 16% of the lots. Yield grade 4 steers and heifers made up less than 10% of the lot for over 86% of the lots reported to contain at least some yield grade 4 steers and heifers. On average, yield grade 4 steers and heifers accounted for only 4.6% of

the steers and heifers in lots reported to contain at least some yield grade 4 steers and heifers (Table 2.6).
Finally, 51.6% of all lots (103,434 lots) were reported to contain at least some yield grade 5 steers and heifers, or 57.4% of the lots for which a yield grade 5 was reported (Tables 2.6 and 2.9). The yield grade 5 percentage was not indicated for 10.2% of the lots. Yield grade 5 steers and heifers made up less than 10% of the lots for 95.7% of the lots that were reported to contain some yield grade 5 steers and heifers. On average, yield grade 5 steers and heifers accounted for only 2.2% of all steers and heifers in lots reported to contain at least some yield grade 5 steers and heifers (Table 2.6).

Quality Grade and Yield Grade

Nearly all lots included steers and heifers of more than one quality and yield grade. Over 80% of the lots included at least some choice, yield grade 2 steers and heifers (Table 2.10). At the same time, over 80% included at least some choice, yield grade 3 steers and heifers. Likewise, nearly 80% of the lots included some select, yield grade 2 steers and heifers and nearly 80% included some select, yield grade 3 steers and heifers. Choice yield grade 4 steers and heifers were included in 57.1% of the lots while select, yield grade 4 steers and heifers were included in 53.5% of the lots. Yield grade 2 and 3 steers and heifers were the most common across all quality grades. Yield grade 5 steers and heifers were least common across all quality grades.

Cattle Type

Over half (53.8%) of all lots purchased were indicated to be steers and about a third (32.3%) were indicated to be heifers (Table 2.11). Nearly 6%, however, were indicated to be "dairy" or "fed holstein" steers or heifers but were not designated as either steers or heifers. About 7% of the lots were indicated to be mixed (steers and heifers). Unfortunately, the cattle type designations for the cattle lots were not mutually exclusive and, therefore, not highly useful for analysis. For example, the "steer" and "heifer" cattle types could have included "dairy" and/or "fed holstein" cattle while "dairy" and "fed holstein" cattle could have included steers and/or heifers.

Lot Yield

Although the reported lot yield ranged from 0% to 80.4% over all lots for which a lot yield was reported (Table 2.6), the yield for most lots (94.9%) was between 60% and 69% (Table 2.12). The mean lot yield was 62.6% with a standard deviation of only 2.0%.

Total Delivered Cost, Commissions Paid, and Transportation Cost

Total reported delivered cost per lot ranged widely from $0 to $1,275,612.50 (Table 2.6). The delivered cost of nearly 90% of the lots (89.1%), however, was between $0 and $200,000 (Table 2.13) with a mean delivered cost of $101,376.96 (Table 2.6).

The commission portion of the total delivered cost was reported separately for only 3,814 lots of steers and heifers (1.9% of all lots) (Table 2.6). For those lots, the commission paid ranged from $0 to $2,295.56 with a mean of $135.01 per lot (Table 2.6). The commission paid on 50% of those lots, however, was less than $100 (Table 2.14).

Transportation cost was also separated out for a small portion of the lots (3,399 lots or 1.7% of the total number of lots) (Table 2.6). The transportation cost for those lots ranged from $0 to $13,621.28 with a mean of $1,041.58 per lot. About a third of those lots (959 lots), however, reported a transportation cost of $0. The non-zero transportation costs per lot ranged from $26.03 to $13,621.28 with a mean of $1,450.95.

Packing Plant Slaughter Characteristics

The transactions records also included a few pieces of information relating to the slaughter of the steer and heifer lots, including kill date, the total weight of the lot, and the average rail cost per lot.

Purchase and Kill Dates

The transaction data were collected over all plants for those lots of steers and heifers *slaughtered* between April 5, 1992, and April 3, 1993. Some of the cattle slaughtered during that period, however, were purchased in preceding months. The slaughter of steers and heifers was distributed fairly evenly throughout the period (Table 2.15). About 25% of all lots and 25% of all steers and heifers were slaughtered during each quarter of the April 1992 through April 1993 period. Slightly more steers and heifers were slaughtered during the spring and summer months than in the fall and winter months.

Although the kill date was indicated for virtually all lots, the corresponding purchase dates were provided for only 88.84% of the lots (178,121 lots, which includes some with obviously incorrect purchase dates; see Table 2.15). Of those lots for which a purchase date was provided, 95.3% were reported to have been purchased during the April 1992 to April 1993 period. Most of the remainder (3.5%) were purchased in the first quarter of 1992. About 1.2% of the lots were reported to have been purchased in 1991 for slaughter during the April 1992 to March 1993 period. The elapsed time between purchase and slaughter ranged from 1 day to 240 days with a mean of 14 days from purchase to slaughter (Table 2.6).

Total Hot Weight of the Lot and Average Rail Cost

The reported total hot weight of the lots slaughtered ranged from 582 lb to 1,042,771 lb with a mean of 85,125.7 (Table 2.6). The hot weight of over 70% of the lots was less than 100,000 lb, with another 22% less than 200,000 lb (Table 2.16). The reported average per hundred weight (cwt) rail cost per lot of the steers and heifers slaughtered ranged from $0/cwt to $818.09/cwt (Table 2.6). The mean, however, was only $120.14/cwt since the average rail cost of 99% of the lots was between $100/cwt and $200/cwt (Tables 2.6 and 2.17). The standard error was only $7.36/cwt.

Consequently, despite a rather wide variation in the size, quality, and yield grade of the lots, the variation in the average per hundred weight cost of the lots was relatively small.

Daily Transactions Data

The discussion of the relatively small amount of information available from the daily transactions dataset is presented in two parts: (1) purchasing plant characteristics and (2) purchased cattle and slaughter characteristics. The daily data did not include information on either cattle seller characteristics or pricing and procurement characteristics. As noted briefly earlier, the data from the daily transactions dataset did not always coincide with that provided in the individual steer and heifer transactions dataset. Consequently, some discrepancies may be noticed in comparing the information derived from the two sets of transactions datasets.

Purchasing Plant Characteristics

As indicated in the previous section, the 48 packing plants included in the transactions dataset included 43 steer and heifer plants and 5 cow and bull plants owned by 24 separate firms. The 48 plants purchased 26,742,467 head of cattle for slaughter which was 3,629,105 head more than the 43 steer and heifer plants purchased during the same period. The average daily slaughter ranged from a low of 98.9 head to a high of 4,081.1 head. For the top 3 firms, average daily slaughter ranged from a low of 275.1 head to 3,761.0 head.

According to the daily transactions data, a total of 1,527,737 head of cows and bulls were slaughtered during the April 5, 1992, to April 3, 1993, period of the data. While only 14 of the 48 plants slaughtered any cows and bulls, just 7 plants accounted for 91.4% of the total cow and bull slaughter. All but one of those plants slaughtered cows and bulls on 245 to 255 days and slaughtered between 373 head/day and 1,081 head/day.

Purchased Cattle and Slaughter Characteristics

On average, the 48 plants slaughtered about 972 head of all cattle types per day between April 4, 1992, and April 3, 1993, with an average daily hot weight of 702,270.4 lb or about 722.6 lb hotweight per head (Table 2.18). The average daily delivered cost per lot was $1,005,542 for an average rail cost per lot of $114.45/cwt. Relatively few daily totals included information on transportation costs or commissions paid. The average daily *reported* per lot cost of transportation and per lot cost of commissions were $7,699.47 and $529.33, respectively.

Cow and bull slaughter averaged 354.1 head/day for a total of 1,527,737 head yielding 930.1 million lb of carcass beef, an average of 215,597.6 lb/day during the period of the data (Table 2.19). The total delivered cost paid by packers for cows and bulls during the period of the data totaled nearly $1.5 billion for an average of $389,243.29 per lot per day. The mean average rail cost for cows and bulls was $99.89/cwt compared to $114.24/cwt for all cattle and $120.14/cwt for steers and heifers (compare Table 2.19 with Table 2.18 and Table 2.6). Transportation costs were reported only for 52 of the daily total observations for cows and bulls. The mean daily transport costs for those

observations was $26,864.61 per lot. Commissions paid were not reported for any lots of the cows and bulls.

Table 2.1: Regional Distribution of Steer and Heifer Packing Plants[1]

Region[2]	Packers	% of Packers	Lots Purchased	% of Lots	Steers and Heifers Purchased	% of Steers and Heifers
	no.	%	no.	%	no.	%
North Atlantic	D	D	D	D	D	D
East North Central	5	11.7	19,186	9.6	1,101,896	4.8
West North Central	20	46.5	112,397	56.0	12,850,942	55.6
South Plains	6	13.9	29,408	14.7	4,696,532	20.3
Mountain	6	13.9	25,905	12.9	3,396,923	14.7
Pacific	D	D	D	D	D	D
TOTAL	43	100.0	200,616	100.0	23,113,362	100.0

D = Deleted to avoid disclosure.
[1] Percentage may not add to 100 percent due to rounding.
[2] North Atlantic = Pennsylvania; East North Central = Illinois, Michigan and Wisconsin; West North Central = Iowa, Kansas, Minnesota, Nebraska; Southern Plains = Texas; Mountain = Arizona, Colorado, Idaho, Utah; Pacific = California and Washington.

Table 2.2: Regional Distribution of Sellers[1]

Region[2]	Sellers	% of Sellers	Lots Purchased	% of Lots	Steers and Heifers Purchased	% of Steers and Heifers
	no.	%	no.	%	no.	%
North Atlantic	181	0.9	1,275	0.6	88,080	0.4
South Atlantic	96	0.5	515	0.3	26,251	0.1
East North Central	2,317	11.9	21,075	10.5	1,255,306	5.4
West North Central	14,741	76.0	106,565	53.1	12,006,876	51.9
South Central	61	0.3	738	0.4	39,795	0.2
South Plains	464	2.4	31,962	15.9	5,110,383	22.1
Mountain	1,021	5.3	22,909	11.4	3,354,718	14.5
Pacific	188	1.0	10,584	5.3	768,178	3.3
Canada	233	1.2	4,844	2.4	450,799	2.0
Unknown	94	0.5	149	0.1	12,976	0.1
TOTAL	19,369	100.0	200,616	100.0	23,113,362	100.0

[1] Percentages may not add to 100 percent due to rounding.
[2] North Atlantic = Connecticut, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Vermont; South Atlantic = Delaware, Maryland, North Carolina, South Carolina, Virginia, West Virginia; East North Central = Illinois, Indiana, Michigan, Ohio, Wisconsin; West North Central = Iowa, Kansas, Minnesota, Missouri, North Dakota, Nebraska, South Dakota; South Central = Alabama, Arkansas, Kentucky, Mississippi, Tennessee; South Plains = Oklahoma, Texas; Mountain = Arizona, Colorado, Idaho, Montana, New Mexico, Nevada, Utah, Wyoming; Pacific = California, Oregon, Washington; Canada = all provinces.

Table 2.3: Seller Sales of Cattle by Number of Head Sold per Seller [1]

Head Sold per Seller	No. of Sellers	% of Sellers	Steers and Heifers Sold	% Steers and Heifers Sold
	no.	%	no.	%
1 - 999	17,266	88.8	3,212,462	13.9
1,000 - 3,999	1,361	7.0	2,262,524	11.3
4,000 - 7,999	299	1.5	1,667,336	7.2
8,000 - 15,999	213	1.1	2,369,595	10.3
16,000 - 31,999	144	0.7	3,311,373	14.3
> 32,000	152	0.8	9,930,072	43.0
TOTAL	19,395	100.0	23,113,362	100.0

[1] Percentages may not add to 100 percent due to rounding.

Table 2.4: Number of Transactions per Seller [1]

No. of Transactions per Seller	No. of Sellers	% of Sellers	Steers and Heifers Sold	% Steers and Heifers Sold
	no.	%	no.	%
1 - 4	14,407	74.3	1,066,323	4.6
5 - 12	2,939	15.1	225,111	1.0
> 12	2,050	10.6	21,821,928	94.4
TOTAL	19,396	100.0	23,113,362	100.0

[1] Percentages may not add to 100 percent due to rounding.

Table 2.5: Transactions by Different Pricing and Procurement Methods

Pricing Method	Procurement Method: Forward Contract	Packer-fed/ Owned	Marketing Agreement	Spot Market	Other/ Unknown	Total
	no. of lots (%)					
Carcass Weight	10,297 (5.1)	2,467 (1.3)	1,221 (0.6)	61,416 (30.6)	7 (0.0)	75,408 (37.6)
Formula	D	D	D	15,184 (7.5)	0 (0.0)	33,570 (16.8)
Live Weight	D	D	D	88,401 (44.1)	3 (0.0)	91,549 (45.6)
Custom Kill/Railers	0 (0.0)	0 (0.0)	0 (0.0)	2 (0.0)	0 (0.0)	2 (0.0)
Unknown	8 (0.0)	1 (0.0)	23 (0.0)	44 (0.0)	11 (0.0)	87 (0.0)
TOTAL	14,057 (7.0)	5,480 (2.7)	16,011 (8.0)	165,047 (82.3)	21 (0.0)	200,616 (100.0)

D = Deleted to avoid disclosure.

Table 2.6: Summary Statistics for Steer and Heifer Lots

Lot Characteristic	No. of Steer and Heifer Lots[1]	Mean	Standard Deviation	Minimum	Maximum
Liveweight (lb)	198,587	134,618.4	111,663.8	0	1,676,098.0
Hotweight (lb)	195,599	85,125.8	70,977.93	582.0	1,042,771.0
Lot Size (head)	200,615	115.2	96.3	1	1,916
Quality Grade (% of lot)					
Prime	40,914	3.4	4.0	0	88.9
Choice	193,173	57.2	21.7	0	100
Select	167,093	35.2	18.7	0	100
Other	130,386	8.9	16.4	0	100
Yield Grade (% of lot)					
Grade 1	60,240	7.9	8.2	0	100
Grade 2	167,279	49.4	21.5	0	100
Grade 3	165,330	42.1	20.0	0	100
Grade 4	125,450	4.6	5.0	0	100
Grade 5	103,434	2.2	8.9	0	100
Lot Yield (%)	183,305	62.6	2.0	0	80.4
Delivered Cost ($)	200,584	101,376.96	85,622.80	0	1,275,612.50
Average Rail Cost ($/cwt)	186,884	120.14	7.36	0	818.09
Transportation Cost ($)	3,399	1,041.58	1,220.43	0	13,621.28
Commission Paid ($)	3,814	135.01	199.7	0	2,295.56
Elapsed Time: Purchase to Kill (days)	164,056	14.0	31.3	1	240

[1] Number of lots for which the indicated characteristic was reported. May not add to the total number of lots (200,616) if the field was left blank or if the field contained negative numbers or extraneous characters. For quality and yield grade, the number of lots is the number reported to include at least some of the indicated quality or yield grade cattle.

Table 2.7: Liveweight and Number of Head of Steer and Heifer Lots

Liveweight per Lot (lb)	No. of Head per Lot					
	0-999		1,000-1,999		Total	
	no. of lots (%)					
0-99,999	104,438	(52.6)	0	(0.0)	104,438	(52.5)
100,000 - 199,999	54,537	(27.5)	2	(0.0)	54,539	(27.5)
200,000 - 299,999	24,139	(12.1)	0	(0.0)	24,139	(12.2)
300,000 - 399,999	8,887	(4.5)	0	(0.0)	8,887	(4.5)
400,000 - 499,999	3,564	(1.8)	0	(0.0)	3,564	(1.8)
500,000 - 599,999	1,627	(0.8)	0	(0.0)	1,627	(0.8)
≥ 600,000	1,367	(0.7)	26	(0.0)	1,393	(0.7)
Total	198,587	(100.0)	28	(0.0)	198,615	(100.0)

Table 2.8: Quality Grades of Steer and Heifer Lots

	No. of Steer and Heifer Lots				% of Steer and Heifer Lots[1]			
% of Lot	Prime	Choice	Select	Other	Prime	Choice	Select	Other
0	49,973	60	1,115	46,666	24.9	0.0	0.6	23.3
0 - 9[2]	37,950	8,600	12,244	101,884	18.9 (92.8)	4.3 (4.1)	6.1 (7.3)	50.8 (7.1)
10 - 19	2,505	3,110	22,767	12,060	1.2 (6.1)	1.6 (1.6)	11.3 (13.6)	6.0 (9.2)
20 - 29	353	8,001	32,119	4,401	0.2 (0.9)	4.0 (4.1)	16.0 (19.2)	2.2 (3.4)
30 - 39	75	15,487	32,619	3,408	0.0 (0.0)	7.7 (8.0)	16.3 (19.5)	1.7 (2.6)
40 - 49	22	25,319	28,144	2,819	0.0 (0.0)	12.6 (13.1)	14.0 (16.8)	1.4 (2.2)
50 - 59	5	32,516	19,926	2,127	0.0 (0.0)	16.2 (16.8)	9.9 (11.9)	1.1 (1.6)
60 - 69	2	37,448	11,768	1,375	0.0 (0.0)	18.7 (19.4)	5.9 (7.0)	0.7 (1.1)
70 - 79	1	34,145	5,500	731	0.0 (0.0)	17.0 (17.7)	2.7 (3.3)	0.4 (0.6)
80 - 89	1	20,872	1,758	361	0.0 (0.0)	10.4 (10.8)	0.9 (1.1)	0.2 (0.3)
90 - 100	0	7,675	248	1,220	0.0 (0.0)	3.8 (4.0)	0.1 (0.1)	0.6 (0.9)
Not reported[3]	109,729	7,383	32,408	23,564	54.7	3.7	16.2	11.7
Total	200,616	200,616	200,616	200,616	100.0 (100.0)	100.0 (100.0)	100.0 (100.0)	100.0 (100.0)

[1] First number is percent of all steer and heifer lots purchased. Number in parentheses is percent of lots that included at least some of the indicated quality grade. Percentages may not add to 100% due to rounding.
[2] Includes entries between 0 and 1.
[3] Includes extraneous entries (e.g., >100 and <0).

Table 2.9: Yield Grade of Steer and Heifer Lots[1]

	No. of Steer and Heifer Lots					% of Steer and Heifer Lots2									
% of Lot	YG 1	YG 2	YG 3	YG 4	YG 5	YG 1		YG 2		YG 3		YG 4		YG 5	
0	23,457	2,133	314	43,696	76,807	11.7		1.1		0.2		21.8		38.3	
0 - 9[3]	42,003	5,702	8,040	108,390	99,006	20.9	(69.7)	2.8	(3.4)	4.0	(4.9)	54.0	(86.4)	49.4	(95.7)
10 - 19	13,390	9,467	13,205	14,310	2,596	6.7	(22.2)	4.7	(5.7)	6.6	(8.0)	7.1	(11.4)	1.3	(2.5)
20 - 29	3,072	15,828	22,893	2,169	753	1.5	(5.1)	7.9	(9.5)	11.4	(13.8)	1.1	(1.7)	0.4	(0.7)
30 - 39	1,014	21,733	30,293	420	225	0.5	(1.7)	10.8	(13.0)	15.1	(18.3)	0.2	(0.3)	0.1	(0.2)
40 - 49	474	28,159	31,883	113	99	0.2	(0.8)	14.0	(16.8)	15.9	(19.3)	0.1	(0.1)	0.0	(0.1)
50 - 59	194	29,130	25,631	32	39	0.1	(0.3)	14.5	(17.4)	12.8	(15.5)	0.0	(0.0)	0.0	(0.0)
60 - 69	69	24,502	16,992	8	15	0.0	(0.1)	12.2	(14.6)	8.5	(10.3)	0.0	(0.0)	0.0	(0.0)
70 - 79	18	18,045	9,917	4	8	0.0	(0.0)	9.0	(10.8)	4.9	(6.0)	0.0	(0.0)	0.0	(0.0)
80 - 89	2	10,317	4,653	1	6	0.0	(0.0)	5.1	(6.2)	2.3	(2.8)	0.0	(0.0)	0.0	(0.0)
90 - 100	4	4,396	1,823	3	687	0.0	(0.0)	2.2	(2.6)	0.9	(1.1)	0.0	(0.0)	0.3	(0.7)
Not reported[4]	116,919	31,204	34,972	31,470	20,375	58.3		15.6		17.4		15.7		10.2	
TOTAL	200,616	200,616	200,616	200,616	200,616	100.0	(100.0)	100.0	(100.0)	100.0	(100.0)	100.0	(100.0)	100.0	(100.0)

[1] YG*i* = Yield grade *i* where *i* = 1, 2, 3, 4, 5.
[2] First number is percent of all lots. Number in parentheses is percent of lots that included at least some of the indicated yield grade. Percentages may not add to100% due to rounding.
[3] Includes entries between 0 and 1.
[4] Includes extraneous entries (e.g., > 100 and < 0).

Table 2.10: Quality and Yield Grades of Steer and Heifer Lots[1]

Yield Grade	No. of Lots Purchased				% of Total Lots Purchased[2]			
	P	C	S	O	P	C	S	O
1	28,715	60,224	55,807	39,360	4.3	30.0	27.8	19.6
2	37,692	164,626	155,837	100,138	18.8	82.1	77.7	49.9
3	37,715	162,770	155,562	100,919	18.8	81.1	77.5	50.3
4	27,467	114,651	107,357	73,600	13.7	57.1	53.5	36.7
5	13,132	45,676	32,826	32,471	6.5	22.8	16.4	16.2

[1] P = Prime, C = Choice, S = Select, O = Other.
[2] Percent of total lots purchased (200,616).

Table 2.11: Type of Cattle in Lots

Type	No. of Lots	%
Steers	107,890	53.8
Heifers	64,551	32.2
Dairy[1]	7,798	3.9
Fed Holsteins	3,680	1.8
Mixed	14,136	7.0
Other[2]	2,398	1.2
Unknown	163	0.1
TOTAL	200,616	100.0

[1]May include fed holsteins.
[2]May include "cows, bulls, stags, or mixed."

Table 2.12: Lot Yield of Steer and Heifer Lots

Lot Yield %	No. of Lots	%
0 - 9	2	0.0
10 - 19	1	0.0
20 - 29	0	0.0
30 - 39	0	0.0
40 - 49	202	0.1
50 - 59	9,142	5.0
60 - 69	173,889	94.9
70 - 79	66	0.0
80 - 89	3	0.0
TOTAL	183,305	100.0

Table 2.13: Total Delivered Cost per Lot

Delivered Cost per Lot ($)	No. of Lots	% of Lots
0 - 49,999	71,264	35.5
50,000 - 99,999	55,369	27.6
100,000 - 199,999	52,090	26.0
200,000 - 299,999	14,844	7.4
300,000 - 399,999	4,385	2.2
400,000 - 499,999	1,729	0.9
500,000 - 599,999	569	0.3
600,000 - 699,999	180	0.1
700,000 - 799,999	90	0.0
800,000 - 899,999	37	0.0
900,000 - 999,999	14	0.0
1,000,000 - 1,099,999	8	0.0
1,100,000 - 1,199,999	3	0.0
> 1,200,000	2	0.0
TOTAL	200,584	100.0

Table 2.14: Commission Paid per Lot

Commission per Lot ($)	No. of Lots	%
0 - 99	1870	49.0
100 - 199	177	4.6
200 - 299	662	17.4
300 - 399	629	16.5
400 - 499	180	4.7
500 - 599	143	3.8
600 - 699	54	1.4
700 - 799	25	0.7
800 - 899	12	0.3
900 - 999	10	0.3
1,000 - 1,099	11	0.3
1,100 - 1,199	11	0.3
1,200 - 1,299	13	0.3
1,300 - 1,399	8	0.2
≥ 1,400	9	0.2
TOTAL	3,814	100.0

Table 2.15: Monthly Steer and Heifer Purchases and Slaughter[1]

Year and Month	No. of Lots		% of Lots		No. of Cattle		% of Cattle	
	Purchases	Slaughter	Purchases	Slaughter	Purchases	Slaughter	Purchases	Slaughter
	--------no.--------		--------%---------		----------head----------		--------%---------	
1991								
January	15	--	0.0	--	2,543	--	0.0	--
February	15	--	0.0	--	2,583	--	0.0	--
March	4	--	0.0	--	515	--	0.0	--
SUB-TOTAL	**34**	**--**	**0.0**	**--**	**5,641**	**--**	**0.0**	**--**
April	27	--	0.0	--	2,240	--	0.0	--
May	56	--	0.0	--	6,792	--	0.0	--
June	41	--	0.0	--	6,173	--	0.0	--
SUB-TOTAL	**124**	**--**	**0.1**	**--**	**15,205**	**--**	**0.1**	**--**
July	119	--	0.1	--	15,793	--	0.1	--
August	64	--	0.0	--	7,797	--	0.0	--
September	225	--	0.1	--	26,964	--	0.1	--
SUB-TOTAL	**408**	**--**	**0.2**	**--**	**50,554**	**--**	**0.2**	**--**
October	298	--	0.2	--	39,582	--	0.2	--
November	489	--	0.3	--	64,509	--	0.3	--
December	716	--	0.4	--	84,444	--	0.4	--
SUB-TOTAL	**1,503**	**--**	**0.8**	**--**	**188,535**	**--**	**0.9**	**--**
1992								
January	1,581	--	0.9	--	176,214	--	0.9	--
February	1,904	--	1.1	--	219,737	--	1.1	--
March	2,707	--	1.5	--	329,408	--	1.6	--
SUB-TOTAL	**6,192**	**--**	**3.5**	**--**	**725,359**	**--**	**3.6**	**--**
April	12,327	13,926	6.9	6.9	1,374,238	1,539,381	6.8	6.7
May	13,909	17,466	7.8	8.7	1,517,563	1,957,637	7.5	8.4
June	15,748	18,776	8.8	9.4	1,722,070	2,103,827	8.5	9.1
SUB-TOTAL	**41,984**	**50,168**	**23.6**	**25.0**	**4,613,871**	**5,600,845**	**22.7**	**24.2**
July	15,062	17,956	8.5	9.0	1,691,096	2,096,110	8.3	9.1
August	15,254	17,531	8.6	8.7	1,741,832	2,056,827	8.6	8.9
September	16,662	17,376	9.4	8.7	1,932,056	2,030,383	9.5	8.8
SUB-TOTAL	**46,978**	**52,863**	**26.4**	**26.4**	**5,364,984**	**6,183,320**	**26.5**	**26.8**
October	14,488	17,682	8.1	8.9	1,632,493	1,980,815	8.1	8.6
November	13,650	15,406	7.7	7.7	1,562,529	1,746,222	7.7	7.6
December	13,187	15,699	7.4	7.8	1,543,924	1,854,552	7.6	8.0
SUB-TOTAL	**41,325**	**48,787**	**23.2**	**24.3**	**4,738,946**	**5,581,589**	**23.4**	**24.1**
1993								
January	13,337	15,396	7.5	7.7	1,559,496	1,872,973	7.7	8.1
February	12,933	14,915	7.3	7.4	1,517,315	1,758,164	7.5	7.6
March[2]	13,242	18,472	7.4	9.2	1,497,534	2,115,805	7.4	9.2
SUB-TOTAL	**39,512**	**48,783**	**22.2**	**24.3**	**4,574,345**	**5,746,942**	**22.6**	**24.9**
TOTAL[3]	**178,060**	**200,601**	**100.0**	**100.0**	**20,277,440**	**23,112,696**	**100.0**	**100.0**

[1] For the slaughter period of April 5, 1992, to April 3, 1993. Some cattle slaughtered during that period were purchased in precedingmonths. All lots with purchase dates before 1991 not included.
[2] Through April 3, 1993, for purchasers and April 5, 1993, for slaughter.

[3] Purchase totals do not include lots for which no purchase date is provided (22,495 lots and 2,835,922 head) and lots with reported purchase dates before January 1991 or after March 1993 (61 lots and 10,474 head). Slaughter totals do not include lots for which no kill date is given (15 lots and 666 head). Percentages may not add to 100 percent due to rounding.

Table 2.16: Total Hot Weight of the Lot

Hot Weight (lb)	No. of Lots Purchased	% of Lots
0 - 99,999	139,619	71.4
100,000 - 199,999	42,703	21.8
200,000 - 299,999	9,574	4.9
300,000 - 399,999	2,608	1.3
400,000 - 499,999	772	0.4
500,000 - 599,999	204	0.1
≥ 600,000	119	0.1
TOTAL	195,599	100.0

Table 2.17: Average Rail Cost of the Lot

Rail Cost ($/cwt)	No. of Lots Purchased	% of Lots
1 - 99	1,576	0.8
100 - 199	185,296	99.2
≥ 200	12	0.0
TOTAL	186,884	100.0

Table 2.18: Total Cattle: Daily Transactions Data Summary Statistics

Characteristic	No. of Observations[1]	Totals	Per Day			
			Mean	Standard Deviation	Minimum	Maximum
Number of Head (head)	27,518	26,742,467	971.8	1,021.3	0	5,812
Hotweight (lb)	27,518	19,325,075,729	702,270.4	751,063.5	0	4,301,182
Delivered Cost ($)	25,392	25,532,727,331	1,005,542.19	1,133,641.04	0	9,536,744.15
Ave. Rail Cost ($/cwt)	23,102	132.12[2]	114.45[3]	16.20	0	213.84
Transportation Cost ($)	1,252	9,639,734.41	7,699.47	8,746.74	0	61,245.93
Commission Paid ($)	1,217	644,191.40	529.33	813.37	0	5,260.41

[1] Number of daily totals for which the indicated characteristic was reported. May not add to the total number of daily total observations (27,518) if the field was left blank or if the field contained negative numbers or extraneous characters.
[2] Weighted average.
[3] Unweighted average.

Table 2.19: Cows and Bulls: Daily Transactions Data Summary Statistics

Characteristic	No. of Observations[1]	Totals	Per Day		
			Mean	Minimum	Maximum
Number of Head (head)	4,314	1,527,737	354.1	1	5,799
Hotweight (lb)	4,314	930,087,833	215,597.6	0	3,054,314
Delivered Cost ($)	3,750	1,459,662,348	389,243.29	0	2,656,405.71
Ave. Rail Cost ($/cwt)	3,397	90.40[2]	99.85[3]	0	127.72
Transportation Cost ($)	52	1,396,959.55	26,864.61	13,222.42	61,245.93
Commission Paid ($)	0	--	--	--	--

[1] Number of daily totals for which the indicated characteristic was reported. May not add to the total number of daily total observations (27,518) if the field was left blank or if the field contained negative numbers or extraneous characters.
[2] Weighted average.
[3] Unweighted average.

PRICE DETERMINATION IN SLAUGHTER CATTLE PROCUREMENT

SECTION 3
TRANSACTIONS DATA: NON-PARAMETRIC ANALYSIS

The overall objective of this section of the study was to use the transactions dataset provided by PSP to detect whether or not statistically significant relationships could be identified in the slaughter cattle procurement activities of the top 43 steer and heifer slaughtering plants and the firms that own them relative to the key characteristics of those transactions during the period of the data (April 5, 1992, through April 3, 1993). In this phase of the analysis, statistical procedures were used to provide evidence that such relationships existed. The specific questions addressed focused on the relationships among particular sets of characteristics of the fed cattle transactions between packing plants or firms and sellers as provided in the dataset. Given the data available, five categories of questions were addressed in this section of the study: (1) purchasing plant/firm characteristics, (2) cattle seller characteristics, (3) pricing and procurement methods, (4) characteristics of the lots of cattle purchased, and (5) packing plant slaughter characteristics. The specific questions in each category addressed are provided in Section 1 of this report.

The organization of this section is as follows. First, a discussion of data transformations which were necessary to perform the analyses is presented. This is followed by a brief treatment of the analytical procedures employed. Next are discussions of the empirical results from the statistical analyses of the specific questions in each of the 5 categories. Finally, a summary and conclusions section which highlights the major findings of this section of the study is included.

Data Transformations

To appropriately address the questions of interest, numerous data transformations were necessary to structure additional variables needed (or more suitable) for statistical analysis from the data provided in the transactions dataset. The set of non-transformed variables used in this analysis are listed with their definitions in Table 3.1a while the same is done in Table 3.1b for the transformed variables. Many of the data transformations focused on restructuring the data in an economic context and, therefore, involved standardizing costs, plant and seller characteristics, and size issues. Data involving lot totals for costs and various weight measures were converted to dollars per hundredweight (cwt) on liveweight and hotweight bases. Additionally, dollars per head were calculated to obtain a representation of average costs paid by packers for fed cattle.

Packing plants were grouped by firm and then, in order to avoid disclosure, packing firms were grouped for analysis into three categories based on the number of head procured: (1) the top three firms (ConAgra, Excel Corp., and IBP, Inc.), (2) the next five firms, and (3) all remaining firms (a total of 12 firms). Sellers were grouped into categories based upon number of head sold per year as a proxy for size of seller to reduce the 17,000+ sellers into smaller groupings which could be meaningfully analyzed. Also, lots were grouped based upon the number of head per lot to assist in analysis and interpretation.

The issues of lot quality grade and lot yield grade were difficult to address due to the nature of the transactions data collected by PSP. That is, the percentage of each quality or yield grade in each lot were reported, but no composite measure which could be logically analyzed was available for either lot characteristic. Therefore, indices for quality grade and yield grade were formulated. Quality grade indices (QGI) and yield grade indices (YGI) were constructed in the same manner. The classes of information (three in the case of quality grade and five in the case of yield grade) were sorted based on the percentage accounted for by each of the lot. For instance, for a lot that was 45% choice, 35% select, and 20% prime, a QGI = 231 was assigned to the lot where 2 = choice, 3 = select and 1 = prime. The same procedure was used for the YGI. Only the three yield grades with the largest percentage composition in the lot were used for YGI to generate a manageable number of classes.

PSP did not provide plant capacities as a part of the transactions dataset for this part of the study[3]. Due to the operational and economic importance of capacity, proxies for "throughput" and "efficiency" were created to measure the capacity characteristics of each plant. Two variables ("daily mean slaughter" and "maximum daily slaughter") were created over the period of the data and used to create variables representing "maximum throughput" and "capacity utilization ratio" for each plant (see Table 3.1b). The capacity utilization ratio is equal to the daily mean slaughter divided by the daily maximum slaughter over the period of the data. Plants were grouped by firm affiliation. The three largest firms had plants with an average maximum daily throughput of over 3,000 head with an average capacity utilization ratio of over 80% (Table 3.2). Smaller firms typically had, of course, smaller maximum daily throughputs but markedly smaller capacity utilization ratios as well. On average, the smallest firms operated at only 59% of capacity. This suggests the definite possibility that significant economies of size exist and that higher efficiency may generally be related to this size economy. Maximum throughput and capacity utilization are grouped into the classification variables MAXGROUP and CUGROUP for analytical purposes related later in this section (see Table 3.1b).

Analytical Methods

[3] Slaughter capacity was ultimately provided for use in the analyses reported in sections 4 and 5 of this report but was provided too late to be used for this part of the study.

Three sub-groups of analytical methods were utilized to determine the existence or strength of any association between the variables of analysis in each of the questions analyzed. Statistical tests used to explore potential relationships were: (1) basic descriptive methods, (2) methods to identify possible correlation between/among variables, and (3) methods which test for statistical differences between/among the variables.

Descriptive techniques employed to obtain an initial indication of possible correlations and statistical relationships included general summary statistics (means, etc.) on continuous variables and cross-tabulations on class variables. In most instances, summary statistics are presented by class variable grouping. Tests for correlation were conducted to identify whether and how variables related to one another. Did changes in a particular variable and one or more transaction characteristics move in the same or opposite directions and what was the magnitude of relatedness? Both the Pearson and Spearman rank correlation coefficients were utilized in this phase of the study.

Tests for statistical differences between or among variables were conducted using the General Linear Models (GLM) construct to derive analysis of variance (ANOVA) results. Due to the size of the data set and the disparity in numbers of transactions contained within each classification category, the various chi-square techniques were judged to add little if any information to the ANOVA analyses and thus are not reported. To account for the differing numbers of observations across classifications, the Student-Newman-Kuhls procedure for multiple - comparison *t*-tests was employed. This allowed for an accurate assessment of statistically significant differences across groupings.

Results of Statistical Analyses

Four groups of analytical results are presented in this section: (1) a descriptive analysis which presents summary statistics for the variables as used in this section, (2) a categorical crosstabulation analysis which presents 2-way contingency tables for a number of key variables, (3) a correlation analysis which presents Pearson and Spearman correlation coefficients for appropriate key variables, and (4) analysis of variance to identify whether some statistically significant relationships existed among key characteristics of transactions between plants and sellers.

Descriptive Analysis

Summary statistics for selected continuous variables relating to dollars paid per head, costs per cwt, and slaughter yield percentage were calculated for the various groupings of the classification variables relating to seller and packer location and size, pricing and procurement methods, and capacity utilization ratios (Table 3.3). Only the frequencies and means are shown. Other statistics, such as standard deviations, maximums, and minimums, were withheld to prevent disclosure of proprietary information. This information is presented in addition to the summary statistics for the variables in the original PSP data set (see section 2) which is provided for reference purposes.

Packers were located in 6 of the 9 PSP geographic regions, with the West North Central accounting for 112,397 of the 200,616 lots procured by all packers (56.0%)[4]. Mean cost per cwt ranged from $117.62 in the Pacific region to $121.06 in the West North Central region. Mean dollars paid per head ranged from $853.17 in the South Plains region to $888.80 in the West North Central region. The lowest mean percentage yield of the lots was 61.31% in the East North Central region and the highest was 63.38% in the South Plains region.

Sellers were found in eight of the nine PSP regions and in Canada. Once again, the greatest number of lots was purchased from the West North Central region (106,565 lots or 53.15%). Costs per cwt for the cattle purchased from each region were lowest in Canada ($117.98) and highest in the South Atlantic region ($120.49) although there was little difference among regions. Dollars paid per head ranged from a low of $855.91 in the South Plains region to $900.06 in Canada. The average yield of slaughtered lots was lowest for steers and heifers from the Mountain region (61.78%) and highest for those from the South Plains (63.50%).

The groupings of the average number of steers and heifers per lot (HEADCAT) provide measures of relative lot size purchased for slaughter by packing plants in this study. HEADCAT grouping 1 is largely ignored in the following analyses because of the very small number of lots containing less than 35 head. This grouping was retained throughout the study, however, to segment out these few very small lots. Costs per cwt ranged from a low of $119.40 in group 2 (35-57 head/lot) to a high of $121.26 in group 5 (> 188 head/lot). Dollars per head ranged from $872.62 in group 2 (35-57 head/lot) to $885.15 in group 4 (108-188 head/lot). Average lot yield for was highest for group 5 (> 188 head/lot) at 63.25% and was lowest for group 2 (35-57 head/lot) at 62.15%.

The groupings of plants by maximum daily throughput (MAXGROUP) for any single day during the year of operation contained in this dataset were used as a proxy for plant slaughter capacity. Summary statistics are provided in Table 3.3 for the following four maximum daily throughput groups: (1) MAXGROUP < 1,000 head/day, (2) MAXGROUP ≥ 1,000 and < 1,996, (3) MAXGROUP ≥ 1,996 and < 4,000, and (4) MAXGROUP ≥ 4,000. Plants slaughtering 4,000 head per day or more accounted for 47.83% of all lots purchased. Costs per cwt were highest for group 3 at $121.32 and lowest for group 2 at $116.49. Lots sold to group 3 yielded the highest total per head at $885.16 and those sold to group 2 yielded the lowest per head at $857.09. The average percentage yield was highest for lots slaughtered by plants in group 4 (63.04%) and lowest for those slaughtered by plants in group 2 (61.01%).

[4] Although the North Atlantic region was included in the analyses reported here, the results for that region were deleted from the tables and discussion to avoid disclosure. For some tables, a collateral deletion of some information for the Pacific region was also necessary to avoid disclosure with respect to the North Atlantic region.

Pricing methods for which data were available and for which summary statistics are provided in Table 3.3 include: (1) carcass weight (C), (2) formula pricing (F), and (3) liveweight (L). The liveweight (L) pricing method was used for 91,549 of the 200,527 lots (45.6%) for which the pricing method was reported. The average cost/cwt differed by only $0.62 among all three pricing methods. On a per head basis, the average cost of cattle procured varied somewhat more widely. In general, however, the average cost/cwt was lowest for cattle priced on a carcass weight basis and highest for those priced on a liveweight basis. Exactly the opposite was the case for the average dollars/head paid. The average lot yield was highest for lots priced on a formula basis (62.91%) and lowest for those priced on a carcass weight basis (62.20%).

Summary statistics are provided in Table 3.3 for four procurement methods: (1) forward contract (C), (2) packer owned (F), (3) marketing agreements (M), and (4) spot market (S). Procurement method (S) was used most frequently as 165,047 of the 200,594 observations (82.28%) were recorded under this procurement method. Cost per cwt was highest under procurement method (M) at $121.14 and lowest under procurement method (C) at $116.90. Procurement method (M) also had the highest dollars per head at $884.65 while method (C) was the lowest again at $860.56. Average lot yield was highest under method (M) at 63.34% and lowest under method (C) at 62.11%.

Packing plants were classified by capacity utilization ratios (CURATIO) into three groups (CUGROUP) so that some idea of relative throughput efficiency might be attained. Summary statistics are provided in Table 3.3 for the following CUGROUP groups of packing plants: (1) CURATIO $\leq$ 0.599; (2) CURATIO $>$ 0.599 and $<$ 0.74; and (3) CURATIO $\geq$ 0.75. Capacity utilization group 3 comprised 68.80% (138,028 of 200,616) of the total number of lots. Cost per cwt was highest in group 3 at $120.76 and lowest in group 1 at $116.65. Group 3 had the highest dollars per head at $880.45 with group 2 having the lowest at $871.34. The average yield peaked at 62.92% in group 3 and bottomed at 60.78% in group 1.

Sellers were grouped by number of head sold (SELERCAT) over the year of the data to firms in this sample as a proxy for seller size. PSP categories for size were utilized and resulted in the following seller size groups: (1) $<$ 1,000 head, (2) 1,000-3,999 head, (3) 4,000-7,999 head, (4) 8,000-15,999 head, (5) 16,000-31,999 head, and (6) $\geq$ 32,000 head. The majority of lots sold were by sellers in seller size groups 1 and 6, accounting for 23.31% and 30.85%, of all lots respectively (Table 3.3). Little difference was evident across categories in terms of costs per cwt, which ranged from $120.54 for seller size group 2 to $119.83 for seller size group 3. Dollars paid per head were highest for seller size group 2 ($886.70) and lowest for seller size group 6 ($869.01). Percentage lot yields for all categories were essentially equal (62.24% to 62.90%).

Sellers reporting more than 1,000 head sold during the reporting period were also placed into three categories according to type: (1) auctions (A), (2) dealers (D), and (3) farmer feeders/feedlots (F). Sellers reporting less than 1,000 head were not identified by type in the PSP dataset and, therefore, are not discussed. The vast majority of lots (84.28%) for which the seller was identified were sold by farmer feeders/feedlots. This seller type category had the highest cost per cwt. The cost of lots sold by dealers ($878.84) and those sold by feeders ($878.86) were virtually the same, while the cost

of lots sold by auctions was the lowest ($869.16). Percentage lot yields were greatest for feeders (62.82%) and dealers (62.14%). Auction lots had average percentage yields of 60.16%.

Categorical Crosstabulations

Summary statistics for lot yield and three measures of costs by various categorical crosstabulations are presented in this section (Tables 3.4 through 3.30). These two-way crosstabulations focus on procurement and pricing methods classed by the following measures of interest: (1) seller region, (2) seller size category, (3) packer region, and (4) capacity utilization ratio groups. Procurement and pricing methods are also crosstabulated with one another. Specifically, Tables 3.4 through 3.12 relate information on costs per cwt. Tables 3.13 through 3.21 present information on dollars per head. Tables 3.22 through 3.30 present summary statistics for lot percentage yields. These tables are presented to provide an overview of key continuous variables by classification variables before presenting the results of the GLM estimations and ANOVA discussions. This information was useful in formulating appropriate hypotheses regarding the feeder pricing and procurement behavior of packers and for interpreting the analytical results of the tests of those hypotheses as reported in sections 4 and 5 of this report.

In general, the two-way crosstabulations allow for comparisons (based upon the relative magnitude in terms of both lots transacted and the four measures of interest listed above) among the several combinations of pricing and procurement methods. Comparisons across these groups can be made for average rail costs ($/cwt) and dollars per head (liveweight). The data suggest that fewer differences exist for average rail costs than for liveweight. Interestingly, lots sold using the liveweight pricing method appeared to have garnered somewhat lower dollars per head across all procurement methods than was the case for other pricing methods except forward contracted cattle (see Table 3.13). In general, larger feeders (i.e., those with sales in excess of 16,000 head) tended to receive lower dollars per head for the cattle they sold across all pricing and procurement methods except perhaps for forward contracted cattle (see Table 3.15).

Similarly, plants in the higher capacity utilization ratio group tended to pay the least in dollars per head for the cattle they procured over all pricing and procurement methods except for those priced on a liveweight basis or procured through forward contracting or as packer fed cattle (Tables 3.17 and 3.21). Packing plants in the West North Central packer region tended to pay more in dollars per head and in $/cwt than those in other regions across all pricing and procurement methods (compare Tables 3.3, 3.4, 3.7, 3.16, and 3.20).

In addition to these tables, one-way crosstabulations for the 10 classification variables used in the GLM estimations and ANOVA discussions in this section of the report are presented in Appendix 3.1. The 10 classification variables used are: (1) capacity utilization ratio group, (2) firm group, (3) seller region, (4) number of head per lot (grouped), (5) pricing method, (6) procurement method, (7) maximum throughput grouping, (8) seller size, (9) packer region, and (10) seller type. These crosstabulations indicate the number of transactions (lots purchased) and the percentage of the total

transactions which occur in each crosstabulation cell. All combinations of crosstabulations for all 10 classification variables are provided in the Appendix 3.1 tables. The reader is urged to review these tables to become further familiarized with the nature of the data. Particular attention should be paid to the distribution of cattle purchase across the various procurement and pricing methods by the largest firms (Appendix Tables 3.1.1 and 3.1.2). In addition, note that there does not appear to be a relationship between size of seller and size of packing firm. While the 3 largest packers purchased nearly one-half of their cattle from the largest sellers (annual sales in excess of 16,000 head), nearly 40% of their purchases were from the smallest sellers (annual sales less than 4,000 head) (see Appendix Table 3.1.3). In fact nearly 25% of all cattle purchased by the 3 largest packers were from sellers with sales of less than 1,000 head per year. On the other hand, although the smallest packers had a tendency to purchase cattle from small sellers, they purchased nearly one-third of their cattle from the largest sellers. Note also from the tables in Appendix 3.1 that cattle purchases were dominated by packers with the highest capacity utilization ratios (see Appendix Table 3.1.29) and large maximum throughput capacities (see Appendix Table 3.1.37). Only slight behavioral differences based upon seller or packer region are obvious from only the crosstabulations tables provided in Appendix 3.1.

Correlation Analysis

Both the Pearson and the Spearman correlation coefficients were generated for all continuous variables. Summary statistics for the continuous variables are provided in Table 3.31. Simple statistics for the analyses were generated by transaction, i.e., they were formed from data available on a transaction-by-transaction basis. Therefore, not all variables analyzed in other parts of Section 3 or elsewhere are shown.

The correlation coefficients were expected to be statistically significant for nearly all relationships due to the large size of the data set being analyzed. Assertions relating to the magnitude of correlations were not made *a priori*. As anticipated, the correlation coefficients for all but three terms in the two analyses were significant at the 0.0001 level (as indicated in the footnotes of Table 3.32). With respect to the magnitudes of the correlation coefficients, many of those with high correlations were related in construct. For example, the total cost of a lot of cattle is mathematically related to the number of head in the lot, the total liveweight of the lot, and the hotweight of the lot. Similarly, cost per cwt is mathematically related to dollars paid on liveweight and hotweight bases for cattle.

Results of the Pearson correlation analysis indicate that aside from the expectedly high correlations just mentioned, only four correlation coefficients exceed 0.4: (1) DOLPLIVE with YIELD (0.531), (2) DOLPHEAD with COSTCWT (0.414), (3) DOLPHEAD with DOLPLIVE (0.408), and (4) DOLPHEAD with DOLPHOT (0.424). The only negative coefficient of any magnitude (except for those related to the variable ELAPSED) was for LIVEPHED with YIELD (-0.310). Due to the method used to calculate the correlation coefficients, the Spearman correlation analysis is somewhat more conservative in the estimated coefficient magnitudes than is the Pearson. No coefficients were estimated to be greater than 0.40 and only seven are greater than 0.30. Those greater than 0.30 include: (1) MAXHEAD with NUMHEAD (0.339), (2) MAXHEAD with LIVEWGT (0.319), (3)

MAXHEAD with HOTWGT (0.326), (4) MAXHEAD with COST (0.346), (5) DOLPHEAD with COSTCWT (0.354), (6) DOLPHEAD with DOLPLIVE (0.318), and (7) DOLPHEAD with DOLPHOT (0.352). The only negative coefficients approaching or exceeding -0.20 were: (1) HOTPHED with COSTCWT (-0.199), (2) HOTPHED with DOLPHOT (-0.197), and (3) DOLPLIVE with LIVEPHED (-0.277).

Analysis of Variance (ANOVA) Results

The General Linear Model procedure (GLM) was performed to yield ANOVA results to determine whether some statistically significant relationships existed among the following transactions data variables and key characteristics of transactions between the 43 steer and heifer packing plants and the sellers from which they procured slaughter cattle: (1) slaughter capacity as measured by maximum daily slaughter and capacity utilization, (2) the regional location of packers, (3) the firm groups associated with individual packing plants, (4) average delivered cost per cwt (hotweight) paid by packers, (5) average rail cost, (6) average delivered cost per head paid by packers, (7) seller type, (8) the regional location of sellers, (9) the size of sellers, (10) packer procurement method, (11) packer pricing method, (12) the number of head per lot, (13) the average delivered cost per cwt (liveweight) paid by packers, (14) the quality grade of the lot, (15) the yield grade of the lot, and (16) the percentage yield of the lot.

Slaughter Plant Capacity

The effects of slaughter plant capacity (as measured by maximum daily slaughter and capacity utilization) were first analyzed using the ANOVA technique (Table 3.33). Recall that capacity groupings related to maximum daily slaughter and capacity utilization were constructed as a proxy for observed capacity in the absence of design capacity which was not included in the transactions dataset provided by PSP. For the maximum throughput measure, the cost and yield figures were statistically different for all groupings. In every case for cost variables, the plants exhibiting a maximum throughput of 1,996 - 4,000 head/day (maximum daily throughput group 3) had statistically higher costs than did the maximum daily throughput group 4 (over 4,000 head per day). The magnitude of difference in costs for the two largest groups was considerable in comparison to the two smallest groups (see Table 3.33 for individual cost result comparisons). In terms of the percentage yield of lots slaughtered, maximum daily throughput group 4 had the highest yield (63.04%) followed closely by maximum daily throughput group 3 (62.80%). The two smallest groups had significantly smaller means across all cost and yield measures.

ANOVA results for the capacity utilization ratio groupings indicate that plants with the highest capacity utilization ratios paid more for cattle than did those with lower capacity utilization (Table 3.34). Plants which were in the largest capacity utilization group accounted for about 68% of all lots slaughtered. All groupings exhibited costs and yields which were significantly different from one another.

Dollars paid per head ranged from $880.45 for the most efficient plant grouping (in terms of capacity utilization) to $871.34 for the mid-range capacity utilization group. Average rail cost was highest for the group with the highest capacity utilization ($120.76) and lowest for the lowest capacity utilization group ($116.65). Similar ordering of results was observed with respect to yield, ranging from 62.9% (CUGROUP 3) to 60.78% (CUGROUP 1). The number of head per lot was directly related to both the MAXGROUP and CUGROUP in terms of size. That is, the larger the throughput and the higher the CURATIO (as measured by CUGROUP), the larger the average lot size purchased.

In general, plants with larger capacities paid more for the cattle they slaughtered, both in terms of liveweight and hotweight, than plants with smaller capacities. Additionally, the percentage yields of lots slaughtered and the number of head per lot were higher the larger the plant. The same relationships held true for capacity utilization ratios. One may infer that gains from processing efficiency and economies of size in processing may have enabled these plants to pay more for higher quality, more uniform animals as inputs into their plant operation. These larger throughput, higher capacity utilization ratio plants were owned primarily by the large national firms with dominant market share whereas smaller throughput, lower capacity utilization firms were owned by small local or regional firms with small market shares (see Table 3.2).

Packer Regional Location

It is reasonable to hypothesize that the geographic locations of the packing plants should have a statistical relationship with key transactions characteristics between plants and sellers (Table 3.35). Packing plants were placed into the same six regional groupings used by PSP in their annual summary report: (1) the North Atlantic (NOA), (2) the East North Central (ENC), (3) the West North Central (WNC), (4) the South Plains (SPL), (5) the Mountain (MTN), and (6) the Pacific (PAC). The results for the North Atlantic region were deleted from the tables and associated discussion to avoid disclosure.

Plants in the West North Central region paid the highest dollars per head for steers and heifers slaughtered in that region ($888.80). Plants in the South Plains paid the lowest in terms of dollars per head ($853.17). All regions were statistically different from one another. Plants in the West North Central and the South Plains regions paid the most per cwt, liveweight ($75.74 and $76.04) and hotweight ($121.02 and $120.10). The East North Central region paid the least on a $/cwt, liveweight basis ($72.75) while the Mountain region paid the least on a $/cwt, hotweight basis ($118.02). Average rail cost followed a similar pattern with the plants in the West North Central region paying a cost of $121.06/cwt and those in the South Plains paying a cost of $120.25/cwt. In this case, however, the average rail cost paid by plants in the Pacific region was the lowest ($117.61). For average rail cost, statistically significant differences were found among four of the five groups.

In terms of lot yield percentages, South Plains had a lot yield of 63.39% compared to the overall mean of 62.62%. The Pacific ranked second highest with 63.05%. The lowest yielding slaughter lots were in the East North Central region (61.31%). All groupings were statistically different from

one another. In terms of average number of head per lot, the South Plains processed lots of 159.70 head, the largest lot size, and the East North Central processed lots of 57.43 head, the smallest lot size. The mean lot sizes in all regions were statistically different.

Packing plants in the two largest volume regions (West North Central and South Plains) paid the most per cwt, liveweight and hotweight, for the cattle they procured. Percentage lot yields were highest and lot sizes largest for plants in the South Plains. The Pacific and Mountain regions fell primarily into the midrange in terms of all cost and yield measures. Plants in the East North Central region paid lower prices and had lower costs and percentage yields than all other regions. Typically, these latter plants were older and smaller than those in the other regions and, therefore, did not likely experience the efficiency nor size advantages of the newer, larger, more technologically up-to-date plants in the West North Central and South Plains regions.

Steer and Heifer Packing Firm Groups

Data were analyzed to detect if some statistical relationship existed between and among the packing firms with which plants were associated and key transactions characteristics between plants and sellers (Table 3.36). Most of the 20 firms were single plants (see Table 1.3 in section 1). The notable exceptions were ConAgra, Excel, and IBP (the three largest firms).

Whether on a per head or a per cwt (liveweight or hotweight), the average cost of cattle procured for slaughter by the three largest packing firms was significantly higher than that of the next five largest firms which was significantly higher than that of the remaining firms. The average cost/head of slaughter cattle ranged from a low of $864.28 paid by the smallest firms to a high of $884.37 paid by the 3 largest firms - a range of $20.09 (2.3% of the mean). Similarly, the average cost/cwt of slaughter cattle ranged from a low of $73.39 (liveweight) and $117.70 (hotweight) paid by the smallest packing firms to a high of $75.76 (liveweight) and $120.77 (hotweight) - ranges of $2.37 on a liveweight basis (3.2% of the mean) and $3.07 on a hotweight basis (2.6% of the mean).

The average percentage yield of the lots purchased by the three largest firms (62.86%) was significantly higher than that of the other two groups of firms. Interestingly, the average percentage yield of the lots purchased by the smallest firms (62.40%) was slightly but significantly higher than that of the second largest group of firms (62.11%).

In summary, the largest firms in terms of numbers of steers and heifers slaughtered clearly paid the highest amount per animal slaughtered as compared to smaller firms. Percentage lot yields of the three largest firms was also the highest among the three groups of firms. The average lot sizes of the larger firms were also larger than those of other smaller firms. These results reinforce, once again, the concept of size and efficiency advantage for larger firms and suggest that the larger firms may be most concerned with their plants operating at full capacity to minimize final product costs.

Average Delivered Cost ($/hundredweight, hotweight)

ANOVA was performed to determine any statistical relationships between and among the average delivered cost/cwt paid on a hotweight basis by packers for fed cattle and key transactions characteristics (Table 3.37). Recall that average delivered cost per cwt, hotweight differs from average rail cost per cwt in that the hotweight cost measure was calculated by dividing total lot costs by total lot hotweight whereas the average rail costs per cwt was taken directly from packer transaction records collected by PSP. Therefore, these two "hotweight" cost measures may differ marginally due to discrepancies in the reported data.

Except for cattle in the smallest lots slaughtered (i.e., HEADCAT group 1 (0 - 34 head/lot)), the results indicate that the larger the size of the slaughter lot, the higher the cost/cwt paid for the cattle in the lot. The average delivered cost/cwt (hotweight) paid for cattle in the largest slaughter lots (i.e., HEADCAT group 5 (> 188 head/lot)) was statistically higher than that of the next largest lot size (HEADCAT group 4 (108 - 188 head/lot)) ($121.09/cwt compared to $120.45/cwt) which was higher than the average delivered cost/cwt of cattle in the next largest lot size and so on.

With respect to procurement method, only two groupings of average delivered cost/cwt (hotweight) resulted. Packers procuring steers and heifers through marketing agreements or the spot market paid a higher delivered price per cwt (hotweight) than firms that forward contracted for cattle ($121.06/cwt and $120.18/cwt compared to $116.75/cwt). Considering the pricing method used in procuring cattle for slaughter, the results indicate no statistical difference in the average delivered cost/cwt (hotweight) paid for cattle among the three pricing methods reported to be used (i.e., carcass weight, liveweight, and formula). In other words, the pricing method chosen to procure cattle tended to have no statistically significant effect on the average cost/cwt (hotweight) paid by packers for the cattle procured.

Statistically significant differences in average delivered cost/cwt (hotweight), however, were found across the geographical locations of sellers. The average cost/cwt (hotweight) of lots from sellers in the West North Central, the South Central, the South Plains, and the Mountain regions ($120.39 - $120.11) was statistically higher than that of lots from sellers in other regions. The average cost/cwt (hotweight) of lots from the South Atlantic, the North Atlantic, and the Canada regions was significantly lower ($117.94 - $117.90) than in any other regions. Also, the average cost/cwt (hotweight) of lots sold by feeders ($120.02), dealers ($119.61), and auctions ($117.62) were all statistically different from one another with auctions bringing the lowest average cost/cwt.

The average cost/cwt (hotweight) of slaughter cattle paid by the three firm groups were all statistically different. The average cost/cwt (hotweight) of cattle procured by the three largest packing firms ($120.77/cwt) was significantly higher than that of the next five largest packing firms ($119.49/cwt) which was significantly higher than that of the remaining packing firms ($117.70).

The effects of maximum throughput, capacity utilization ratio, packer region, and packing firm on average delivered cost/cwt (hotweight) were discussed earlier in connection with Tables 3.33 through 3.36. The results are presented again in Table 3.37 for convenience and are identical to the results presented and discussed earlier.

In summary, although the pricing method used in procuring lots of cattle for slaughter had no statistically significant effect on the average delivered cost/cwt (hotweight) of those lots of cattle, the size of the firm procuring the cattle did have a significant effect on that cost. The larger the firm, the higher the average cost/cwt (hotweight) of the cattle procured tended to be. Conversely, the smaller the firm, the lower the average cost/cwt (hotweight) tended to be. The largest three firms paid the highest average cost/cwt (hotweight) of all cattle procured by all firms. The procurement method also had some effect on the average cost/cwt (hotweight) of the cattle procured for slaughter. Lots procured by forward contracting had the lowest average cost/cwt (hotweight) of any procurement method. The region from which cattle were procured also resulted in some statistical differences in the average cost/cwt (hotweight) for the cattle procured. In general, the average costs per cwt (hotweight) of cattle procured from the Atlantic regions (North and South) and Canada were statistically lower than those for cattle procured from any other region.

Average Rail Cost

The average rail costs is another measure of the cost/cwt (hotweight) that was analyzed to detect if any statistical relationship existed in the average cost/cwt paid by packers for fed cattle (Table 3.38). Remember that the previously analyzed average delivered cost/cwt (hotweight) differs from average rail cost/cwt in that the average delivered cost/cwt was calculated using total lot costs and total lot hotweight whereas the average rail cost/cwt was taken directly from the packer transaction records collected by PSP. The average rail cost measures may differ from the hotweight cost because the number of lots for which average rail cost were provided was much smaller than the number of lots for which the average delivered cost/cwt (hotweight) could be calculated. Therefore, the differences in the means of the variables as presented in Tables 3.37 and 3.38 should be primarily the result of the differences in the number of observations. Even given the same number of observations, however, the means of the variables might differ between the two tables if the average delivered cost/cwt (hotweight) as calculated from the data provided is not closely related to the average rail cost/cwt as reported by packers.

With respect to lot size, the average rail cost of $121.26/cwt for HEADCAT group 5 (> 188 head) was greater than that for all other HEADCAT groups except for those of less than 35 head but only statistically greater than that of the HEADCAT group 2 (35-57 head). The average rail costs of mid-sized lots were not statistically different from one another. In general, however, the smaller the lot size, the lower the average rail cost.

The average rail costs of lots procured by marketing agreements, through the spot market, or those which were packer fed ($121.14/cwt, $120.35/cwt, and $119.95/cwt, respectively) were not statistically different from one another but were statistically higher than that of lots procured through forward contracting ($116.90/cwt).

The method by which cattle lots were priced had no statistically discernible effect on their average rail cost. Whether priced on a carcass weight, liveweight, or formula basis, the means of the average rail costs of the cattle lots procured across all packers ($120.52/cwt, $120.47/cwt, and $120.04/cwt, respectively) were not statistically different.

By seller region, however, average rail costs did differ statistically. Nevertheless, the majority of all lots purchased (82%) were in the same cost category. Steer and heifer lots originating from the South Atlantic, the West North Central, the South Plains, and the Mountain seller regions had significantly higher average rail costs than those from the North Atlantic, the Pacific, and the Canada seller regions. The means of the average rail costs ranged from a high of $120.49/cwt for the South Atlantic region to $117.98/cwt for the Canada region. The mean average rail cost in the top grouping had a range of only $0.31/cwt from the South Atlantic to the Mountain regions.
The means of the average rail costs of the slaughter cattle procured by the three firm groups were all statistically different with the highest cost paid by the three largest firms ($120.75/cwt) and the lowest paid by the smallest firms ($117.38/cwt).

The effects of maximum throughput, capacity utilization ratio, packer region, and packing firm on average rail cost were discussed earlier in connection with Tables 3.33 through 3.36. The results are presented again in Table 3.38 for convenience and are identical to the results presented and discussed earlier.

The pattern of results for average rail cost presented in this section mirrors that of the previous section. As before, these result verify that: (1) pricing method had little effect on the cost/cwt paid by packers for slaughter cattle and (2) the average cost/cwt of forward contracted cattle was significantly lower than that of cattle purchased by any other method. Interestingly, the results also indicate that the larger the lot size, the higher the cost/cwt, which could be due to factors such as quality differences among the lots purchased. These results highlight the differences between the variable COSTCWT (average rail cost) which was provided in the transactions dataset and DOLPHOT (average delivered cost/cwt, hotweight) which was calculated from existing transactions data (see Tables 3.1a and 3.1b). Because the number of observations for which average rail cost (COSTCWT) was provided was considerably less than the number of lots for which the average delivered cost/cwt (hotweight) (DOLPHOT) could be calculated, the variable DOLPHOT was used in subsequent analyses in sections 4 and 5 of this report.

Average Delivered Cost ($/head)

The delivered costs of steers and heifers slaughtered were measured in terms of dollars per head paid on a lot basis (Table 3.39). This variable was analyzed to identify any statistical relationship which might exist between and among delivered cost of steers and heifer slaughtered and key transaction characteristics.

Little statistical difference was found in terms of lot size. The larger lots, however, tended to have higher delivered costs per head (i.e., $885.15 for HEADCAT group 4 (108 - 188 head/lot) compared to $872.62 for HEADCAT group 2 (35 - 57 head/lot)). In terms of procurement methods, lots purchased through marketing agreements and the spot market had statistically higher average delivered costs per head ($884.65 and $879.57) than did those purchased by packer fed or forward contract methods ($867.62 and $860.56). In terms of pricing methods, no statistically significant differences were found on an average delivered cost per head basis. An analysis of average

delivered costs per head based on the region of origin indicated that lots sold by sellers in the Canada region cost packers statistically more per head ($900.06) than those sold by sellers in all other seller regions. The largest number of lots originated from the West North Central region, where the average delivered cost per head was $887.95. The East North Central and Mountain regions fell into the next grouping with costs of $875.14 and $871.17 per head, respectively. Lots from the Pacific and South Plains regions cost least on a per head basis ($860.16 and $855.91, respectively).

Lots sold by dealers had a significantly higher per head cost ($878.84) than did those sold by feeders ($875.86) or auctions ($869.16). With respect to seller size, the smallest feeders, in terms of number of head sold per year, received the highest dollar amounts per head.

Plants from the largest three firms were scattered throughout the average delivered cost/head distribution but were primarily in the top half of those costs for all plants. The average delivered costs per head paid by the three firm groups were all statistically different. The average delivered cost/head of cattle procured by the three largest packing firms ($884.37/head) was significantly higher than that of cattle procured by the next five largest packing firms ($870.70/head) which, in turn, was significantly higher than that paid by the remaining packing firms for the cattle they procured ($864.28/head).

The effects of maximum daily throughput and capacity utilization ratio, packer firms, and packer location on costs per head were discussed earlier with their associated tables (Tables 3.33 through 3.36). Results are repeated here for convenience of the reader.

Average delivered cost per head represents the cost to packers of procuring lots of steers and heifers from feeders. Note that no statistical differences existed based upon lot size (except for the few lots in the smallest size category) and pricing method. The cost per head paid for lots of fed cattle procured through marketing agreements and the spot market (the vast majority of all lots sold) were the highest among the four procurement methods analyzed. Surprisingly, the cost per head of lots sold by smaller sellers was higher than that of lots sold by larger sellers. However, since the delivered costs per head include transportation costs, it may be that transportation costs are simply higher for smaller lots more distant from packers than for larger ones located more closely to packing plants. Alternatively, cattle from smaller sellers may be heavier or may be used as a mechanism to "top-off" or fillout packing plant capacity.

Seller Type

ANOVA analyses were conducted to detect whether some statistical relationships existed between and among the type of sellers from which cattle were purchased and key characteristics of transactions between plants and sellers (Table 3.40). As previously discussed, only sellers which reported selling 1,000 or more head to plants in this sample were included. Statistical differences were found for all cost and yield measures investigated. Lots sold by dealers cost the most per head, followed by farmer feeders/feedlots (hereafter referred to as feeders). For the other cost factors investigated, however, costs were generally highest for lots sold by feeders, followed by those sold

by dealers, and then those sold through auctions. Although all three measures of cost/cwt were statistically different across all three seller types, the actual difference between the costs/cwt of lots sold by feeders and those sold by dealers was small. The magnitude of difference in the cost/cwt of auction lots and that of the other two types of sellers was larger. The large percentage of the lots sold by feeders necessarily pushed the overall mean of all lots toward that of the feeder lots. Percentage yields were 62.84% and 62.14% for feeders and dealers, respectively, compared to 60.16% for auction lots. Feeders also had the largest lot size (138.60 head) compared to 85.16 head and 70.14 head for auctions and dealers, respectively. Overall, lots sold by feeders cost significantly more and represented the majority of cattle marketed than those sold by any other seller type among those lots for which seller type was indicated.

Seller Regional Location

The question of whether some statistical relationship existed between and among the geographical location of the seller and key characteristics of transactions between plants and sellers also was addressed. ANOVA was utilized to compare mean values of key cost and yield variables across seller regions as defined by PSP (Table 3.41). In terms of dollars paid per head, steers and heifers purchased from sellers in Canada had the highest mean cost ($900.06/head). The North Atlantic and the West North Central regions sold steers and heifers at the next highest cost grouping ($891.84 and $887.95 per head, respectively). Slaughter cattle purchased from the South Central, the Pacific, and the South Plains cost the least per head from $860.94 down to $855.91. On a dollar per cwt (liveweight) basis, the highest cost was paid for cattle sold by sellers in the South Plains region ($76.28/cwt). The dollar/cwt (liveweight) costs of cattle from the Mountain, the West North Central, and the South Central regions were not significantly different from one another and comprised the second cost grouping ($75.42.cwt, $75.13/cwt, and $75.06/cwt, respectively). The South Atlantic region had the lowest cost of $70.78/cwt (liveweight). Based upon dollars paid per cwt (hotweight), the West North Central, South Central, South Plains and Mountain regions comprised the highest cost grouping, with the West North Central region being the highest at $120.39/cwt. The South Atlantic, North Atlantic, and Canada regions made up the lowest cost region grouping with cost/cwt (hotweight) near $117.90/cwt.

The average rail cost was highest for cattle from sellers in the South Atlantic, the West North Central, the South Plains, and the Mountain regions. The average rail cost of cattle sold by sellers in those regions was statistically different from that of cattle sold by sellers in the North Atlantic, Pacific, and Canada regions. The average rail costs of cattle sold by North Atlantic, Pacific, and the Canada regions were $118.77/cwt, $118.16/cwt, and $117.98/cwt, respectively. The mean percentage yield was highest in the South Plains region (63.5%) and lowest in the North Atlantic region (61.79%). The mean yield for the West North Central (the largest region in terms of lots sold) was 62.47% and fell into the third tier of regions based on yield percentage.

As expected, the statistical relationship between the several cost/cwt measures and seller location is much the same as the relationship between those cost measures and packer location, primarily due to the concentration of feeders near packing plants. The larger volume seller regions exhibited higher costs/cwt than the smaller volume seller regions. These results reinforce the regional cost behavior

seen earlier in which higher average rail costs were seen to be related to larger volume regions. No consideration for quality or yield grades has been made thus far. Such considerations could impact these observed regional differences. The statistical relationship among the cost of cattle and lot percentage yields as well as size of lots was previously summarized in those respective sections.

Size of Seller

To identify the potential statistical relationships that might exist between and among size of sellers and key transactions characteristics between packers and sellers, a size of seller grouping based upon head sold per year to the packers in this sample was created. These seller categories were constructed based upon the PSP size groupings for feedlots/feeders as follows: (1) 1 = sales < 1,000 head/year; (2) 2 = sales of 1,000-3,999 head/year; (3) 3 = sales of 4,000-7,999 head/year; (4) 4 = sales of 8,000-15,999 head/year; (5) 5 = sales of 16,000-31,999 head/year; and (6) 6 = sales of 32,000 head or more per year. Cost, yield, and volume data were analyzed for these groupings (Table 3.42).

Lots sold by sellers in the two smallest sales groupings (< 4,000 head/year) received significantly higher prices per head ($886.70 for group 2 and $886.34 for group 1) than did all other sales groupings. Each sales grouping for feeders selling over 4,000 head per year was significantly different from all others with the largest grouping (≥ 32,000 head/year) having the lowest mean in dollars per head ($869.01). On an average delivered cost/cwt (hotweight) basis, the costs of cattle sold by the two smallest seller groupings (< 4,000 head/year) were not statistically different ($120.35/cwt and $120.31/cwt) but lots from those two groups had statistically higher costs than lots from all other groups. The remaining groupings ranged from $120.01/cwt down to $119.59/cwt. The cost/cwt (hotweight) of cattle sold by seller size groups 5 and 6 were significantly greater than that for group 3. The average delivered cost/cwt (hotweight) of cattle sold by group 4 was not statistically different from that of either group 6 or group 3. In terms of the average delivered cost/cwt (liveweight), the lots sold by groups 6, 5, and 2 had statistically higher costs ($75.32/cwt, $75.26/cwt, and $75.22/cwt) than did other groups. The average costs per cwt (liveweight) of cattle sold by mid-sized sellers (4,000-7,999 and 8,000-15,999 head/year) in the sample were the lowest and were not statistically different from each other ($74.50/cwt and $74.47/cwt). Lots purchased from those feeders selling from 1,000-3,999 head/year had the highest average rail costs ($120.54/cwt). The average rail costs of cattle sold by sellers in the two largest size groupings (16,000-31,999 and ≥ 32,000) were statistically different from each other, with group 5 having a statistically higher average rail cost ($120.28/cwt) than group 6 ($119.87/cwt), a difference of $0.41/cwt.

The mean percentage lot yield was highest for the largest sellers and lowest for the medium-sized sellers, ranging from 62.90% and 62.73% for groups 6 and 5, respectively, down to 62.26% and 62.24% for groups 4 and 3, respectively. Although the yields for these groups were statistically different from one another, the practical difference may be questioned. With respect to the mean

number of head per lot, each seller size group was statistically different from the others, with the order descending from largest to smallest seller grouping. Group 6 had a mean number of head per lot of 160.44 compared to the group 1 mean of 68.73 head per lot. Seller groups 6 and 1 sold the most lots (61,890 and 46,740, respectively) corresponding to 9,929,632 head and 3,212,440 head of cattle, respectively, or 56.9% of the total 23,112,921 head sold during the data period.

In terms of both average delivered cost/head and average delivered cost/cwt (hotweight), lots sold by sellers in the smaller size categories cost packers more than lots sold by sellers in the larger size categories. Also note that the average delivered costs of cattle in lots sold by the sellers in the largest-size categories (16,000 - 31,999 head/year and more than 32,000 head/year) were the lowest on a per head basis but the highest on per cwt (liveweight) basis. This implies that the cattle from the largest-sized seller categories are relatively smaller than the cattle sold by sellers in the smaller size categories.

Packer Procurement Method

A primary question of interest was whether there was a statistically significant relationship between and among the lot procurement method used and key transactions characteristics (Table 3.43). Results of the ANOVA suggest that based upon the delivered cost/head paid for cattle, no statistical differences existed among the various procurement methods despite the range of means between the cost/head of cattle purchased through marketing agreements ($884.65/head) and those purchased through forward contracting ($860.56/head). This may be due to the fact that in excess of 80% of all lots was procured on the spot market. In terms of delivered cost/cwt (hotweight), cattle procured using marketing agreements, the spot market, and packer fed arrangements cost significantly more ($121.06/cwt, $120.18/cwt, and $119.91/cwt, respectively) than those procured by forward contract ($116.75/cwt). A similar pattern held for the delivered cost/cwt (liveweight), except that the costs of cattle procured through the spot market and packer fed arrangements were not significantly different from one another. Average delivered cost/cwt (liveweight) ranged from $76.64/cwt for marketing agreement lots to $72.56/cwt for forward contract lots. Average rail costs held to the same pattern, with the costs of cattle procured through marketing agreements ($121.14/cwt), the spot market ($120.35/cwt), and packer-fed arrangements ($119.95/cwt) significantly higher than the cost of cattle procured by forward contract ($116.90/cwt). No statistical differences were found among percentage yields across procurement methods.

Consequently, only the average cost of cattle procured through forward contracting was statistically different from those of cattle procured through other methods in terms of all three cost/cwt measures. The most probable explanation for the fact that the average delivered cost/cwt of forward contracted cattle was significantly lower than that of cattle procured by other methods centers around the concept of shared risk by the packer, whereby the feeder "locks in" a price for the cattle, thus forfeiting potential increases in the market to ensure that there will be no exposure to price decreases.

Packer Pricing Method

Pricing methods used in purchasing lots also were of concern in this analysis. That is, were there statistically significant relationships between and among pricing methods used in purchasing lots of steers and heifers and key transactions characteristics of these lots? Based on the transactions data, the ANOVA results indicate that the answer to that question is no. There were no statistically significant differences in any cost or yield measure based upon pricing method (Table 3.44). On a per head basis, average delivered costs ranged only slightly from a high of $888.50 for animals priced on a carcass weight basis to $873.80/head for animals priced on a liveweight basis. The range of mean costs was only $0.44/cwt, $0.42/cwt, and 0.48/cwt on liveweight, hotweight, and average rail bases, respectively.

In summary, the lack of statistically significant differences of costs among pricing methods suggests that pricing method may not be a reasonable explanation for often "observed" lower prices for so-called captive supplies. If this were truly the case, the cost of cattle priced on a liveweight basis would be expected to be significantly higher than the cost of those cattle procured and priced as "captive supplies". This analysis provides no evidence consistent with that expectation.

Number of Head per Lot

An ANOVA analysis also was done to explore whether some statistical relationships existed between and among the size of the lot purchased and key characteristics of transactions between packers and sellers (Table 3.45). With respect to the variable HEADCAT (size groupings of the number of head in kill lots), the mean number of head per lot reflects that 9.6 million head (group mean x number of lots) were sold in HEADCAT group 5 (lots greater than 188 head) and 6.1 million were sold in HEADCAT group 4 (lots containing between 88 and 188 head). HEADCAT group 2 (lots containing from 35 to 57 head), however, was the predominant group in terms of transactions. Lots procured as packer fed cattle were statistically larger (173.98 head) than all other groups; those procured on the spot market were the smallest (110.89 head). Even so, spot market sales accounted for 18 million of the total head sold. With respect to pricing, the size of the lots procured was not significantly affected by pricing method.

Lots originating from sellers in the South Plains were the largest (159.91 head/lot) while those from the South Central and South Atlantic regions were smallest (53.92 head/lot and 50.97 head/lot). The average sizes of lots differed by region. Sellers in the South Plains, Mountain, and West North Central regions accounted for 5.1 million, 3.3 million, and 11.8 million head, respectively, of the cattle sold during the data period. Lot sizes by packer regions followed a similar pattern, with plants in the South Plains procuring lots of 159.91 head, on average, and plants in the Mountain and West North Central regions procuring lots averaging 147.90 head and 113.17 head, respectively.

Lot sizes were significantly different for each of the six seller size categories and decreased in the same manner as the seller size categories (160.44 head/lot for those selling in excess of 32,000 head/year down to 68.73 head/lot for those selling less than 1,000 head/year).

The average lot size differed significantly by packing firm group. The mean lot size of the 3 largest packing firms was 124.99 head followed by the next 5 largest firms with a mean lot size of 101.42 head and all remaining firms with a mean lot size of 67.95 head. Maximum throughput and capacity

utilization ratio groupings followed a similar pattern, with packing plants having the largest maximum throughput and the highest capacity utilization ratios procuring the lots of the largest size. Plants in the largest throughput category procured 14.2 million head and those in the largest capacity utilization ratio category procured 17.3 million head.

Generally speaking, larger firms and predominant selling and packing regions had average lots sizes larger than those of other firms or regions. Accordingly, large lot sizes accounted for the majority of all cattle transacted. Associated with this measure of lot size is the total number of head transacted by packers and feeders in relation to their respective sizes. The top three packing firms (about 15% of the packing firms in the sample) accounted for over 75% of the lots transacted (Table 3.45) while the largest 4% of feeder firms likewise accounted for nearly 75% of all lots transacted (see Table 2.3). This suggests that concentration in feeding is at least as prevalent as it is in packing. The largest percentage of cattle transactions were procured through the spot market despite the smaller average size of the lots procured by this method than by others. In contrast, even though the largest percentage of lots was priced on a liveweight basis, the lots size also was greater than those priced by other methods, but not significantly so. The role which transactions costs of each pricing and procurement method play in determining lot size is not discernable because the necessary transactions cost information was not provided in the PSP transactions dataset.

Average Delivered Cost ($/hundredweight, liveweight)

An ANOVA analysis was done to determine whether some statistically significant differences existed between and among the liveweight cost paid by packers (average delivered cost/cwt, liveweight) and key transactions characteristics for plants and sellers (Table 3.46). The mean cost/cwt, liveweight of lots of sizes greater than 188 head (HEADCAT group 5) was the highest ($76.44/cwt), with the exception of the very few lots of less than 35 head. Lots of sizes between 35 and 57 head (HEADCAT group 2) cost the least ($74.10/cwt). The mean cost/cwt, liveweight of lots in all lot size categories over 35 head were statistically different from one another.

With regard to procurement method, the average delivered cost/cwt, liveweight of lots procured through marketing agreements ($76.64/cwt) was statistically greater than the cost of lots procured by all other methods. Forward contracted lots cost the least ($72.56/cwt). The average cost/cwt, liveweight of lots purchased on the spot market ($75.14/cwt) was not statistically different than that of those lots which were packer fed. No statistical difference in the average cost/cwt, liveweight were found based on pricing methods. The range of the average delivered cost/cwt, liveweight of the lots procured by packers was only $0.44/cwt across the three pricing methods. The average delivered cost/cwt, liveweight of lots priced on a liveweight basis was the highest at $75.48/cwt and those priced on a carcass weight basis the lowest at $75.04/cwt.

The average delivered cost/cwt, liveweight of lots sold by sellers in the South Plains was statistically greater ($76.28/cwt) than that of lots sold by sellers in all other regions. The average delivered costs/cwt, liveweight of lots from the Mountain, West North Central, and South Central regions ($75.42/cwt, $75.13/cwt, and $75.06/cwt, respectively) were greater than those of lots from all other regions. Lots from the South Atlantic cost the least ($70.78/cwt). Lots sold by feeders cost the most

($75.36/cwt) among types of sellers while those sold by auction cost the least ($71.28/cwt). The average delivered costs/cwt, liveweight of cattle sold by all three seller types were significantly different from one another.

The average delivered costs/cwt, liveweight of cattle purchased from sellers in the two largest seller size categories (i.e., 16,000-31,999 head and 32,000 head or more) were significantly higher ($75.26/cwt and $75.32/cwt, respectively) than the cost of cattle from most smaller feedlots. However, the average delivered cost/cwt, liveweight of cattle sold by sellers in two intermediate size categories (4,000-7,999 head and 8,000-15,999 head) were significantly lower ($74.47/cwt and $74.5 0/cwt, respectively) than those of sellers in the smallest size categories.

The results also clearly indicate that the larger the firm, the higher the cost of cattle procured by the firm. As with all other cost measures, the average delivered cost/cwt, liveweight paid by the three firm groups were all statistically different. The average delivered cost/cwt, liveweight of cattle procured by the three largest packing firms ($75.76/cwt) was significantly higher than that of cattle procured by the next five largest packing firms ($74.35/cwt) which, in turn, was significantly higher than that paid by the remaining packing firms for the cattle they procured ($73.39/cwt). Though statistically significant, however, the actual differences in the average delivered costs/cwt, liveweight of cattle procured by the three firms groups were small as was the case for the other cost measures.

Discussions of the effect of firm maximum throughput, capacity utilization ratio, and packer region are presented with sections relating to Tables 3.33, 3.34 and 3.35.

The primary concern of this study is whether the steer and heifer procurement activities of the large packers have exerted downward pressure on market prices. Although the evidence presented to this point in the report can neither support nor reject that assertion, the ANOVA results presented so far clearly indicate that costs paid per hundredweight for slaughter steers and heifers were actually higher for all of the following during the period of the data: (1) larger firms, (2) firms with higher throughput capacities and capacity utilization ratios, (3) procurement through marketing agreements, and (4) cattle originating and/or slaughtered in the major cattle producing and packing regions. A probable explanation for these results is that the efficiencies gained as a result of size, scale, and geographic concentration result in lower average total costs per unit sold and, therefore, more than offset the higher costs for cattle inputs. A strict economies of size argument driven by industrial engineering and manufacturing principles may, in fact, be the most powerful reasoning available with which to propose hypotheses related to exertion of market power and pricing activities by sellers and packers.

Quality Grades of Lots

An ANOVA analysis provided empirical evidence of any statistical relationships that existed between quality grades of lots and key characteristics of transactions between plants and sellers (Table 3.47). Quality was measured by a quality grade index (QGI) which describes, in descending order, the predominant quality grades of a lot (see Table 3.1b). Lots which were predominantly

choice followed by select (QGI = 4) accounted for 71.07% of all lots. Those which were predominantly select followed by choice (QGI = 0) accounted for another 26.39%. Note that the magnitude of predominance *is not* considered in the QGI, only the general overall ordering of the lot quality.

No statistically significant differences were found to exist between QGI 4 and QGI 0 with respect to any cost or yield attribute. Generally speaking, lots of quality QGI 4 had higher magnitudes of all cost measures, costing roughly $2/cwt more than those with QGI 0. The mean delivered cost/head showed that QGI 4 lots were $884.95/head and those of QGI 0 were $861.05/head. The number of head per lot for QGI 0 was larger (131.23 head) than for QGI 4 (110.70 head) but this difference was not statistically significant. These results likely reflect the historical market preference for choice grade beef and the rising importance of select grade beef in the marketplace as stimulated by consumer desire for leaner beef cuts.

Yield Grades of Lots

The data also were analyzed to identify statistically significant differences between and among yield grades of lots and key transaction characteristics between plants and sellers (Table 3.48). Yield grade effects were measured by constructing a Yield Grade Index (YGI) in which the lots were grouped based upon the three most predominant yield grades in the lot (see Table 3.1b). Once again, the magnitude of predominance was not considered. The sixteen YGI groups with 1,000 or more lots were analyzed. The greatest number of lots was of the yield grade characteristic YGI 342, accounting for 23.16% all lots. Note that each number in the YGI group designation represents, in descending order, the three most predominant yield grades. YGI 234, YGI 231, and YGI 235 accounted for 21.43%, 12.85%, and 13.93% of all lots, respectively. These four YGI accounted for 71.37% of all lots slaughtered.

The mean cost of lots in YGI 342 on a dollars/head basis was the highest ($909.51/head). The YGI 324 group, the largest grouping, had a mean cost of $893.12 per head. The lowest cost was for lots in the YGI 543 group ($775.54/head). The other three YGI groups with large percentages of lots sold had costs in the upper half of all YGI. With a few minor differences, the same pattern held for cost/cwt on a liveweight basis. The largest percentage groupings were near the top of all YGI in terms of cost/cwt, liveweight and were above the overall mean for all lots. These YGI were in the second tier of costs and were not statistically different from one another. The maximum cost/cwt, liveweight was for the YGI 321 group ($76.49/cwt) and the minimum for the YGI 543 group ($64.42/cwt). As discussed earlier, costs measured in dollars/cwt, hotweight and average rail costs are similar to the other cost measures. In terms of average rail cost, none of the top percentage groupings of YGI are significantly different from one another and all appear in the top half of YGI groups.

Lot yields are significantly different among most YGI groups. The top lot yield is 63.69% for YGI 351 and the lowest is 59.12% for YGI 123. The larger YGI groups again appear in the top half of all YGI yields. In other words, the lots of cattle with the most common yield grade type combinations have the highest lot yields.

Lot sizes range from 154.82/head for YGI 231 down to 51.42/head for YGI 351. Generally speaking, lot sizes differ significantly across YGI groups with the largest YGI groupings having larger lot sizes as measured by number of head per lot.

The preceding results indicate that during the period of analysis, packers paid more for lots which have predominant yield grade characteristics of yield grades 2 and 3 and that those types of lots accounted for over 70% of all lot transactions. In addition, such lots generally were larger in size than lots of alternative yield grade combinations. For the largest packers, yield grades 2 and 3 dominated as the leading classifications of lots. The desire by those packers for uniformity in the cattle they process was most likely driven by the need to maximize capacity utilization and throughput by processing highly uniform lots. An overall desire for uniformity in cattle slaughtered with respect to their yield grade characteristics and a desire for less heavily finished cattle or poor carcass yielding cattle (yield grades 4 or 5) also was evidenced.

Percentage Yield for Lots

An ANOVA was done to determine whether any statistically significant differences existed between and among lot yields and key transaction characteristics of plants and sellers (Table 3.49). HEADCAT group 5 (> 188 head/lot) and HEADCAT group 4 (108-188 head/lot) had statistically greater yields (63.28% and 62.96%, respectively) than did smaller lot sizes. HEADCAT group 2 (35 - 57 head) had the lowest yields (62.28%).

No statistically significant differences were found to exist for lot yields across either procurement methods or pricing methods. Some significant differences in lot yields across seller and packer geographic regions, however, were evident. Yields of lots originating from the sellers in the South Plains region or procured by firms in that region were significantly higher than those sold from or procured by all other seller or packer regions (63.51%). Sellers in the West North Central region sold lots with mean yields in the third tier (62.59%) and those in the North Atlantic sold the lots with the lowest mean yield (61.78%). The results by packer regions are similar.

The two largest seller groups sold cattle with significantly greater yields (63.08% and 62.80%, respectively) than was the case for sellers in smaller size groups. The mid-sized sellers (groups 4 and 3) had the lowest yields (62.32% and 62.27%, respectively). As previously stated in relation to Table 3.40, lots sold by feeders have statistically greater yields (62.93%) than those sold by other seller types.

The mean lot yield of cattle procured by the three largest packing firms (62.86%) was significantly higher than that of the other packing firms. Interestingly, however, the yield of lots procured by the smallest firms was significantly greater than that of the five packer firms in the second largest firm group.

An analysis of the relationship between lot yield and maximum throughput as well as capacity utilization ratios were discussed earlier in association with Tables 3.33 and 3.34.

Although the actual differences in lot yield over various classification variables may seem small in terms of magnitude (often 1% or less), these differences should be put into perspective. For example, on an average live animal of 1,200 pounds (63% yield of liveweight), a 1% decrease in yield would translate into an increase in costs from $120 to $121/cwt assuming a mean liveweight cost/cwt of $75.00. An increase of roughly $7.50 per carcass in costs for a firm slaughtering 5 million head of cattle per year is approximately $37.5 million. Taken in this light, even minor yield differences across regions, pricing and procurement methods, and other factors could potentially translate into quite sizeable sums of money for the firm.

Summary and Conclusions

Pricing and procurement activities between and among various types and locations of sellers and packing firms have been the focus of the analysis presented in this section of the report. By and large, no difference was found across pricing methods in their effects on any cost or yield measures. Little difference was found across procurement methods either except that the cost of lots procured by forward contracting was generally lower than that of lots procured by any other method. The three largest firms (ConAgra, Excel, and IBP) operated plants with larger throughput capacities and higher capacity utilization ratios over the period of the data. The lots of cattle procured by those three firms were also significantly higher in cost and generally higher in quality and uniformity than lots purchased by smaller firms. Lots originating from sellers and/or slaughtered by plants in the regions in which those three large firms have a major presence (West North Central and South Plains) showed similar cost relationships.

Perhaps the most interesting and important conclusion to evolve from the analysis in this section relates to the cost relationships of large firms which have large throughput capacity and high capacity utilization ratios. In general, firms with plants of generally larger capacities were found to have paid more for the cattle they slaughtered, both in terms of liveweight and hotweights, than plants with smaller capacities. Additionally, percentage yields of lots slaughtered and the number of head per lot were higher the larger the firm. The same relationships held true for capacity utilization ratios. There are two plausible explanations for these results. One is that the large firms possess a sufficient degree of market power to bid away lots from smaller competing firms in the market with the potential of so-called "sweetheart" deals between packing firms and sellers. Another equally plausible explanation is that large firms with high capacity utilization ratio plants are willing to pay higher amounts (or incur higher costs) so that adequate numbers of cattle are made available to the plant to maintain a throughput which minimizes average costs of all head slaughtered. The increased costs of these cattle would be more than offset by the cost efficiencies gained by maintaining a high plant throughput. In a product market characterized by declining demand and production plants which utilize divergent levels of technology, it is reasonable to expect larger more efficient plants to continue to drive down production costs. As efficiencies increase, it becomes even more important for slaughter plants to obtain sufficient numbers of cattle to maintain economically efficient operation, which may result in these same plants incurring higher delivered costs for the animals slaughtered. Smaller, less efficient firms may be unable to respond adequately

to this behavior and, therefore, lose their competitive position relative to the larger firms. Unless these smaller plants are geographically isolated or supply a niche product market, they will operate only until a short-run shutdown point is reached, at which time they must choose to add technology or, alternatively, go out of business. The latter alternative results in further concentration of the industry. Sections 4 and 5 provide further analysis and testing of these alternative hypotheses.

Some specific observations relating to the analysis in this section include the following:

- In general, plants with larger capacities paid more for the cattle they procured than plants with smaller capacities. Also, the largest firms in terms of numbers of steers and heifers slaughtered clearly paid the highest amount per animal slaughtered relative to smaller firms. The largest three firms paid the highest average cost/cwt of all cattle procured by all firms. Additionally, the percentage yields of lots slaughtered and the number of head per lot were higher the larger the plant and the larger the firm. The same relationships held true for capacity utilization ratios. Gains from processing efficiency and economies of size in processing likely enabled these plants and firms to pay more for higher quality, more uniform animals as inputs into their operations. The larger throughput, higher capacity utilization ratio plants are owned primarily by the large national firms with dominant market shares whereas smaller throughput, lower capacity utilization firms are owned by small local or regional firms with small market shares. These results reinforce the concept of size and efficiency advantage for larger firms and suggest that the larger firms may be most concerned with their plants operating at full capacity to minimize final product costs.

- The cost of cattle was lowest for lots sold by sellers in the largest-size categories on a per head basis but was the highest on a per cwt, liveweight basis. This implies that the cattle from the largest-sized seller categories are physically smaller than the cattle sold by sellers in the smaller size categories.

- There does not appear to be a relationship between size of seller and size of packing firm. While the three largest packers purchased nearly one-half of their cattle from the largest sellers (annual sales in excess of 16,000 head), nearly 40% of their purchases were from the smallest sellers (annual sales less than 4,000 head). In fact nearly 25% of all cattle purchased by the three largest packers were from sellers with sales of less than 1,000 head per year. On the other hand, although the smallest packers had a tendency to purchase cattle from small sellers, they purchased nearly one-third of their cattle from the largest sellers.

- Packing plants in the two largest volume regions (West North Central and South Plains) paid the most per cwt, liveweight and hotweight for the cattle they procured. Plants in the lower volume regions were likely older and smaller than those in the West North Central and South Plains regions and, therefore, may not have experienced the efficiencies nor size advantages of the newer, larger, more technologically up-to-date plants in the higher volume regions.

- The statistical relationship between the several cost/cwt measures and seller location was much the same as between those cost measures and packer location, primarily due to the

concentration of feeders near packing plants. The larger volume seller regions exhibited higher costs/cwt than the smaller volume seller regions.

- Lots sold by feeders cost significantly more and represented the majority of cattle marketed than those sold by any other seller type among those lots for which seller type was indicated.

- The procurement method also had some effect on the cost/cwt (liveweight and hotweight) of the cattle procured for slaughter. Lots procured through forward contracting had the lowest cost/cwt (liveweight and hotweight) of any procurement method. The most probable explanation for these results involves the concept of shared risk by the packer, whereby the feeder "locks in" a price for the cattle, thus forfeiting potential increases in the market to ensure no exposure to price decreases.

- There were no statistically significant differences in any cost or yield measure based upon pricing method. The lack of statistically significant differences in costs among pricing methods suggests that pricing method may not be a reasonable explanation for often "observed" lower prices for so-called captive supplies. If this were truly the case, the cost of cattle priced on a liveweight basis would be expected to be significantly higher than the cost of those cattle procured and priced as "captive supplies". This analysis provides no evidence consistent with that expectation.

- Generally speaking, larger firms and predominant selling and packing regions had average lots sizes larger than those of other firms or regions.

- No statistically significant differences were found to exist between lots that were predominantly choice, select, and prime grade quality (in that order) and those that were predominantly select, choice, and prime grade quality (in that order) with respect to any cost or yield attribute. These results probably reflect that the historical market preference for choice grade beef is giving way to the rising importance of select grade beef in the marketplace as stimulated by consumer desire for leaner beef cuts.

- During the period of analysis, packers paid more for lots which have predominant yield grade characteristics of yield grades 2 and three and that those types of lots accounted for over 70% of all lot transactions and were generally larger in size than lots of alternative yield grade combinations. For the largest packers, yield grades 2 and three dominated as the leading classifications of lots. The desire by those packers for uniformity in the cattle they process was most likely driven by the need to maximize capacity utilization and throughput by processing highly uniform lots. An overall desire for uniformity in cattle slaughtered with respect to their yield grade characteristics and a desire for less heavily finished cattle or poor carcass yielding cattle (yield grades 4 or 5) was also evidenced.

- No statistically significant differences were found to exist for lot yields across either procurement methods or pricing methods. Some significant difference in lot yields across seller and packer geographic regions, however, were evident. Percentage lot yields were

highest and lot sizes largest for plants in the South Plains. Also, percentage lot yields and the cost/cwt of cattle paid by packing plants in the North Atlantic and East North Central regions were lower than in all other regions. Typically, those latter plants were older and smaller than those in other regions and, therefore, may not have experienced the efficiency nor size advantages of the newer, larger, more technologically up-to-date plants in the West North Central and South Plains regions.