EXCLUSIVE MARKETING/PROCUREMENT AGREEMENTS AND MARKETING METHOD PRICE DIFFERENCES WITHIN THE FED CATTLE MARKET: AN EXPERIMENTAL SIMULATION APPROACH

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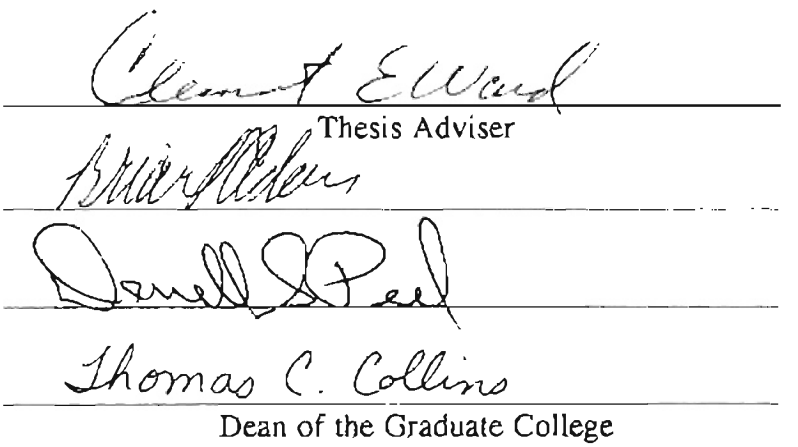

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PREFACE

This thesis consists of two separate essays. The first essay is titled "Impacts of Exclusive Marketing/Procurement Agreements on Fed Cattle Transaction Prices: An Experimental Simulation Approach". This first essay seeks to determine how exclusive marketing/procurement agreements affect the level and variability of fed cattle transaction prices. A simulated fed cattle market was used to evaluate fed cattle transaction prices during periods where exclusive marketing/procurement agreements were being utilized by the largest simulated meatpacking firm and two large simulated feedlot firms. This essay also considers fed cattle transaction prices during periods when no exclusive marketing/procurement agreements active. Furthermore, this essay seeks to determine whether or not the level and variability of simulated transaction prices were significantly different during periods when the subjects of experimental simulation were being rewarded with economic incentives than during periods when subjects were not being rewarded. Primary contributions of this essay, unlike previous research, are evaluations of level and variability impacts on fed cattle transaction prices observed by: the entire fed cattle market during agreement and non-agreement periods, the participants of exclusive marketing/procurement agreements during agreement and non-agreement periods, and the non-participants of exclusive marketing/procurement agreements during agreement and non-agreement periods. The data analyzed in this

essay were generated by students of the Agricultural Economics Course 3990 at Oklahoma State University. The experimental design included two 16-week periods, out of a total of 75 experimentally simulated trading weeks, where exclusive marketing/procurement agreements where actively being utilized. The experimental design also included 4-7 week periods when subjects were being rewarded. Reward periods were randomly interspersed throughout the entire 75 weeks of simulated trading.

The second essay, titled "Marketing Method Price Differences in the Fed Cattle Market: An Experimental Simulation Approach", seeks to determine the significance of fed cattle transaction price differences under three alternative marketing methods. The alternative marketing methods considered in this essay are: cash transactions, cash forward contracts, and exclusive marketing/procurement agreements. Level and variability differences in simulated fed cattle transaction prices were evaluated among each of these methods. The simulated transaction price data and experimental design considered in this essay is the same as that which was considered by the first essay. Hence, the data and experimental design for both essays is presented once in the first essay and is excluded from duplication in this essay. The difference is that this essay does not separate prices observed by the participants and non-participants of the exclusive marketing/procurement agreements. This allows the comparison of all exclusive marketing/procurement agreement transactions to cash forward contracts and cash transactions. The primary contribution of this essay is that, unlike previous

research, it includes price variance differences between each marketing method as well as mean and variance differences for each method utilized by individual firms.

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Finally, I am thankful for my Lord and personal savior Jesus Christ. He has also been there with support and a loving spirit through thick and thin. My success is a true testimony to the grace and blessings that he bestows on those who believe. Without him, this and all other work in my life is not possible, nor is it meaningful.

In Memory of My Mother

Diana F. Dowty

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IMPACTS OF EXCLUSIVE MARKETING/PROCUREMENT AGREEMENTS ON FED CATTLE TRANSACTION PRICES: AN EXPERIMENTAL SIMULATION APPROACH

Abstract

The recent increase in exclusive marketing/procurement agreements between meatpacking and feedlot firms has created concern about how the level and variability of fed cattle transaction prices are affected. Existing agreements involve written or verbal contracts that allow the participating firms to market or purchase finished cattle at formula based prices for which the details are not made public. Experimental exclusive marketing/procurement agreements were applied to a simulated fed cattle market. Two econometric models were developed from previous studies to evaluate price level and variability differences between agreement and non-agreement periods. Price level and variability differences between participating and non-participating firms of the agreements during agreement and non-agreement periods were also evaluated. The effects of economically rewarding the subjects of experimental simulation studies on fed cattle transaction prices were evaluated. Results indicate that participants of exclusive marketing/procurement agreements realized significantly lower price means and variances than non-participating firms. However, the mean and variance of market prices were found to be higher during the agreement periods than during the non-agreement periods. Economic reward and non-reward periods were not found to have significantly different price levels.

IMPACTS OF EXCLUSIVE MARKETING/PROCUREMENT AGREEMENTS ON FED CATTLE TRANSACTION PRICES: AN EXPERIMENTAL SIMULATION APPROACH

Introduction

Problem

Price discovery is described as the process of buyers and sellers gathering and interpreting information about the supply and demand of the product or products in question, formulating bid and asking prices, negotiating those prices, and adjusting the formulated bid and asking prices according to new market information as it becomes available across time (Purcell 1991). This process is completed several times each day in the fed cattle market as meatpacking and feedlot firms negotiate the sale or purchase of finished cattle. Due to both horizontal and vertical integration, price discovery issues within the fed cattle market have become a topic of focus over the last ten years. These issues range from the degree of concentration among beefpacking firms to the availability and value of market information. Due to the internalization of private information, the primary and secondary data required for the analysis of these issues is difficult to acquire.

Among price discovery issues is the question of how different types of captive supplies impact fed cattle transaction prices. Over the last decade, meatpacking and feedlot firms have increased in size and some have entered into exclusive marketing/procurement agreements. These agreements involve a verbal or a written contract between one meatpacking firm and one or more feedlot firms. Many of the

agreements are structured so that they allow participating firms to engage in profit-sharing pricing strategies. Existing agreements have also been structured so that additional firms cannot be included and so that details of each agreement are not made public. Industry concerns range from the actual impacts that these exclusive agreements have on transaction prices, to their effects on the availability of market information. However, collecting data from the relevant firms has become increasingly difficult as a direct result of the consolidation and concentration of firms, and the confidentiality and complexity of the marketing/procurement agreements that have evolved within the industry. By simulating the fed cattle market in a way that buyers and sellers behave in a manner parallel to today's fed cattle market, many data collection problems are overcome. Furthermore, the impacts of exclusive marketing/procurement agreements on specific characteristics of the fed cattle market can be addressed through the application of experimental agreements to the simulated market.

Research Significance

Research is needed that will focus on exclusive marketing/procurement agreements between meatpacking and feedlot firms that exist in today's fed cattle market. This research could provide the insight needed to assess how these exclusive marketing/procurement agreements will affect price variability, the short-run supply of fed cattle, and changes in the financial stability of the individual participating firms

resulting from the agreement. By doing so, real world developments in the fed cattle industry that were discussed above can be addressed.

Two research projects have estimated the impacts of different forms of captive supplies on the fed cattle market (Schroeder et al.; Ward et al. 1996a). The three most commonly recognized forms of captive supplies are: (1) forward contracting, (2) packer owned or packer fed cattle, and (3) marketing/procurement agreements. In general, these studies evaluated the overall response of market prices to one or more of the three forms of captive supplies using data collected from the industry. This study differs from previous research in the sense that it uses a realistically simulated market to produce data that allows focus on how prices behave during periods when agreements are being utilized versus market periods when no agreements exist. This study also evaluates how participant prices differ from non-participant prices during both agreement and non-agreement periods. Therefore, this study will refute or strengthen previous research considering marketing/procurement agreements and focus on the specific details of exclusive marketing/procurement agreement impacts on the fed cattle market.

The conclusions made from this study will be of interest to several groups of people who are involved in livestock marketing, procurement, and food processing. One commonly cited reason for the need of this type of study is centered around the noted changes involved in all of the U.S. meat markets leading towards a value based marketing system which has been and can be further facilitated by extensions of exclusive marketing/procurement agreements. This could be accomplished through

meatpacking and feedlot firms by specifying premiums for selected meat quality within the terms of the agreements.

Purpose and Objectives

The purpose of this research is to answer industry questions about the short and long-term effects of exclusive marketing/procurement agreements on specific characteristics of the fed cattle market. The first question is centered around impacts of exclusive marketing/procurement agreements on transaction price levels in the fed cattle market and how prices respond to these agreements. Another is the variability of transaction prices and whether or not price variances are increased or decreased by the existence of marketing agreements. Another characteristic of interest within the fed cattle market is firm and industry wide profits and their relationship to marketing agreements. An additional purpose to this study is provide information about the impacts of economically rewarding the subjects of simulated markets.

The general objective of this study is to determine how exclusive marketing/procurement agreements between meatpacking and feedlot firms will affect specific characteristics of the fed cattle market. Specific objectives are: (1) to determine the effects of exclusive marketing/procurement agreements on the level of fed cattle transaction prices, (2) to determine the effects of exclusive marketing/procurement agreements on the variability of fed cattle transaction price levels, (3) to determine the effects of exclusive marketing/procurement agreements on

weekly mean fed cattle transaction prices, (4) to determine how economically rewarding or not rewarding participants of a simulated market affects the level of transaction prices, (5) to determine how economically rewarding or not rewarding participants of a simulated market affects the variability of transaction prices, and (6) to determine how weekly mean fed cattle transaction prices are affected by economically rewarding or not rewarding the subjects of the simulated market.

Scope and Limitations of Experimental Simulation

Experimental simulation has been referred to as the integration of business simulation and experimental economic methods (Ward et al. 1996b). In this light experimental simulation often entails the components of microeconomic systems that have been identified by experimental economists for laboratory experiments (Smith 1982; Friedman and Sunder). Thus, within a specified market structure and a set institutional structure, teams or firms and the subjects of experimental simulation studies are allowed to make decisions that have a direct effect on the performance of their particular firm and on the entire market.

The point of separation between experimental economics and experimental simulation revolves around the amount of physical control the researcher has on the subjects of the microeconomic system. In most experimental economics research designs, the experimenter purposefully and directly controls specific variables of the system. This allows the experimenter to monitor and focus on other specific variables

in order to draw conclusions about how those variables react to different types of economically oriented changes (Friedman and Sunder). On the other hand, experimental simulation designs control very few of the variables within microeconomic systems which allows the economic variables to naturally interact with one another much like real-world markets (Ward et al. 1996b). In this setting, participants of the simulated market are left to observe the consequences of the interrelated and sometimes simultaneous decisions that they must make as they function within their respective markets. Therefore, experimental simulation studies are restricted to the decision making behavior of the participants in the simulated market and in the experimental setting. Data produced by experimental simulation can be analyzed using econometric models that explain the interrelationships of the economic variables within the market in question. These studies must also use models that capture the dynamic decision making behavior of market participants. The purpose of experimental simulation is to evaluate dynamic relationships between many economic variables of a specified market when major components of that market are affected by realistic market changes (Ward et al. 1996b).

Relevant Theory in Previous Research

Previous research has been conducted to answer many questions about how changing market conditions have affected the fed cattle market. Economic theory was used in these studies to develop the methodology chosen to evaluate each question.

These questions consider topics that range from the impacts of structural change to the factors which explain fed cattle transaction prices. This study utilizes theoretical developments from previous research to examine another fed cattle market occurrence and fulfill the stated objectives. Additionally, this study considers previous experimental economics research which focuses on the design of economic experiments and the impacts of rewarding experimental subjects. The specific research used as a basis for this study is briefly discussed here.

The Fed Cattle Market

The degree of firm consolidation and concentration in the beef slaughtering industry increased dramatically during the 1980s. Purcell (1990) noted that four-firm concentration ratios in boxed beef production increased from 51% in 1979 to 79% in 1988. Hayenga and O'Brien found that dramatic decreases in the number of beef slaughtering plants and plant owners since 1980 in the southern plains states have significant impacts on the prices paid for fed cattle. Schroeter evaluated the impacts of recent increases in firm concentration in the U.S. beef packing industry and found that significant monopoly/monopsony price distortions exist. This increase has fueled a growing concern about the possibility of non-competitive market performance in slaughter cattle and wholesale beef markets. The impacts of increased consolidation and concentration on market prices have been examined since the early 1980s (Schroeter 1988, 1990; Purcell 1990; Conner; Ward 1992; Hayenga and O'Brien).

These studies have examined techniques that use U.S. beef packing industry data to test the competitiveness of the industry's input and output markets. The results of concentration and consolidation research relative to the fed cattle market have suggested that the decline in structural competitiveness of the beef packing industry has not impacted the magnitude of the price distortions that previously existed (Schroeter 1988).

Other research in this area has evaluated the chain of events leading to the four firm concentration existing in today's beef packing industry and has discussed the market power evaluation techniques that were used during the early to late 1980's (Connor; Purcell 1990; Schroeter 1990). Conclusions suggest that both the Bainsian Structure-Conduct-Performance Paradigm (SCPP) and the New Empirical Industrial Organization (NEIO) approaches have produced rich detail about the structural changes in the beef industry, but there are several areas of research that are yet to be satisfied by both schools of thought (Schroeter 1990; Connor). Research has also been conducted that examines the economics of consolidation and concentration in the beefpacking industry and that reveals possible reasons for its occurrence as well as why it was allowed to occur (Purcell 1990). Results generally suggest that increased efficiency was achieved by the leading firms through acquisitions and mergers. These studies commonly suggested that it was often cheaper to buy capacity rather than to build it which helped create the industry giants that are known as IBP, Excel, and ConAgra. Furthermore, consolidation and firm concentration research in the fed cattle market has indicated that firms have economic incentives to operate larger plants with

multiple labor shifts and to keep the plants operating at or near capacity utilization levels. Therefore, there is a range of plant sizes and annual volumes that achieve cost economies for most of the plants operating in the beefpacking industry (Purcell 1990; Ward 1993).

During the 1980 to 1990 period of increasing concentration and consolidation, fed cattle transaction prices were indirectly impacted by changing market characteristics. Initially, transaction price models were developed in order to analyze the short-term pricing process of the fed cattle market by estimating alternative models that explained the variation in transaction prices for fed cattle (Ward 1981; Ward 1982). These models have also revealed the important variables that explain fed cattle transaction prices such as wholesale carcass beef prices, wholesale boxed beef prices, and live cattle futures market prices. These early studies often suggested that the variation among transaction price equations for the short study periods created difficulty in developing accurate short-period price forecasting equations. Furthermore, results indicated that the economic variables considered were most often unable to measure the psychological and sociological factors involved in the discovery of transaction prices for fed cattle in short time periods. Early transaction price studies also evaluated whether or not larger firms have the ability to pay lower prices compared to the smaller firms in the beefpacking industry. Results were often mixed due the non-availability of accurate fed cattle pricing information (Ward 1981; Ward 1982).

Related research followed in the early 1990's that examined the differences in

fed cattle transaction prices among buyers and buyer groups following the mergers of the meatpacking firms in the late 1980's. Results produced by these studies often indicated that significant relationships do exist between the transaction price and the number of days between purchase and delivery, that there are significant price differences among individual buyers and buyer groups, and that significantly lower prices were being experienced by the largest firms within the fed cattle market. Additional research conducted during this time period evaluated the differences between the average prices paid by individual buyers and buyer groups within regions and subregions (Ward 1992; Jones et al.; Schroeder et al.).

Experimental Economics

Experimental economic research has traditionally been focused on the use of laboratory experiments to evaluate a wide variety of theoretical issues that range from the testing of market hypotheses to the stability of equilibrium prices in specific types of markets. Early experimental economics research revealed the value of laboratory experiments. This research focused on the importance and significance of testing different economic theories in experimental systems where "real world" characteristics arise naturally (Smith 1976). It was found in these early experiments that economically rewarding subjects increased their individual performance based on several different types of criterion (Smith 1982). Game boredom was often cited as the primary reason for these results.

Experimental economic studies also examined the structure of microeconomic experiments and explained the various ingredients that make up experimental microeconomic systems (Smith 1982; Plott 1982). The use of experimental microeconomic systems was commonly offered as a plausible method of testing the hypotheses embedded in economic theories. Accordingly, experimental economic research used laboratory experiments as a valuable way of validating economic theories (Smith 1976; Smith 1982). More recent experimental economic studies have been conducted to reveal other types of explanations for economists performing laboratory experiments (Forsythe et al.; Plott et al.). A common objective among many experimental economists is to probe the sources of a theory's failure in order to disclaim the theory or to make the adjustments needed for correction. These studies suggest that many experimental economists take confounding problems with conflicting hypotheses and construct experiments that test the validity of those hypotheses.

Furthermore, experimental economists have been said, in recent studies, to be interested in conducting experiments that uncover the validity of sound theories, as well as experiments that define the source of weakness in poorly developed theories (Smith 1994). Examples of economic experiments of this nature are well founded. Many detail the impacts of specific changes within certain types of markets on the prices observed within each market (Adam et al.; Plott et al.). Other recent experiments have been conducted to evaluate alternative experimental designs for economic experiments. Examples of these studies evaluate specific issues within the common design of recently conducted experiments and suggest modifications needed for improvement of

experimental designs in future research (Palfrey and Rosenthal; Forsythe et. al.).

Experimental simulation research is closely related to experimental economics research with the main distinction centering around the researcher's inability to employ substantial amounts of control on the actions of subjects in simulated markets. Recent experimental simulation research has focused on simulation in the classroom to improve the student understanding of agricultural markets and how realistic factors affect agricultural markets such as government regulations (White). Experimental simulation research has also focused on explaining how experiential learning and economic simulation are linked (Koontz et al. 1995b). Cooperative learning has been described to involve the development of higher-order decision-making skills that require the actions of more than one individual (Koontz et al. 1995c). Experimental simulation allows the participants of the market to practice many different skills while facing realistic economic problems. Therefore, combining the two may allow participants to observe the outcomes and consequences of their decisions (Ward et al. 1996b).

Data

Data for this research project was generated by students of the Agricultural Economics Course 3990 which was held in weekly 90 minute sessions during the 1995 spring semester at Oklahoma State University. Students were primarily juniors or seniors and their fields of study included agricultural economics, animal science, and agricultural education. The project began by allowing the students to trade without

experimentation while being instructed on how the Fed Cattle Market Simulator (FCMS) operates. The FCMS is a simulated fed cattle market developed by Dr. Stephen Koontz, Dr. Derrell Peel, Dr. Jim Trapp, and Dr. Clement Ward of the Agricultural Economics Department at Oklahoma State University (Koontz et al. 1994a). The FCMS has been effectively used by its developers in extension education (Koontz et al. 1994b) and in teaching interested agricultural oriented students in a classroom setting (Koontz et al. 1995a). It includes eight simulated feedlot firms and four simulated meatpacking firms, all of which are designed to represent the largest firms in the fed cattle industry. The FCMS is an experiential learning tool used by its developers to instruct interested groups of people on decision making processes known to feedlot marketing and meatpacking procurement managers in the fed cattle market. Most of these participating groups have been high school and university students, employees of various agribusiness firms, and agricultural producers. The range of knowledge levels in these groups is from the high school level to the level of corporate executives. Fundamental components of the FCMS and details on how the simulator operates are thoroughly described in detail by previous literature (Ward et al. 1996b; Koontz et al., 1994a, 1994b, 1995a, 1995b, 1995c).

The nature of the data collected for this study primarily consisted of transaction prices with associated transaction level and variability information. Data were collected for approximately 75 weeks of trading between the simulated firms or 2,770 pens of fed cattle. The cattle are bought or sold in pens of 100 hundred head each and are marketed by the feedlot firms at one of five weight classes (1100, 1125, 1150,

1175, and 1200 pounds). The number of cattle supplied throughout the marketing period follows a realistic supply pattern. Thus, the experiment considered the impacts of exclusive marketing/procurement agreements under both abundant and tight cattle supply conditions.

Each data record consisted of one transaction which is the sale/purchase of one simulated pen of 100 steers between one feedlot firm and one meatpacking firm. Data for each transaction included: week traded, meatpacker purchasing the cattle, feedlot selling the cattle, weight of cattle traded, agreed upon transaction price, and type of transaction (cash, forward contract, or exclusive marketing/procurement agreement). Other data recorded for each week of simulated trading consisted of: break-even prices for 1150 pound cattle for each feedlot and the largest meatpacker, boxed beef price for beef sold that week, the closing nearby futures market price for the preceding week, number of fed cattle marketings from the previous week, and number of pens of cattle on the show list at the beginning of each trading week. An example of the transaction cards used in the FCMS data entry system is presented in Appendix A.

Procedure

Methods

The methods used for this project consisted of three linear regression models that were estimated to test three statistical hypotheses. In addition to the linear regression models, sample statistics were examined. The statistical hypotheses

considered in this study are presented in Table 1. The linear regression models focus on determining the effects of the exclusive marketing/procurement agreements on the level and variation of fed cattle transaction prices. These models were estimated for the entire simulated fed cattle marketing period to consider the level and variation in both the individual and mean weekly transaction price levels due to exclusive marketing/procurement agreements and other variables which influence market prices. In addition, the models mentioned above include variables that explain whether or not economically rewarding versus not rewarding the subjects of experimental simulation affects market prices.

The hypothesis tests use sample statistics to evaluate differences in fed cattle transaction prices and firm profits. The samples were computed for experimental agreement and non-agreement periods. These tests were conducted in conjunction with the linear regression models to fulfill the objectives of the study.

Experimental Design

A graphical depiction of the experimental design of this study is presented in Figure 1. The exact design for collecting the relevant data for this research project was completed as follows. Students began trading on week 21 without experimentation to allow each to gain familiarity with the FCMS. After trading a few simulated weeks the twelve teams were rotated so that each student was allowed the opportunity to pose as both an upper level marketing manager of a feedlot firm and an upper level

procurement manager of a meatpacking firm. The first rotation occurred after week 24 and the second occurred after week 28. During these periods, participants of the experiment were required to complete risk assessment and consent forms concerning the use of human subjects for economic research. Final teams for the research project were established prior to week 33. At week 40, the FCMS computer system began the process of recording team profits, price discovery data, and financial performance data. This process is documented in previous research (Koontz et al. 1995a). Data was recorded and stored for each simulated week throughout the entire experimental period in order to be evaluated on a later date.

Students continued to trade for 36 simulated weeks and then teams were rotated to begin a 39-week trading period. The above stated 36-week period was divided into two subperiods (i.e., a 20-week pre-experiment subperiod and a 16-week experiment subperiod). The above stated 39-week period was divided into three subperiods (i.e., a 20-week pre-experiment subperiod, a 16-week experiment subperiod, and a 3-week post-experiment subperiod). The entire data collection period began on week 40 and ended on week 114. Hence, students traded for 36 weeks before switching teams on week 76. Students then traded for another 39 week experimental period or through week 114. This period (i.e., the 75 simulated weeks from 40 to 114) will be referred to as the entire marketing period of the experiment (Figure 1). During the entire marketing period, the two experiments conducted in this research project began. An overview of these procedures is presented in Appendix B.

Within the two periods discussed above (i.e., weeks 40-75 and weeks 76-114)

there were two experimental subperiods each being 16 weeks in duration. The first experiment of this study involved imposing an exclusive marketing/procurement agreement during these two 16 week periods between the largest meatpacking firm (Packer #4) and the two largest feedlot firms (Feedlot #2 and Feedlot #5). The participating firms were informed that the agreement was to become active only at the beginning of the first week of the agreement and were not informed as to how long the agreement extended into the future. The non-participating firms were not informed on any details of the agreement. However, an announcement (i.e., much like a brief press release) was made to the entire simulated market. The nature and mechanics of the marketing agreement were given and explained to the participating firms outside of the simulated market so that non-participating firms had no means of determining the details of the agreement. The general structure of the formula based exclusive marketing/procurement agreements used in this study is presented in Table 2.

Under the agreement, Feedlots #2 and #5 marketed all their cattle when they reached 1150 pounds to Packer #4. The 1150 pound weight class has been determined to be the optimal weight for medium framed cattle within the FCMS in relation to the marketability of finished steers (Koontz et al. 1994a). Within the agreement, each participating firm negotiated profit-sharing prices based on the difference between Packer #4's break-even price for 1150 lb. steers and the feedlots' break-even price for 1150 lb. steers. Examples of how these transactions were agreed upon are presented in Table 3. It is important to note that Packer #4 dealt with Feedlots #2 and #5 on an individual basis. Accordingly, Feedlots #2 and #5 did not market finished cattle to

Packer #4 as a collective group. All transactions produced by the agreements were recorded as a unique type of contract (i.e., marketing method 3) by the FCMS system.

The second experiment involved rotating periods of rewarding the students based on their profit performance in randomly-selected four-week to seven-week periods which were interspersed by randomly-selected four-to-seven week periods of not rewarding the students (Figure 1). Total periods of reward versus non reward were equal (16 weeks in each subperiod). This experiment was structured according to the traditional induced value theory that is outlined in experimental economics literature. Smith (1976), formally introduced induced value theory by describing the sufficient conditions for controlling subject preferences in an economic experiment. These conditions are noted to be nonsatiation or monotonicity, salience, dominance, and privacy (Smith 1976, 1982). The present experiment is averse to controlling the actions and/or preferences of the subjects, but is focused on the importance of a reward medium in experimental simulation studies. Hence, the conditions set out for induced value theory will be discussed.

Friedman and Sunder define the three sufficient conditions of induced value theory. The first of which is known as monotonicity which generally means that subjects (students in this case) must prefer more of the reward provided by the researcher to less. Accordingly, the subjects' desire for the reward must be prominent enough to prevent them from becoming satisfied with the experimental setting to the point of boredom. The second sufficient condition is salience. This condition is commonly noted when the process by which the reward medium changes depends upon

the actions of each individual subject as well as the actions of other agents within the experimental market. Furthermore, the subjects' actions must be defined according to the rules set out by the institutions of the particular market in question (Friedman and Sunder). Therefore, subjects of laboratory experiments must fully understand the rules and responsibilities related to each buying and selling entity of a given market (i.e., feedlot and meatpacking firm interrelationships in the fed cattle market). The third condition is dominance or privacy which in simplest terms means that the subjects' utility from the experiment must come predominantly from the reward medium and that other influences have no effect. In this study, attention was given to the design of the experiment in order to determine whether or not subjects of experimental simulation are further motivated when provided with the above stated induced value theory conditions.

Students had no knowledge of when they were getting rewarded for their performance until the beginning of each reward period and they were not informed as to how long each reward period extended into the future. In addition to announcing that a reward period had begun, each firm was presented with an explanation of how they were getting rewarded at the beginning of the marketing period (week 40). The explanation involved specifying a formula to be calculated at the conclusion of each week within a given reward period. The formula used to calculate weekly rewards per firm was based on the financial performance of the respective firm. Hence, the nature of the reward system in this study revolved around each team's financial performance. Specifically, teams were rewarded based on their average profit per head calculated by the FCMS system and presented to each simulated firm through profit or loss

statements at the conclusion of each trading week. Students shared a total of $900 or approximately $20 per person. All firms were given a beginning balance of $10. After the initial balance, each team's profit/head was monitored and as profit/head increased or decreased by $1, payment also increased or decreased, respectively, by $.02/dollar of profit/head. However, complete payment was not awarded until the final week of the experiment. Examples of the mechanics of the reward system and corresponding profit or loss calculations are presented in Table 4. Examples of firm profit/loss figures accounted for in each week of the above mentioned experimental periods are presented in Appendix C.

In addition to being participants of experimental simulation experiments, students were required to complete a survey designed to reflect their observations of exclusive marketing/procurement agreements in the fed cattle market (Appendix D). This provided data that would allow the evaluation of how each student observed the exclusive marketing/procurement agreement affecting the performance of their respective firm and the simulated market, whether they participated in the exclusive marketing/procurement agreement or not. Surveys were collected and will be evaluated in future research. Hence they were not considered in this study.

Transaction Price Models

Econometric models were used to examine the questions implied in each specific objective of this study. The first econometric model is a transaction price level model

(Model A) which was developed to explain how exclusive marketing/procurement agreements affect the level of transaction prices within the fed cattle market. The initial transaction price level model (Model A) is specified and was estimated as follows:

$$(1)\quad TPFC_{it} = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 LCFMP_{t-1} + \alpha_3 TM_{t-1} + \alpha_4 TSL_{t-1} + \alpha_5 PPL_t + \sum_{j=1}^{8} \alpha_{6j} DFDLT_{ijt} + \sum_{j=1}^{4} \alpha_{7j} DPKR_{ijt} + \sum_{j=1}^{2} \alpha_{8j} DMPA_{ijt} + \sum_{j=1}^{2} \alpha_{9j} DRNR_{ijt} + \sum_{j=1}^{2} \alpha_{10j} DMAP_{ijt} + \sum_{j=1}^{2} \alpha_{11j} DNMP_{ijt} + v_{it}.$$

where, t = time in simulated weeks = 40, 42, 43, ..., 114 and i = observations within a week = 1, 2, 3, ..., N_t. The definition of each variable and the expected sign for each coefficient is presented in Table 5. The pooled cross-section time series model was estimated for unbalanced panel data because the number of transactions observed each week was not equal over the 75 week experimental period. Unequal transaction price observations among weeks are due to the fact that FCMS participants adjust marketing or procurement strategies in reaction to market changes as needed.

It is not statistically plausible to estimate Model A as shown in equation 1. A variable from each of the following binary groups must be excluded from the estimation process: $DFDLT_{ijt}$, $DPKR_{ijt}$, $DMPA_{ijt}$, $DMAP_{ijt}$, $DNMP_{ijt}$, and $DRNR_{ijt}$. The variables that were not included will be referred to the "base" variables in subsequent tables and figures. Base variables are noted in Table 5.

Model A is specified as a Weighted Random Effects Model (WREM) and was estimated for unbalanced panel data using LIMDEP 6.0 econometric software

(Greene).

The WREM model specification was used in this study to correct for multiplicative heteroskedasticity in the error term (v_{it}) resulting from the two experiments that were applied to the simulated marketing period (Judge et al.). The WREM is an Estimated Generalized Least Squares (EGLS) regression model that assumes that the error term (v_{it}) contains two components

(2) $\quad v_{it} = e_{it} + u_t$.

The first component is randomness of the transaction prices within each week which is known as white noise and the second component measures the random impact that is common to each simulated week of trading (Judge et al.). The component error term has disturbances ($\sigma_e^2 + \sigma_u^2$) that are equal to σ^2 and are assumed to be uncorrelated as follows:

(3) $\quad E[u_t] = 0,$

(4) $\quad Var[u_t] = \sigma_u^2,$

(5) $\quad Cov[e_{it}, u_t] = 0,$

and

(6) $\quad Var[e_{it} + u_t] = \sigma_e^2 + \sigma_u^2 = \sigma^2.$

However, for a given t, the disturbances are assumed to be correlated by virtue of their common component ($\rho = \sigma_u^2/\sigma^2$) as follows:

(7) $\quad Corr[e_{it} + u_t, e_{is} + u_s] = \rho = \sigma_u^2/\sigma^2.$

Multiplicative heteroskedasticity was found among simulated weeks due to the randomized reward/non-reward and agreement/non-agreement periods. The random

effects model was weighted (Wts_{it}) to correct for the multiplicative form of heteroskedasticity as follows:

(10) $Wts_{it} = 1/\exp(\hat{\epsilon}_{it}^{\,2})$.

Where $\hat{\epsilon}_{it}^{\,2}$ represents the squared error or conditional variance for each observation.

The model yielded Estimated Generalized Least Squares estimates for the relevant economic variables using LIMDEP 6.0 software (Greene). Variations of this model were estimated to evaluate the robustness of the estimated impacts of the agreement and reward periods on transaction price levels. Each of the model variations are presented in Appendix E.

Ward et al. 1996b notes that many of the traditional economic variables of transaction price models found in previous research are accounted for or held constant by the FCMS. These variables generally include cattle quality characteristics such as age, weight, sex, quality grades, yield grades, etc. Reasons for the inclusion of these types of variables in transaction price models that explain fed cattle prices are well developed in Jones et al., Schroeder et al., Ward et al. 1996a, Ward 1981, Ward 1982, and Ward 1992. As a result, variable explanation at this juncture will focus on those variables that are specific to this study.

The price of boxed beef (*BBP*) was lagged one week (t-1) because meatpacking firms (buying agents) base their procurement decisions on the market information that has been reported most recently. The price of boxed beef is reported at the conclusion of each simulated week and represents the price for which boxed beef is sold in that week. Therefore, buying agents within the FCMS utilize boxed beef prices for fed

cattle that were purchased in the previous week (i.e., buying agents purchase cattle in one week and sell beef produced by those cattle the following week). A graphical depiction of BBP_{t-1} throughout the simulated marketing period is presented in Figure 2 and the descriptive statistics for BBP_{t-1} in different experimental periods are reported in Table 6. Lagged boxed beef prices were found to be highly correlated with the average price paid for fed cattle in each simulated week (Figure 2). The rationale for including the previous week's closing futures market price for the nearby live cattle contract ($LCFMP_{t-1}$) is much the same as the rationale for including lagged boxed beef prices (BBP_{t-1}). The exception is that both the buying agents and the feedlot firms (selling agents) formulate marketing/procurement decisions that are based on the closing nearby live cattle futures market price. A graphical depiction of $LCFMP_{t-1}$ throughout the simulated marketing period is presented in Figure 3 and the descriptive statistics for $LCFMP_{t-1}$ in different experimental periods are reported in Table 6.

Two specific independent variables were used to represent the supply of fed cattle. Total number of fed cattle on the show list (TSL) for the previous week (t-1) is known by all firms within the FCMS. Number of cattle on the show list represents cattle that can be marketed in the current week (i.e., fed cattle that weigh between 1,100 lbs. and 1,200 lbs.). Previous research has indicated that this number is important in forecasting prices in the fed cattle market (Ward et al. 1996b; Bacon, Trapp, and Koontz). Graphical depictions of TSL_{t-1} throughout the simulated marketing period are presented in Figures 1 and 4. Descriptive statistics for TSL_{t-1} in different experimental periods are reported in Table 6. Total number of pens marketed

in the previous week (TM_{t-1}) is another supply variable that has also been found to significantly effect prices paid for fed cattle (Schroeder et al.). These two variables were not found to be highly correlated with one another (Figure 5). An explanation for this is that the buying agents purchase fed cattle to fulfill a known low cost or optimal plant capacity during each week of trading. This causes total marketings (TM_{t-1}) to remain constant relative to the amount of cattle supplied to the market or on the total show list (TSL_{t-1}) from week to week (Figure 6). Descriptive statistics for TM_{t-1} in different experimental periods are reported in Table 6.

When the buying and selling agents of the FCMS approach one another to agree upon a bid or ask price, they negotiate or bargain until a final transaction price is reached. The amount for which they negotiate revolves around how to split or share the available profits or losses in the market at the time of the trade. In order to do this, participants of the FCMS must estimate the feedlot and meatpacker break-even prices for fed cattle in each trading period. The difference between the largest meatpacker's break-even price for the 1150 lb. weight class and the feedlots' break-even price for the same weight class represents the profits or losses (PPL_t) that are available to the market in week t. This amount can be shared by the simulated firms in each trading period. The available profits or losses (PPL_t) in this study were used as a measure of the bargaining range or the distribution of profits or losses between the buying and selling agents of the FCMS. A graphical depiction of PPL_t throughout the simulated marketing period is presented in Figure 7 and the descriptive statistics for PPL_t in different experimental periods are reported in Table 6.

Ward et al. 1996b found that significant price differences are observed among simulated firms due to individual negotiation skills that are unique to each simulated feedlot and meatpacking firm. Separate variables were included in model **A** to explain how each feedlot firm and each meatpacking firm within the FCMS affects transaction prices. Hence, there are eight variables which represent the feedlot firms ($DFDLT_{ijt}$) and four variables that represent the meatpacking firms ($DPKR_{ijt}$). These variables provide an indication of the overall effects that each firm has on fed cattle prices in relation to one other firm. Descriptive statistics of each firm's transaction prices are presented in Table 7. Graphical depictions of mean prices observed by each feedlot firm and each meatpacking firm are presented in Figures 8 and 9, respectively.

Previous research has evaluated the impacts of captive supplies on market transaction prices (Schroeder et al.; Ward et al. 1996a). However, little research has been conducted to contrast the response of market transaction prices during active and non-active agreement periods. An additional set of variables were included in the model to represent the effects of exclusive marketing/procurement agreements on the transaction prices paid/received for fed cattle. The first of these variables indicates how market transaction prices differ during periods where there were exclusive marketing/procurement agreements ($DMPA_{ijt}$) versus those periods where there were no agreements. The second marketing/procurement agreement variable in the model represents the prices experienced by participating firms of the exclusive marketing/procurement agreements during agreement periods ($DMAP_{ijt}$) compared to the prices experienced by non-participating firms during same market periods (i.e.,

market periods where active agreements were being utilized). A third agreement variable was included in the model to measure differences between prices experienced by participating firms of the exclusive marketing/procurement agreements during periods when there were no active agreements ($DNMP_{ijt}$) compared to the prices experienced by the non-participating firms the same periods (i.e., market periods when there were no active agreements being utilized). Graphical depictions of participant and non-participant prices ($DMAP_{ijt}$ and $DNMP_{ijt}$) throughout the simulated marketing period are presented in Figures 10 and 11. The descriptive statistics for participant and non-participant prices ($DMAP_{ijt}$ and $DNMP_{ijt}$) in both agreement and non-agreement experimental periods are reported in Table 8.

This study also evaluates the effects of rewarding market participants on transaction prices for fed cattle within the FCMS. Rewarding participants of experimental markets has been used as a tool which provides the control of subject preferences (Smith 1976, 1982; Plott). In this study, significant changes in subject preferences are hypothesized to be reflected in the market prices that are produced by participants of the FCMS. Under the salience condition set out by Friedman and Sunder, the reward medium should prevent subjects from becoming bored, which is noted as an important reason for using cash rewards over other types of reward mediums. Transaction price differences are evaluated in this study during randomized periods of rewarding the subjects ($DRNR_{ijt}$) versus market periods where the subjects are not being rewarded. A significant coefficient for the reward period variable in this study could mean students did experience behavior and preference changes during

market periods where rewards were being offered. Descriptive statistics for fed cattle transaction prices during reward and non-reward periods ($DRNR_{ij}$) are presented in Table 9.

Transaction Price Variance Models

The second econometric model (model **B**) is a transaction price variability model used to explain how exclusive marketing/procurement agreements affect the variance of transaction prices. The dependent variable ($VTPFC_{it}$) of model **B** is represented by the natural logarithm of the squared residuals from model **A** which serve as estimates of the variance about the conditional mean of the dependent variable or the level of transaction prices (Judge et. al.). A more precise definition of $VTPFC_{it}$ can be found in Table 5. Graphical depictions of $VTPFC_{it}$ throughout the simulated marketing period for participants and non-participants are presented in Figures 12 and 13, respectively. The descriptive statistics for participant and non-participant price variance estimates ($VTPFC_{it}$) in different experimental periods are reported in Table 10.

Model **B** was estimated using the Ordinary Least Squares technique for unbalanced panel data with the traditional assumptions for the Classical Linear Regression Model (CLRM) employed by LIMDEP 6.0 econometric software (Greene). Model **B** utilizes the same independent variables and subscript notations that appear in model **A**. The base transaction price variability model is specified and was estimated as follows:

$$(9)\quad VTPFC_{it} = \gamma_0 + \gamma_1 BBP_{t-1} + \gamma_2 LCFMP_{t-1} + \gamma_3 TM_{t-1} + \gamma_4 TSL_{t-1} + \gamma_5 PPL_t +$$

$$\sum_{j=1}^{8} \gamma_{6j} DFDLT_{ijt} + \sum_{j=1}^{4} \gamma_{7j} DPKR_{ijt} + \sum_{j=1}^{2} \gamma_{8j} DMPA_{ijt} +$$

$$\sum_{j=1}^{2} \gamma_{9j} DRNR_{ijt} + \sum_{j=1}^{2} \gamma_{10j} DMAP_{ijt} + \sum_{j=1}^{2} \gamma_{11j} DNMP_{ijt} + e_{it}.$$

The model produced OLS estimates of the impacts that the identified variables have on the variability of transaction price levels in the simulated fed cattle market. A fragility analysis was also conducted by using the squared residuals from an OLS transaction price level model with the same independent variables as model **A**. The resulting variance model is identical in specification and estimation with the exception of specifying OLS squared residuals as the dependent variable instead of the WREM squared residuals. The main reason for this consideration is centered around the fact that the WREM model most likely does not produce residuals that are the best estimates of the standard deviation around the conditional mean. This is due to the fact that the WREM corrects for multiplicative heteroskedasticity using the Estimated Generalized Least Squares technique. However, the results from both types of residual variance models were similar and the conclusions about marketing agreement and reward period impacts on the variability of transaction prices derived from each were identical.

The rationale for including the variables of the transaction price level model in the residual variance model are similar to the rationale for each that has been discussed above (Table 5). The definition of each remains the same but their hypothesized impacts on the variability of transaction prices may be different. The main reason for

using the traditional transaction price variables found in model **A** in this study is that variables explaining levels of transaction prices are assumed to also explain the variability of transaction prices. Hence, discussion of variable rationale is limited to the hypothesized relationships between exclusive marketing/procurement agreements and the variability of transaction prices.

There have been numerous studies detailing the overall impacts of exclusive marketing agreement impacts on transaction prices. However, none have considered the impacts that these agreements have on the variability of fed cattle prices. The agreement variables used in model **A** are used in model **B** to determine how market transaction price variances differ during periods of active versus non-active exclusive marketing/procurement agreements. $DMPA_{ijt}$ explains the difference in transaction price variances during market periods where agreements are active versus transaction price variances during non-active agreement periods. $DMAP_{ijt}$ represents the difference in transaction price variances experienced by the participating firms of the agreements during active agreement periods compared to the transaction price variances experienced by the non-participating firms during the same periods. $DNMP_{ijt}$ is used to explain the transaction price variances experienced by the participating firms during non-active agreement periods versus the transaction price variances experienced by the non-participating firms during the same periods.

The impacts of rewarding FCMS participants on transaction price variances was also evaluated by this study. Significant price variance impacts due to rewarding students may be caused by changes in subject preferences during the reward periods.

$DRNR_{ijt}$ represents the transaction price variances experienced by FCMS participants during reward periods compared to the transaction price variances experienced by the participants during trading periods where no rewards were being offered.

Weekly Price Models

An additional set of econometric models were used to examine exclusive marketing/procurement agreement impacts on weekly transaction price levels. Specifically, model C is specified to determine the manner in which exclusive marketing/procurement agreements affect mean weekly transaction price levels ($AVGPRC_t$) within the fed cattle market. Variations of this model were estimated in the same manner as estimated for model A to evaluate the robustness of estimated agreement related impacts on weekly transaction price levels. Each of the model variations are presented in Appendix E. These models are specified as Autocorrelated Classical Linear Regression Models (ACLRM). The models yielded OLS estimates of the relevant economic variables that were corrected for first order autocorrelation. The initial mean weekly transaction price model (model C) is specified and was estimated as follows:

$$(10) \quad AVGPRC_t = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 LCFMP_{t-1} + \alpha_3 TM_{t-1} + \alpha_4 TSL_{t-1} + \alpha_5 PPL_t + \sum_{j=1}^{2} \alpha_{6j} DMPA_{jt} + \sum_{j=1}^{2} \alpha_{7j} DRNR_{jt} + e_t .$$

Definitions and rationale for the variables in model **C** are, for the most part, identical to those discussed for model **A** with minor exceptions. The first exception is that instead of specifying individual transaction prices as the dependent variable, the mean transaction price for each week ($AVGPRC_t$) is specified. This allows the evaluation of exclusive marketing/procurement agreement impacts on weekly market transaction prices for fed cattle. Agreement and non-agreement periods ($DMPA_{j,t}$) are the agreement related variables in this model which represents weekly market prices for fed cattle during the weeks where active agreements existed versus trading weeks where there were no active agreements in place (Table 5).

The impacts of reward periods on weekly prices were also considered by this study. A significant impact of reward periods on weekly prices observed in the FCMS could mean that subject preferences were substantially changed much like reward period impacts on transaction price levels in model **A**. $DRNR_{j,t}$ represents the weekly prices experienced by the participants of the FCMS during reward periods compared to periods where no rewards were being offered.

Sample Statistic Differences

Several further hypothesis tests were specified and tested to evaluate sample differences between the participating and non-participating firms of the exclusive marketing procurement agreements. Sample differences of interest included

participant/non-participant profit levels, participant/non-participant profit variability, participant/non-participant transaction price levels, and participant/non-participant transaction price variability. These tests involved the use of sample means and variances of transaction prices and weekly firm profits. Details about the null and alternative hypothesis and the market periods considered by these tests are presented in Table 1.

The usual *t*-statistic used for determining the difference between two means ($\bar{x}_1$ and $\bar{x}_2$) from independent samples is as follows:

$$(11) \quad t = (\bar{x}_1 - \bar{x}_2) / [s^2(1/n_1 + 1/n_2)]^{1/2}$$

with observations in each sample (n_1 and n_2) and a pooled variance s^2. This *t*-statistic is used under the assumption that the variances in each sample are equal. In this study the variances in each sample are not assumed to be equal. The approximate *t*-statistic used under this assumption is

$$(12) \quad t = (\bar{x}_1 - \bar{x}_2) / [(s_1^2/n_1 + s_2^2/n_2)]^{1/2}.$$

The approximated *t*-statistic considers unequal pooled variances (s_1^2 and s_2^2) for each independent sample (Satterthwaite 1946). Satterthwaite 1946 noted an accurate approximation of the degrees of freedom (df) for t-tests involving unequal variances. The Satterthwaite's approximation for df was used in this study which is calculated as

$$(13) \quad df = (s_1^2/n_1 + s_2^2/n_2) / [(s_1^2/n_1)^2/(n_1 - 1) + (s_2^2/n_2)^2/(n_2 - 1)].$$

In addition to testing for differences in sample means, the folded form of the F-statistic (F') was used to test for differences in sample variances (Steel and Torrie). The F' is calculated from the pooled variances as follows:

(14) $F' = (\text{larger of } s_1^2, s_2^2) / (\text{smaller of } s_1^2, s_2^2)$.

The F' is a two-tailed F-statistic, since it is not known which of the pooled variances (s_1^2 and s_2^2) are larger. The null hypothesis considered in a F' is that the variances of two independent samples are equal ($\sigma_1^2 = \sigma_2^2$).

The first set of tests involve testing whether or not the mean and variance of prices observed by the participants were significantly different from the mean and variance of prices observed by the non-participants in periods when marketing/procurement agreements were active versus periods when marketing/procurement agreements were not active. The second set of tests involved testing whether or not the mean and variance of weekly profits observed by the participants were significantly different from the mean and variance of weekly profits observed by the non-participants in periods when marketing/procurement agreements were active versus periods when marketing/procurement agreements were not active. The third set of statistical hypothesis tests determine whether or not the mean and variance of transaction prices during reward periods were different from the mean and variance of transaction prices during non-reward periods. All of these hypothesis tests were conducted in the same format. The general format for the tests concerning the means of prices and profits is presented in Table 11. Accordingly, the general format for the tests concerning variances of prices and profits is presented in Table 12. In addition to the basic formats, the statistics and hypothesis involved in each test are summarized in Table 1.

Empirical Results and Discussion

Model Results

The transaction price level model (model **A**) explained over 80 percent of the variation in fed cattle transaction prices (Table 13). Model **A** was found to be highly significant with an F-statistic of 773.19 and yielded estimates of the relevant economic variables that had been corrected for multiplicative heteroskedasticity within each week and serial correlation throughout the weeks considered by the experimental trading periods. The random effects in model **A** were found to be highly significant in relation to the specification of the statistical model. In general, this reduced the significance of the independent variables that remained constant within each week of the experimental trading period. The transaction price variability model (model **B**) exhibited an expectedly low explanation (7.23 percent) of the variation in the variance estimates (Table 13). However, the model was found to be significant at the 1 percent level with an F-statistic of 11.91.

The weekly mean transaction price model (model **C**) explained over 90 percent of the variation in weekly fed cattle transaction prices (Table 14). Model **C** was found to be significant with an F-statistic of 108.87 and produced estimates of the relevant economic variables that were corrected for first order autocorrelation. The estimated results for each coefficient in models **A**, **B**, and **C** are presented in Tables 13 and 14.

In addition, estimated results from the robustness analysis for exclusive marketing/procurement agreement and reward/non-reward coefficients are presented in Table 15 for model variations of **A** and **C**.

Sample Mean and Variance Differences

The mean and variance of prices between participating and non-participating firms of exclusive marketing/procurement agreements were found to be statistically different in this study under the assumption that price variances were different between agreement and non-agreement sample periods. Price means and variances in each sampling period considered by this study are presented in Table 16. Firms that were participants of the agreements were found to experience a $0.27/cwt lower mean price than non-participating firms during the agreement periods. Participating firms also experienced significantly lower price variances than non-participating firms during active agreement periods (Table 16). Conversely, participating firms did not experience significantly higher mean prices than non-participating firms by $0.49/cwt during the non-agreement sample periods. Sample variances between participating and non-participating firms were not found to be significantly different during the non-agreement sample periods (Table 16).

The mean and variance of weekly profits between participating and non-participating firms of exclusive marketing/procurement agreements were also found to be statistically different in this study under the assumption that weekly profit variances

were different between agreement and non-agreement sample periods. Graphical depictions of feedlot and meatpacker profits are presented in Figures 14 and 15, respectively. Descriptive statistics for meatpacker and feedlot profits during agreement and non agreement periods are presented in Table 17. The means and variances of weekly profits for each sampling period considered by this study are presented in Table 16. Participants of the agreements were not found to experience weekly mean profits that were significantly different than non-participating firms during the non-agreement periods. However, participating firms did experience a significantly lower variance in weekly profits compared to the non-participating firms during the non-agreement periods. Weekly mean profit differences between participating and non-participating firms during the agreement periods were also found to be statistically insignificant. However, weekly profit variances were found to be significantly lower for participating firms than for non-participating firms, during agreement periods (Table 16). Participant and non-participant weekly mean profits were not found in this study to be significantly different between the agreement and non-agreement periods. However, the participating firms did experience significantly lower profit variances during the agreement than during non-agreement periods (Table 16). Weekly profit variances between agreement and non-agreement periods were not found to be significantly different for the non-participating firms.

Sample statistic differences between reward and non-reward periods were also considered in this study. Mean prices between reward and non-reward periods of the experiment were not found to be statistically different under the assumption that price

variances were different between reward and non-reward sample periods. However, price variances were found to be significantly higher during reward periods than during non-reward periods (Table 16).

Traditional Price Discovery Model Variables

The lagged boxed beef price (BBP_{t-1}) has been found in previous research to be significantly related to fed cattle transaction prices. In this study, the coefficient for BBP_{t-1} was found to be significant and positively related to simulated fed cattle transaction prices (Table 13). Specifically, fed cattle transaction prices are found to increase by $0.33/cwt. with a $1/cwt. increase in the lagged boxed beef price (BBP_{t-1}). Similarly, BBP_{t-1} was found to be significant and positive in its relationship to the weekly mean of simulated fed cattle transaction prices. Weekly mean fed cattle transaction prices are found to increase by $0.22/cwt. with a $1/cwt. increase in the lagged boxed beef price (BBP_{t-1}). These findings are consistent with relevant economic theory concerning derived demand and parallel to findings in previous research (Schroeder et al.; Ward et al. 1996b; Ward 1992). Lagged live cattle futures market prices ($LCFMP_{t-1}$) have also been found in previous research to have significant positive impacts on fed cattle transaction prices (Schroeder et al.; Ward 1981, 1982, 1992). Lagged live cattle futures market prices in this study were also found to be positive and significant. Fed cattle transaction prices were found to increase by $0.27/cwt. for every $1/cwt. increase in the lagged live cattle futures market price. Accordingly, weekly mean fed cattle transaction prices were found to increase by $0.16/cwt. for

every $1/cwt. increase in the lagged live cattle futures market price.

The relationships between the two cattle supply related variables used in this study and fed cattle transaction prices are consistent with one another and with economic theory about how changes in the quantity supplied impacts prices within a given market. The total supply of cattle in the market window or the number of cattle available for purchase within a given week is known as the number of cattle on the total show list. This type of information is not publicly reported in the real-world market. However, private organizations often attempt to collect show list data from their members (Ward et al. 1996b). The total number of pens of cattle (100 hd./pen) on the show list for the previous week (TSL_{t-1}) was found in a previous study to have a negative and significant relationship with fed cattle transaction prices (Ward et al. 1996b). In this study, the coefficient for TSL_{t-1} was also found to be negative and significant in its relationship to both fed cattle transaction prices and the weekly mean of fed cattle transaction prices. Specifically, simulated fed cattle transaction prices are found to decrease by $0.05/cwt. with an additional pen of cattle on the previous week's show list. Weekly mean fed cattle transaction prices are found to decrease by $0.08/cwt. with an additional pen of cattle on the previous week's show list. The number of cattle marketed by feedlots or slaughtered by meatpackers has been considered in two previous studies. Schroeder et al. found that the number of cattle marketed or slaughtered significantly affected fed cattle transaction prices. However, Ward et al. 1996b did not find that the total number of cattle marketed in each week significantly impacted simulated fed cattle transaction prices. In the FCMS setting, this

number is reported at the end of each week. As a result, the subjects are allowed to use the total number of marketings from the previous week (TM_{t-1}) to formulate and arrive at bid or ask prices for pens of finished cattle. In this study, TM_{t-1} was found to have a negative and significant relationship to fed cattle transaction prices, similar to the impact of TSL_{t-1}. The coefficient indicates that simulated fed cattle transaction prices decreased by $0.06/cwt. with a one pen increase in the number of pens marketed for the previous week. The weekly mean of fed cattle transaction prices was not significantly impacted by the number of pens marketed or slaughtered in the previous week.

Ward et al. 1996b notes that a specific type of firm behavior is commonly observed in the FCMS setting that is related to the manner in which meatpacking firms and feedlot firms share available profits. The authors suggest that feedlot firms are more often willing to be satisfied with a targeted, cost-plus profit margin that can be realized under normal market conditions. The authors also suggest that meatpacking firms more often attempt to gain the highest possible profit available in the market under given market conditions at the time of negotiation. As a result, when there are known profits to be shared in the fed cattle market, meatpacking firms commonly attempt to capture the largest portion of the amount to be negotiated. Much like in the real world, the subjects of the FCMS are able to calculate the meatpacker and feedlot break-even price for 1150 lb. cattle from week to week. The difference in the largest meatpacking firm's break-even price for 1150 lb. cattle and the feedlot firms' break-even price for 1150 lb. cattle is a proxy in this study for the amount of profits to be

shared in a particular week or the bargaining range. This amount will be referred to as the potential profit/loss for each week (PPL_t). Previous research results have indicated that there is a negative and significant relationship between PPL_t and fed cattle transaction prices (Ward 1996b). Results found in this study are consistent with previous findings in that a \$1/cwt. increase in the potential profit/loss for each week is associated with a \$0.15/cwt. decrease in fed cattle transaction prices. The weekly mean of fed cattle transaction prices was not significantly impacted by a \$1/cwt. increase in the potential profit/loss for each week (model C).

Differences in managerial and negotiation skills exist between individuals within the firms that participate in most markets. These differences become collective for each firm as the individuals work together to accomplish a common set of goals. Previous research has indicated that these collective differences result in different types of market behavior and performance which is often linked to the price differences among competing firms (Ward et al. 1996b; Carlton and Perloff). Previous research findings using the FCMS suggests that significant price differences do indeed occur between the simulated meatpacking and feedlot firms (Ward et al. 1996b). In this study, several of the simulated feedlot firms ($DFDLT_1$ - $DFDLT_8$) received higher prices for the cattle that were marketed than the other feedlot firms. Accordingly, two of the simulated meatpacking firms ($DPKR_1$ -$DPKR_4$) received lower prices for the cattle that were purchased than the other meatpacking firms. These results are consistent with previous findings that consider price differences among firms using real-world data (Jones et al.; Schroeder et al.; Ward 1982, 1992, 1996a). Significant

feedlot firm price differences found here ranged from $0.49/cwt. to $0.22/cwt. higher than the mean price received by Feedlot #1. Significant price differences among the meatpacking firms ranged from $0.48/cwt. to $0.32/cwt. lower than the mean price paid for Meatpacker #1. These results are not consistent with economies of size theory due to the fact that the smallest meatpacker (#1) paid the highest price on average. Economies of size studies typically suggest that the largest meatpacking firm can pay the highest price given that there is adequate inter-firm competition within the market (Ward 1993). Similar results were found by Ward et al. 1996b where the authors suggested that these results may be due to the differences in the managerial skills of the individuals operating the simulated firms.

Exclusive Marketing/Procurement Agreement Variables

Specific types of captive supplies have been found in previous research to have a negative relationship with fed cattle transaction prices (Schroeder et al.; Barkley and Schroeder; Ward et al. 1996a). This study examines more closely one type of captive supplies, exclusive marketing/procurement agreements. To go beyond the general impacts of captive supplies, this study distinguishes the participating firms of these agreements during active agreement periods ($DMAP_1$) from the non-participating firms during the active agreement periods ($DMAP_2$). Results from model A suggest participants ($DMAP_1$) realized significantly lower mean prices than non-participants ($DMAP_2$) during active agreement periods which is consistent with previous research

(Ward et al. 1996a). Specifically, the mean price realized by participants ($DMAP_1$) was \$0.71/cwt. lower on average than the mean prices realized by non-participants ($DMAP_2$) during the active agreement periods. In addition to different mean prices, the $DMAP_1$ coefficient in model **B** suggests that participants ($DMAP_1$) realized a significantly lower price variance by \$0.86/cwt. on average than the price variance realized by non-participants ($DMAP_2$) of the agreements during agreement periods.

This study also distinguishes participants ($DNMP_1$) from non-participants ($DNMP_2$) during the non-active agreement periods. Results from model **A** indicate that participants ($DNMP_1$) and non-participants ($DNMP_2$) of the agreements did not realize significantly different mean prices during the non-agreement periods. Furthermore, results from model **B** indicate that participants ($DNMP_1$) and non-participants ($DNMP_2$) did not observe significantly different price variances during the non-active agreement periods.

Another variable in this study that extends beyond traditional captive supply studies is the response of market prices during agreement periods ($DMPA_1$) versus market prices during the non-agreement periods ($DMPA_2$). Results from model **A** suggest that significant price differences do exist in the fed cattle market between agreement ($DMPA_1$) and non-agreement ($DMPA_2$) periods. The coefficient for agreement periods ($DMPA_1$) in model **A** indicates that the mean level of fed cattle transaction prices was \$1.27/cwt. higher during active agreement period than the mean price level during non-active agreement periods. Additionally, the agreement period coefficient ($DMPA_1$) in model **B** suggests that fed cattle transaction prices are

significantly more variable during agreement periods than during non-agreement periods. The agreement period coefficient ($DMPA_1$) indicates that market prices have a \$0.54/cwt. higher variance during agreement periods than during non-agreement periods. The weekly mean of fed cattle transaction prices was not found to be significantly impacted by exclusive marketing/procurement agreement periods in model C.

Economic Reward Variables

Economically rewarding subjects of experimental economic research has been found to be an effective method of inducing subjects to maintain a high level of interest while participating in economic experiments. Previous experimental economic research results suggest that properly rewarding subjects who are rational or who prefer more income to less controls their individual preferences in such a way that they remain competitive throughout the duration of the experiment. As a result, the extended competition allows the market to realistically respond to repeated applications of a particular economic treatment (Smith 1976, 1982; Plott; Friedman and Sunder). This study evaluates rewarding the subjects of experimental simulation to determine whether or not changes in subject preferences and subsequent subject competition impact market prices. Here, it is hypothesized that any increases in the level of competition due to preference changes would be reflected by significantly different price levels during periods where the subjects were being rewarded ($DRNR_1$) than prices during periods

where the subjects were not being rewarded ($DRNR_2$). Results from model **A** indicate that fed cattle transaction prices are not significantly different between reward ($DRNR_1$) and non-reward ($DRNR_2$) periods. Likewise, the weekly mean of fed cattle transaction prices is not found to be significantly different between reward ($DRNR_1$) and non-reward periods ($DRNR_2$) in model **C**. However, the reward period coefficient ($DRNR_1$) in model **B** suggests that transaction prices are significantly more variable during periods when the subjects of experimental simulation are rewarded than during periods when the subjects were not being rewarded. Specifically, the reward period coefficient ($DRNR_1$) in model **B** indicates that the subjects observed a $0.63/cwt. higher variance during periods when subjects were being rewarded than during periods when subjects were not being rewarded.

Summary, Implications, and Conclusions

This study focused on exclusive marketing/procurement agreements as a captive supply method within an experimental simulation setting. This type of agreement is quickly becoming a common arrangement used by large meatpacking and cattle feeding firms in the fed cattle market. As a result of structural changes in the fed cattle market over the past decade, both large and small firms limit the amount of price discovery data that is available to the public. Experimental simulation enables conducting economic research that attempts to adequately answer industry and market questions about how different types of captive supplies affect specific characteristics of the fed

cattle market. Ward et al. 1996b notes that the Fed Cattle Market Simulator (FCMS) was developed to provide a realistic market framework and institutional structure which allows market participants to compete in an experimental simulation setting. This setting was used to evaluate the manner in which exclusive marketing/procurement agreements impact the level and variability of fed cattle transaction prices. By applying experimental agreements to the simulated market and then observing the response of market prices, limitations associated with collecting real-world data are overcome.

Data for this study were collected from the FCMS during the Spring 1995 semester at Oklahoma State University. Transaction price level and variability models were employed to determine the effects of exclusive marketing/procurement agreements on fed cattle transaction prices. Over 75 weeks of trading were evaluated which produced 2,770 independent transactions within two experimental periods and four subperiods.

Many economic variables were found to be generally consistent with a prior FCMS study (Ward et al. 1996b) and other research projects dealing with fed cattle transaction prices (Jones et al.; Schroeder et al.; Ward et al. 1996a; Ward 1981, 1982, 1992). These variables include boxed beef prices from the previous week, live cattle futures market prices from the previous week, total marketings/slaughter from the previous week, the individual feedlot firms, and the individual meatpacking firms. The potential profit/loss within each week and the number of cattle on the show list from the previous week have also been found to significantly impact fed cattle transaction prices, but are not available in industry data. Results indicate a significant positive

relationship exists between fed cattle transaction prices and both lagged boxed beef prices and lagged live cattle futures market prices. The number of head on the total show list and the number of cattle marketed each week were consistent with economic theory in that they had significant negative impacts on fed cattle transaction prices. The amount of potential profit/loss to be shared by meatpacking and feedlot firms was found to have a significant and negative effect on fed cattle transaction prices. This is parallel to findings in a previous study. The inverse relationship of the potential profit/loss in a given week to fed cattle transaction prices suggests that feedlots use a cost-plus strategy that is hypothesized to be followed by cattle feeding firms in previous research (Ward 1996b).

Differences in prices paid by meatpacking firms were found to be consistent with previous price discovery research (Ward et al. 1996b), but not consistent with economies of size theory (Ward 1993). An explanation that is commonly offered for this discrepancy is that managerial skills differ among individuals within each firm. These differences are magnified as a group of individuals cooperate to achieve similar goals which affects the way a feedlot or meatpacking firm or team behaves within a market. The behavioral differences can be attributed to the manner in which prices were different between the simulated firms in this study.

The central question to be answered by this study is centered around the impacts of exclusive marketing/procurement agreements on the level and variability of fed cattle transaction prices. Research findings indicate that: (1) significant price differences exist between participants and non-participants of exclusive marketing/procurement

agreements, (2) exclusive marketing/procurement agreement transactions had a significant negative impact on fed cattle transaction prices, and (3) that market prices are significantly higher during agreement periods than during non-agreement periods. Results indicate that the meatpacking and cattle feeding firms that enter into exclusive marketing/procurement agreements realized a significantly lower mean and variance of prices by $0.71/cwt. and $0.86/cwt., respectively than those firms that did not enter into such agreements. Furthermore, participating firms did not realize significantly different prices than non-participating firms during non-agreement periods. An implication of this is that cattle feeding firms are willing to accept lower prices and subsequently lower profits in order to ensure that: (1) cattle on show list inventories remain current and (2) less variable market prices are realized. On the other hand, the meatpacking firm is able to realize lower purchase prices and lower price variability which may allow the firm to achieve long-run financial stability in exchange for capturing the absolute maximum profits that are available within the market. A graphical summary of mean and standard deviation differences of prices for both participants and non-participants is presented in Figure 16.

During the periods where the participating firms were actively engaged in agreements, mean transaction prices realized by the entire market were found to be $1.27/cwt. higher than periods were there were no active agreements. The price variance during the active period was also found to be higher by $0.54/cwt. on average. An explanation offered for this finding is that the exclusive marketing/procurement agreements create a short-term reduction in the quantity of

cattle which are available to the market for an extending time period into the future. This is done because the largest meatpacking firm secures 83% or more of its optimal slaughtering capacity by entering the agreement which is approximately 25% of the cattle that are typically marketed or slaughtered from week to week in the FCMS. This reduction in the supply of cattle causes upward pressure on market prices which translates into higher mean prices during the active agreement periods. In the midst of the supply reduction, the firms that are excluded from the marketing/procurement agreements counter-react by adjusting their marketing or procurement strategies in order to maximize profits or minimize losses. These strategy adjustments are hypothesized to cause the more variable market prices as an indirect result of the exclusive marketing/procurement agreements.

Another question considered by this study is centered around the effects of economically rewarding or not rewarding the subjects of experimental simulation. Rewarding the subjects of experimental economic research where the environment is highly controlled has been found to be an effective method of retaining subject motivation and controlling subject preferences in economic experiments where the validity of specific economic theories are to be tested. This study evaluated rewarding subjects in an experimental simulation setting where very little of the environment is controlled which allows dynamic interrelationships between both the simulated firms and the economic variables to react to one another much like in the real world. Results indicate that mean fed cattle transaction prices are not significantly different during periods when the subjects of the FCMS system are being rewarded. However,

transaction prices were found to have a significantly higher variance by $0.56/cwt. during periods when the subjects were being rewarded than during periods of no economic rewards. An implication of these findings is that rewarding subjects in experimental simulation settings will not affect their firms' financial performance in a such a way that the level of market prices are significantly impacted, but it does create added variability in simulated market transaction prices. The added variability is most likely caused by the mere reaction of the subjects to the reward periods instead of an increased motivation which was hypothesized in this study to impact fed cattle transaction price levels.

Future research involving the use of experimental simulation is possible provided that an adequate market and institutional structure is developed. The FCMS is an example of an experimental simulation setting that allows its participants to learn from the consequences of different types of decisions that are made in the fed cattle price discovery process. This creates a realistic relationship between the simulated cattle feeding and meatpacking firms which can be experimentally evaluated by the application of experimental models of real-world occurrences in the fed cattle market. The FCMS offers an opportunity to extend the topic considered in this study to determining the effectiveness of marketing agreements opposed to contracts in securing desired cattle quality characteristics in a value based marketing system. Beyond captive supply issues within the fed cattle market, there are growing numbers of fed cattle market questions that could be adequately addressed using experimental simulation approaches within the FCMS.

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TABLE 1: SUMMARY OF MEAN AND VARIANCE HYPOTHESIS TESTS CONSIDERED WITHIN AND BETWEEN AGREEMENT AND NON-AGREEMENT PERIODS

Value Considered	Null Hypothesis (H_o)	Alternative Hypothesis (H_a)
Means Between Agreement Periods		
Participant Prices[a] Non-participant Prices Participant Profits[b] Non-participant Profits	The mean of each value is equal for the agreement and non-agreement periods $(\bar{x}_1 - \bar{x}_2 = 0)$.	The mean of each value is not equal for the agreement and non-agreement periods $(\bar{x}_1 - \bar{x}_2 \neq 0)$.
Means Between Reward Periods		
Transaction Prices	The mean of prices is equal for the reward and non-reward periods $(\bar{x}_1 - \bar{x}_2 = 0)$.	The mean of prices is not equal for the reward and non-reward periods $(\bar{x}_1 - \bar{x}_2 \neq 0)$.
Variances Between Agreement Periods		
Participant Prices Non-participant Prices Participant Profits Non-participant Profits	The variance of each value is equal for the agreement and non-agreement periods $(\sigma_1^2 - \sigma_2^2 = 0)$.	The mean of each value is not equal for the agreement and non-agreement periods $(\sigma_1^2 - \sigma_2^2 \neq 0)$.
Variances Between Reward Periods		
Transaction Prices	The variance of prices is equal for the reward and non-reward periods $(\sigma_1^2 - \sigma_2^2 = 0)$.	The variance of prices is not equal for the reward and non-reward periods $(\sigma_1^2 - \sigma_2^2 \neq 0)$.

[a] All prices are reported in \$/cwt.
[b] All profits are reported in \$/1000.

TABLE 2: STRUCTURE OF EXCLUSIVE MARKETING/PROCUREMENT AGREEMENTS

Agreement Firms	Responsibilities of Each Firm
Meatpacker #4	Responsible for securing up to 83 1/3 % of optimal low cost slaughter (12 pens or 1200 hd.) by purchasing all of the 1150 lb. steers on inventory in Feedlot #2 and Feedlot #5 at an agreed upon profit/loss sharing price.
Feedlot #2	Responsible for marketing all of its 1150 lb. steers to Meatpacker #4 at an agreed upon profit/loss sharing price.
Feedlot #5	Responsible for marketing all of its 1150 lb. steers to Meatpacker #4 at an agreed upon profit/loss sharing price.

TABLE 3: EXAMPLES OF EXCLUSIVE MARKETING/PROCUREMENT AGREEMENTS

Example	Calculated Marketing/Procurement Agreement Adjustments
Week Number 65:	
Feedlot #2	Calculated Break-Even Price (BEP) for 1150 lb. Cattle = $69.00/cwt.
Packer #4	Calculated Break-Even Price (BEP) for 1150 lb. Cattle = $72.00/cwt.
	BEP Difference = Packer #4 BEP - Feedlot #2 BEP = $3.00/cwt.
Profit/Loss Sharing Price (PLSP) = Packer #4 BEP - (BEP Difference / 2)	
	PLSP = Feedlot #2 BEP + (BEP Difference / 2)
	PLSP = $70.50/cwt.
Feedlot #2	Transaction Profit = $1.50/cwt.
Packer #4	Transaction Profit = $1.50/cwt.

TABLE 3: CONTINUED

Example	Calculated Marketing/Procurement Agreement Adjustments
Week Number 65:	
Feedlot #5	Calculated Break-Even Price (BEP) for 1150 lb. Cattle = $73.50/cwt.
Packer #4	Calculated Break-Even Price (BEP) for 1150 lb. Cattle = $72.00/cwt.
	BEP Difference = Feedlot #5 BEP - Packer #4 BEP = $1.50/cwt.
	Profit/Loss Sharing Price (PLSP) = Packer #4 BEP + (BEP Difference / 2)
	PLSP = Feedlot #5 BEP - (BEP Difference / 2)
	PLSP = $72.75/cwt.
Feedlot #5	Transaction Loss = ($0.75/cwt.)
Packer #4	Transaction Loss = ($0.75/cwt.)
Week Number 85:	
Feedlot #2	Calculated Break-Even Price (BEP) for 1150 lb. Cattle = $73.75/cwt.
Packer #4	Calculated Break-Even Price (BEP) for 1150 lb. Cattle = $73.75/cwt.
	BEP Difference = Feedlot #2 BEP - Packer #4 BEP = $0
	Profit/Loss Sharing Price (PLSP) = Packer #4 BEP + (BEP Difference / 2)
	PLSP = Feedlot #2 BEP - (BEP Difference / 2)
	PLSP = $73.75/cwt.
Feedlot #2	Transaction Break-Even = $0
Packer #4	Transaction Break-Even = $0

TABLE 3: CONTINUED

Example	Calculated Marketing/Procurement Adjustments
Week Number 85:	
Feedlot #5	Calculated Break-Even Price (BEP) for 1150 lb. Cattle = $70.60/cwt.
Packer #4	Calculated Break-Even Price (BEP) for 1150 lb. Cattle = $72.00/cwt.
	BEP Difference = Packer #4 BEP - Feedlot #5 BEP = $1.40
	Profit/Loss Sharing Price (PLSP) = Packer #4 BEP + (BEP Difference / 2)
	PLSP = Feedlot #5 BEP - (BEP Difference / 2)
	PLSP = $71.30/cwt.
Feedlot #5	Transaction Profit = $0.70/cwt.
Packer #4	Transaction Profit = $0.70/cwt.

TABLE 4: EXAMPLES OF THE FCMS REWARD SYSTEM

Example	Average Profit/Loss Per Head (PLHD)	Average Pen Profit/Loss (PLP)	Reward Account Adjusted Balance (RAAB)
Week Number 47: Feedlot #7	PLHD = \$4.50/cwt.	PLP = PLHD * Pens Marketed PLP = \$4.50/cwt. * 6 Pens PLP = \$27.00/cwt.	RAAB = Balance From Previous Week[a] + (PLP * .02) RAAB = \$15.00 + \$0.54 RAAB = \$15.54
Week Number 47: Packer #1	PLHD = \$2.75/cwt.	PLP = PLHD * Pens Purchased PLP = \$2.75/cwt. * 9 Pens PLP = \$24.75/cwt.	RAAB = Balance From Previous Week + (PLP * .02) RAAB = (\$10.50) + \$0.50 RAAB = (\$10.00)
Week Number 82: Packer #3	PLHD = (\$1.30/cwt.)	PLP = PLHD * Pens Purchased PLP = (\$1.30/cwt.) * 11 Pens PLP = (\$14.30/cwt.)	RAAB = Balance From Previous Week + (PLP * .02) RAAB = \$25.00 + (\$0.29) RAAB = \$24.71
Week Number 82: Feedlot #1	PLHD = (\$5.25/cwt.)	PLP = PLHD * Pens Marketed PLP = (\$5.25/cwt.) * 7 Pens PLP = (\$36.75/cwt.)	RAAB = Balance From Previous Week + (PLP * .02) RAAB = \$0.50 + (\$0.74) RAAB = (\$0.24)

[a] Each simulated firm was given a \$10.00 account balance at the beginning of the experimental period.

TABLE 5: VARIABLE DEFINITIONS FOR MODELS A, B, AND C WITH EXPECTED SIGNS

Variables	Definition of Variable	Expected Sign
Dependent Variables		
$TPFC_{it}$	i^{th} transaction price for one pen of fed cattle ($/cwt.) in week t	N/A
$AVGPRC_t$	The weekly mean of fed cattle transaction prices ($/cwt.) in week t	N/A
$VTPFC_{it}$	The natural log of the i^{th} transaction price variance estimate ($/cwt.) calculated from model A in week t	N/A
Independent Variables		
BBP_{t-1}	The boxed beef price ($/cwt.) for Choice Yield Grades 1-3 550-700 lb. carcasses, lagged one week	Positive
$LCFMP_{t-1}$	The live cattle futures market closing price ($/cwt.) for the nearby contract period, lagged one week	Positive
TM_{t-1}	The total number of pens (100hd./pen) marketed or slaughtered, lagged one week	Negative
TSL_{t-1}	The total number of pens of cattle (100hd./pen) on the market ready show list, lagged one week	Negative
PPL_t	The potential profit or loss per head ($/cwt.) in week t which is the largest meatpacker's break-even price for 1,150 lb. cattle less the mean feedlot break-even price for 1,150 lb. cattle	Negative
$DFDLT_{ijt}$	Binary dummy variables distinguishing each individual feedlot firm, j=1-8, 1=FDLT1 (Base), 2=FDLT2, 3=FDLT4, 4=FDLT4, 5=FDLT5, 6=FDLT6, 7=FDLT7, and 8=FDLT8	Pos /Neg.
$DPKR_{ijt}$	Binary dummy variables distinguishing each individual meatpacking firm, j=1-4, 1=PKR1 (Base), 2=PKR2, 3=PKR4, and 4=PKR4	Pos./Neg.
$DMPA_{ijt}$	Binary dummy variables distinguishing the active and non-active exclusive marketing/procurement periods, j=1-2, 1= Agreement and 2=Non-Agreement (Base)	Pos./Neg.

TABLE 5: CONTINUED

Variables	Definition of Variable	Expected Sign
Independent Variables		
$DNMP_{ijt}$	Binary dummy variables distinguishing the participants and non-participants during the non-active exclusive marketing/procurement periods, j=1-2, 1=Participants and 2=Non-Participants (Base)	Pos./Neg.
$DMAP_{ijt}$	Binary dummy variables distinguishing the participants and non-participants during the active exclusive marketing/procurement periods, j=1-2, 1=Participants and 2=Non-Participants (Base)	Pos./Neg.
$DRNR_{ijt}$	Binary dummy variables distinguishing the economic reward periods, j=1-2, 1=Reward and 2=Non-Reward (Base)	Pos./Neg.

TABLE 6: DESCRIPTIVE STATISTICS FOR TRADITIONAL INDEPENDENT VARIABLES FOUND IN FED CATTLE PRICE DISCOVERY RESEARCH

Variables	Mean	Standard Deviation	Minimum	Maximum	N
Entire Marketing Period					
BBP_{t-1}	125.62 [a]	5.21	114.01	138.25	75
$LCFMP_{t-1}$	78.14	2.36	72.10	81.60	75
TSL_{t-1}	113.88	14.68	88.00	146.00	75
TM_{t-1}	37.13	5.42	20.00	46.00	75
PPL_t	2.02	3.37	-5.46	8.95	75
Agreement Periods					
BBP_{t-1}	129.07	3.76	123.91	138.25	32
$LCFMP_{t-1}$	78.17	1.59	76.05	81.40	32
TSL_{t-1}	107.16	12.88	88	134	32
TM_{t-1}	36.56	5.03	20.00	43.00	32
PPL_t	2.92	4.05	-5.46	8.95	32
Non-Agreement Periods					
BBP_{t-1}	123.05	4.64	114.01	132.65	43
$LCFMP_{t-1}$	78.12	2.82	72.10	81.60	43
TSL_{t-1}	118.88	14.04	97.00	146.00	43
TM_{t-1}	37.56	5.72	24.00	46.00	43
PPL_t	1.34	2.62	-4.44	7.07	43

[a] Variable definitions and their respective units of measure are presented in table 5.

TABLE 7: DESCRIPTIVE STATISTICS FOR FIRM PRICES DURING AGREEMENT AND NON-AGREEMENT PERIODS

Variables	Mean	Standard Deviation	Minimum	Maximum	N
Agreement Periods					
$DFDLT_1$ [a]	80.80	1.80	77.50	86.00	154
$DFDLT_2$ [b]	80.54	2.02	77.22	87.03	161
$DFDLT_3$	81.71	2.03	77.75	86.67	131
$DFDLT_4$	81.27	1.90	78.00	85.35	130
$DFDLT_5$	80.95	2.19	77.10	88.45	138
$DFDLT_6$	81.71	1.97	77.15	85.90	134
$DFDLT_7$	81.32	1.71	77.10	85.50	143
$DFDLT_8$	80.83	2.02	76.25	85.50	167
$DPKR_1$	81.58	1.73	77.50	86.67	221
$DPKR_2$	81.03	2.00	77.75	86.66	241
$DPKR_3$	81.07	1.96	76.25	85.90	303
$DPKR_4$	80.93	2.12	77.10	88.45	393
Non-Agreement Periods					
$DFDLT_1$	77.21	3.48	70.00	82.00	195
$DFDLT_2$	77.57	3.32	70.40	82.00	206
$DFDLT_3$	78.14	3.26	71.75	82.75	191
$DFDLT_4$	78.02	3 13	69.80	82.00	200
$DFDLT_5$	78.24	2.82	71.00	81.90	223

TABLE 7: CONTINUED

Variables	Mean	Standard Deviation	Minimum	Maximum	N
$DFDLT_6$	77.79	3.34	69.00	82.10	211
$DFDLT_7$	77.52	3.31	69.00	85.50	192
$DFDLT_8$	77.48	3.17	71.50	81.50	194
$DPKR_1$	77.79	3.22	71.10	81.90	301
$DPKR_2$	77.62	3.31	70.00	82.50	372
$DPKR_3$	77.59	3.32	69.00	82.15	447
$DPKR_4$	77.99	3.11	70.40	82.75	492

[a] Variable definitions are presented in table 5.

[b] Feedlot #2, Feedlot #5, and Packer #4 participated in the exclusive marketing/procurement agreements.

TABLE 8: DESCRIPTIVE STATISTICS FOR PARTICIPANT AND NON-PARTICIPANT PRICES DURING AGREEMENT AND NON-AGREEMENT PERIODS

Variables	Mean	Standard Deviation	Minimum	Maximum	N
Entire Marketing Period					
Participating Firms	79.00	3.12	70.40	88.45	1162
Non-Participating Firms	79.27	3.32	69	86.67	1608
Agreement Periods					
$DMAP_1$ [a]	80.93	2.12	77.10	88.45	393
$DMAP_2$	81.20	1.92	76.25	86.67	765
Non-Agreement Periods					
$DNMP_1$	78.01	3.09	70.40	82.75	769
$DNMP_2$	77.52	3.35	69.00	82.50	843

[a] Variable definitions and their respecive units of measure are presented in table 5.

TABLE 9: DESCRIPTIVE STATISTICS FOR PRICES DURING REWARD AND NON-REWARD PERIODS

Variables	Mean	Standard Deviation	Minimum	Maximum	N
Reward Periods					
$DRNR_1$	79.07	3.49	69.00	88.45	1368
Non-Reward Periods					
$DRNR_2$	79.24	2.97	69.00	84.92	1402

[a] Variable definitions and their respecive units of measure are presented in table 5.

TABLE 10: DESCRIPTIVE STATISTICS FOR RESIDUAL VARIANCE ESTIMATES CALCULATED FROM MODEL A

Variables	Mean	Standard Deviation	Minimum	Maximum	N
Entire Marketing Period					
Participating Firms	1.52	3.24	0.00[a]	26.75	1162
Non-Participating Firms	1.94	3.12	0.00	29.07	1608
Agreement Periods					
$DMAP_1$ [b]	1.45	2.90	0.00	29.07	393
$DMAP_2$	1.82	3.35	0.00	26.75	765
Non-Agreement Periods					
$DNMP_1$	1.56	3.41	0.00	26.75	769
$DNMP_2$	1.84	3.24	0.00	29.07	843

[a] Minimum residual estimates in this study are small positive numbers.

[b] Variable definitions and their respective units of measure are presented in table 5.

TABLE 11: HYPOTHESIS TEST FORMATS CONCERNING THE MEANS OF PRICES AND PROFITS

Steps	Process
Step 1	H_o : Mean of value i in period A[a] = Mean of value i in period B Where, i is one of the selected mean values in Table 1.
Step 2	H_a : Mean of value i in period A ≠ Mean of value i in period B
Step 3	Level of Significance 5% (α=0.05)
Step 4	Two tailed test under a normal probability distribution function.
Step 5	Calculate students t-statistic (t*). Where, $t^* = (x1 - x2) / \sqrt{(s12/n1 + s22/n2)}$ and $df = \dfrac{(s_1^2/n_1 + s_2^2/n_2)^2}{(s_1^2/n_1)^2/(n_1-1) + (s_2^2/n_2)^2/(n_2-1)}$.
Step 6	Conclusion derivation from the comparison of the critical t-value to t*.

[a] Period A includes agreement period and period B includes non-agreement periods

TABLE 12: HYPOTHESIS TEST FORMATS CONCERNING THE VARIANCE OF PRICES AND PROFITS

Steps	Process
Step 1	H_o : Variance of value i in period A[a] = Variance of value i in period B
Step 2	H_a : Variance of value i in period A ≠ Variance of value i in period B
Step 3	Level of Significance 5% (α=0.05)
Step 4	Two tailed test under a normal F-distribution.
Step 5	Calculate the folded form of the F-statistic, the F ' statistic. Where, $F' = \left(\text{larger of } s_1^2,\ s_2^2\right) / \left(\text{smaller of } s_1^2, s_2^2\right)$
Step 6	Conclusion derivation from the comparison of the F ' value to the critical F value.

[a] Period A includes agreement periods and period B includes non-agreement periods

TABLE 13: ESTIMATED IMPACTS OF THE RELEVANT ECONOMIC VARIABLES ON FED CATTLE TRANSACTION PRICES

	Price Level Estimates	Price Variability Estimates
Explanatory Variable	Model A	Model B
Intercept	24.9020 *** [a]	3.1753[c] ***
	(3.866) [b]	(7.359)
BBP_{t-1}	0.3277 ***	0.0282 **
	(11.272)	(1.852)
$LCFMP_{t-1}$	0.2688 ***	-0.0401 **
	(3.881)	(-1.713)
TM_{t-1}	-0.0605 ***	-0.0689 ***
	(-2.752)	(-5.978)
TSL_{t-1}	-0.0498 ***	0.0433 ***
	(-4.304)	(8.786)
PPL_t	-0.1460 ***	-0.1884 ***
	(-3.392)	(-7.971)
$DFDLT_1$	Base	Base
$DFDLT_2$	0.0816	-1.0901 ***
	(0.904)	(-3.327)
$DFDLT_3$	0.4948 ***	-1.8381 ***
	(6.759)	(-7.196)
$DFDLT_4$	0.2452 ***	-1.5533 ***
	(2.916)	(-6.122)
$DFDLT_5$	0.3296 ***	-1.0498 ***
	(3.577)	(-3.211)
$DFDLT_6$	0.2904 ***	-1.1419 ***
	(3.710)	(-4.594)
$DFDLT_7$	0.2221 ***	-1.1254 ***
	(2.853)	(-4.457)
$DFDLT_8$	-0.0095	-1.7957 ***
	(-0.121)	(-7.119)
$DPKR_1$	Base	Base
$DPKR_2$	-0.3254 ***	0.4098 **
	(-6.462)	(2.112)
$DPKR_3$	-0.4801 ***	0.1343

TABLE 13: CONTINUED

Explanatory Variable	Price Level Estimates Model **A**	Price Variability Estimates Model **B**
	(-10.247)	(0.708)
$DPKR_4$	-0.0672	0.5609 **
	(-0.877)	(1.794)
$DMPA_1$	1.2656 ***	0.5375 ***
	(4.006)	(2.642)
$DMPA_2$	Base	Base
$DMAP_1$	-0.7059 ***	-0.8581 **
	(-6.201)	(-1.833)
$DMAP_2$	Base	Base
$DNMP_1$	-0.0292	-0.5291 *
	(-0.354)	(-1.593)
$DNMP_2$	Base	Base
$DRNR_1$	0.0373	0.5631 ***
	(0.163)	(4.559)
$DRNR_2$	Base	Base
N	2770	2770
Adjusted R^2	0.8423	0.0723
$F_{(19, 2750)}$ [d]	773.1942 ***	11.9052 ***

[a] Significance levels are denoted as follows:
*** significant @ the 1% level of significance,
** significant @ the 5% level of significance,
and * significant @ the 10% level of significance.

[b] All figures presented in parenthesis are the calculated t-statistics for each coefficient.

[c] All coefficient results of model **B** are reported as the exponential value of each coefficient.

[d] The F-statistic in this study was used in a hypothesis test which is structured as follows:

Null Hypothesis (H_o): The estimated coefficients in the respective model (**A** or **B**) are equal to zero.

Alternative Hypothesis (H_a): At least one of the estimated coefficients in the respective model (**A** or **B**) is significantly different from zero.

TABLE 14: ESTIMATED IMPACTS OF THE RELEVANT ECONOMIC VARIABLES ON THE WEEKLY MEAN OF FED CATTLE TRANSACTION PRICES

	Weekly Price Level Estimates
Explanatory Variable	Model C
Intercept	48.4350 *** [a]
	(5.138) [b]
BBP_{t-1}	0.2218 ***
	(7.655)
$LCFMP_{t-1}$	0.1624 *
	(1.758)
TM_{t-1}	-0.0275
	(-1.130)
TSL_{t-1}	-0.0781 ***
	(-4.340)
PPL_t	-0.0371
	(-0.550)
$DMPA_1$	0.7236
	(1.636)
$DMPA_2$	Base
$DRNR_1$	-0.1781
	(-0.645)
$DRNR_2$	Base
N	75
Adjusted R^2	0.9192
$F_{[7, 67]}$ [c]	108.8740 ***

[a] Significance levels are denoted as follows:
*** significant @ the 1% level of significance,
** significant @ the 5% level of significance,
and * significant @ the 10% level of significance.

[b] All figures presented in parenthesis are the calculated t-statistics for each coefficient.

[c] The F-statistic in this study was used in a hypothesis test which is structured as found in table 12 except with respect to model C.

TABLE 15: ESTIMATED IMPACTS OF AGREEMENT AND REWARD VARIABLES ON FED CATTLE TRANSACTION PRICES ACROSS ALTERNATIVE MODELS OF ROBUSTNESS ANALYSIS

	Explanatory Variable of Interest				
Alternative Models	$DMPA_t$[a]	$DMAP_t$	$DNMP_t$	$DRNR_t$	Adjusted R^2
Transaction Models					
A1-1[b]	1.2656***[c]	-0.7059***	-0.0292	0.0373	0.8423
	(4.006)[d]	(-6.201)	(-0.354)	(0.163)	
A1-2	0.9234***	-0.6250***	0.0718	-0.1997	0.8536
	(2.849)	(-4.747)	(0.741)	(-0.825)	
A1-3	3.3286***	-0.9171***	-0.2289	-0.2377	0.7717
	(3.892)	(-4.010)	(-1.552)	(-0.782)	
A2-1	1.0531***	-0.6671***	-0.0218	0.1038	0.8327
	(3.334)	(-5.454)	(-0.242)	(0.446)	
A2-2	0.4386	-0.7610***	-0.0246	-0.1859	0.8215
	(1.371)	(-4.809)	(-0.228)	(-0.739)	
A2-3	2.7290***	-0.7913***	-0.1155**	0.1922	0.7394
	(6.162)	(-9.732)	(-2.182)	(0.493)	
A3-1	1.1065***	-0.6889***	-0.0116	0.0780	0.8202
	(3.482)	(-5.527)	(-0.013)	(0.332)	
A3-2	0.43217	-0.7987***	-0.0605	-0.2284	0.8191
	(1.276)	(-5.262)	(-0.582)	(-0.845)	
A3-3	2.7704***	-0.8542***	-0.1788***	0.1782	0.7289
	(6.252)	(-9.002)	(-2.874)	(0.456)	
A4-1	1.8077***	-0.9425***	-0.2380**	0.2718	0.7937
	(5.275)	(-7.079)	(-2.488)	(-0.995)	
A4-2	1.1112**	-0.7732***	-0.1168	-0.2058	0.6759
	(2.444)	(-4.677)	(-1.028)	(-0.560)	
A4-3	3.5450***	-0.8856***	-02343***	0.3881	0.6810
	(8.556)	(-11.923)	(-4.863)	(0.933)	

TABLE 15: CONTINUED

Alternative Models	Explanatory Variable of Interest				Adjusted R^2
	$DMPA_t$	$DMAP_t$	$DNMP_t$	$DRNR_t$	
Weekly Models					
C1-1	0.7236	N/A[c]	N/A	-0.1781	0.9192
	(1.636)			(-0.645)	
C1-2	0.4885			-0.2330	0.9214
	(1.057)			(-0.895)	
C1-3	0.4423			0.4423	0.9019
	(-1.130)			(-0.780)	
C2-1	0.6404			-0.1670	0.9190
	(1.492)			(-0.612)	
C2-2	0.4747			-0.2294	0.9197
	(1.044)			(-0.875)	
C2-3	0.5694			-0.0887	0.8678
	(0.956)			(-0.269)	
C3-1	0.6261			-0.1695	0.9187
	(1.425)			(-0.627)	
C3-2	0.4359			-0.2061	0.9204
	(0.962)			(-0.804)	
C3-3	0.7004			-0.1521	0.8589
	(1.159)			(-0.446)	
C4-1	0.3538			-0.0491	0.9123
	(0.739)			(-0.187)	
C4-2	0.3431			-0.0610	0.9125
	(0.723)			(-0.237)	
C4-3	0.6189			-0.0595	0.8561
	(1.021)			(-0.179)	

[a] Variable definitions and base specifications can be found in table 5.
[b] Each model considered in the robustness analysis is specified in Appendix E.
[c] Significance levels are denoted as follows:
*** significant @ the 1% level of significance,
** significant @ the 5% level of significance,
and * significant @ the 10% level of significance.
[d] All figures presented in parenthesis are the calculated t-statistics for each coefficient.
[e] Participant and Non-Participant prices were not considered in weekly models.

TABLE 16: MEAN AND VARIANCE HYPOTHESIS TEST RESULTS

Value Considered	Mean	Std. Deviation	Calculate *t*-statistic	Folded F-statistic
Prices				
Participant Prices in Period A [a]	80.93	2.12	-18.908 *** [b]	2.13 ***
Participant Prices in Period B	78.01	3.09	(1066) [c]	(768,392)
Non-Participant Prices in Period A	81.20	1.92	-27.347 ***	3.03 ***
Non-Participant Prices in Period B	77.52	3.35	(1366)	(842,764)
Participant Prices in Period A	80.93	2.12	2.129 **	1.21 **
Non-Participant Prices in Period A	81.20	1.92	(728)	(392,764)
Participant Prices in Period B	78.01	3.094	-1.350	0.98
Non-Participant Prices in Period B	77.52	3.349	(1610)	(842,768)
Profits				
Participant Profits in Period A	6838.31	186465.80	0.974	1.72 ***
Participant Profits in Period B	20715.08	237646.09	(222)	(128,95)
Non-Participant Profits in Period A	771.22	237497.29	0.327	1.04
Non-Participant Profits in Period B	7797.84	279404.45	(625)	(386,287)

TABLE 16: CONTINUED

Value Considered	Mean	Std. Deviation	Calculate *t*-statistic	Folded F-statistic
Profits				
Participant Profits in Period A	6838.31	186465.80	0.305	2.15 ***
Non-Participant Profits in Period A	771.22	237497.29	(239)	(287,95)
Participant Profits in Period B	20715.08	237646.09	-0.511	1.38 **
Non-Participant Profits in Period B	7797.84	279404.45	(255)	(386,128)
Reward vs. Non-Reward Prices				
Reward Periods	79.07	3.493	1.466	1.38 ***
Non-Reward Periods	79.25	2.973	(2677)	(1367,1401)

[a] Agreement periods are Period A and Non-Agreement periods are Period B.

[b] Significance levels are denoted as follows:
*** significant @ the 1% level of significance,
** significant @ the 5% level of significance,
and * significant @ the 10% level of significance.

[c] Calculated degrees of freedom (df) are reported in parenthesis for both *t** and F '.

TABLE 17: DESCRIPTIVE STATISTICS FOR FIRM PROFITS DURING AGREEMENT AND NON-AGREEMENT PERIODS

Variables	Mean	Standard Deviation	Minimum	Maximum	N
Agreement Periods					
Industry	-0.32 [a]	134.34	-449.38	267.22	34
Feedlots	-3.08	68.39	-179.28	110.61	34
Meatpackers	2.67	168.89	-559.99	443.39	34
$DFDLT_1$ [b]	47442.26	268275.94	445270.00	573432.00	34
$DFDLT_2$ [c]	20859.74	235688.67	-445800.00	789663.00	34
$DFDLT_3$	-28347.03	251550.70	-413934.00	436394.00	34
$DFDLT_4$	-64877.74	234221.93	-438380.00	629082.00	34
$DFDLT_5$	-54025.24	149634.87	-346584.00	263454.00	34
$DFDLT_6$	-26056.94	147797.48	-283890.00	340172.00	34
$DFDLT_7$	20301.44	234184.46	-351521.00	611089.00	34
$DFDLT_8$	87609.15	287682.69	-462786.00	790450.00	34
$DPKR_1$	31692.40	287682.69	-462786.00	790450.00	34
$DPKR_2$	45162.15	344389.15	-985320.00	830420.00	34
$DPKR_3$	-81636.22	324609.65	-110088.00	102015.00	34
$DPKR_4$	85268.21	164709.62	-399456.00	508060.00	34
Non-Agreement Periods					
Industry	21.71	125.77	-279.44	291.44	41
Feedlots	11.37	67.52	-118.83	138.38	41
Meatpackers	10.35	164.88	-342.42	410.28	41

Table 17: Continued

Variables	Mean	Standard Deviation	Minimum	Maximum	N
$DFDLT_1$	16052.20	206434.16	-433880.00	421880.00	41
$DFDLT_2$	-2847.61	192955.87	-446255.00	387306.00	41
$DFDLT_3$	35952.88	274690.19	-464775.00	119827.00	41
$DFDLT_4$	40674.05	266439.42	-580950.00	749474.00	41
$DFDLT_5$	51229.17	187961.75	-397380.00	399698.00	41
$DFDLT_6$	45222.24	200652.55	-372513.00	514339.00	41
$DFDLT_7$	-11485.07	234478.51	-594815.00	664678.00	41
$DFDLT_8$	-68946.54	254325.63	-596493.00	472647.00	41
$DPKR_1$	-12323.76	363741.12	-770421.00	841868.00	41
$DPKR_2$	11764.76	156277.83	-351729.00	387770.00	41
$DPKR_3$	24698.80	458890.22	-105899.00	104639.00	41
$DPKR_4$	21215.56	315404.51	-932332.00	770452.00	41

[a] Industry and firm profits are reported as weekly profits ($/1000).

[b] Variable definitions are presented in table 5.

[c] Feedlot #2, Feedlot #5, and Packer #4 participated in the exclusive marketing/procurement agreements.

FIGURE 1: GRAPHICAL DEPICTION OF EXPERIMENTAL DESIGN

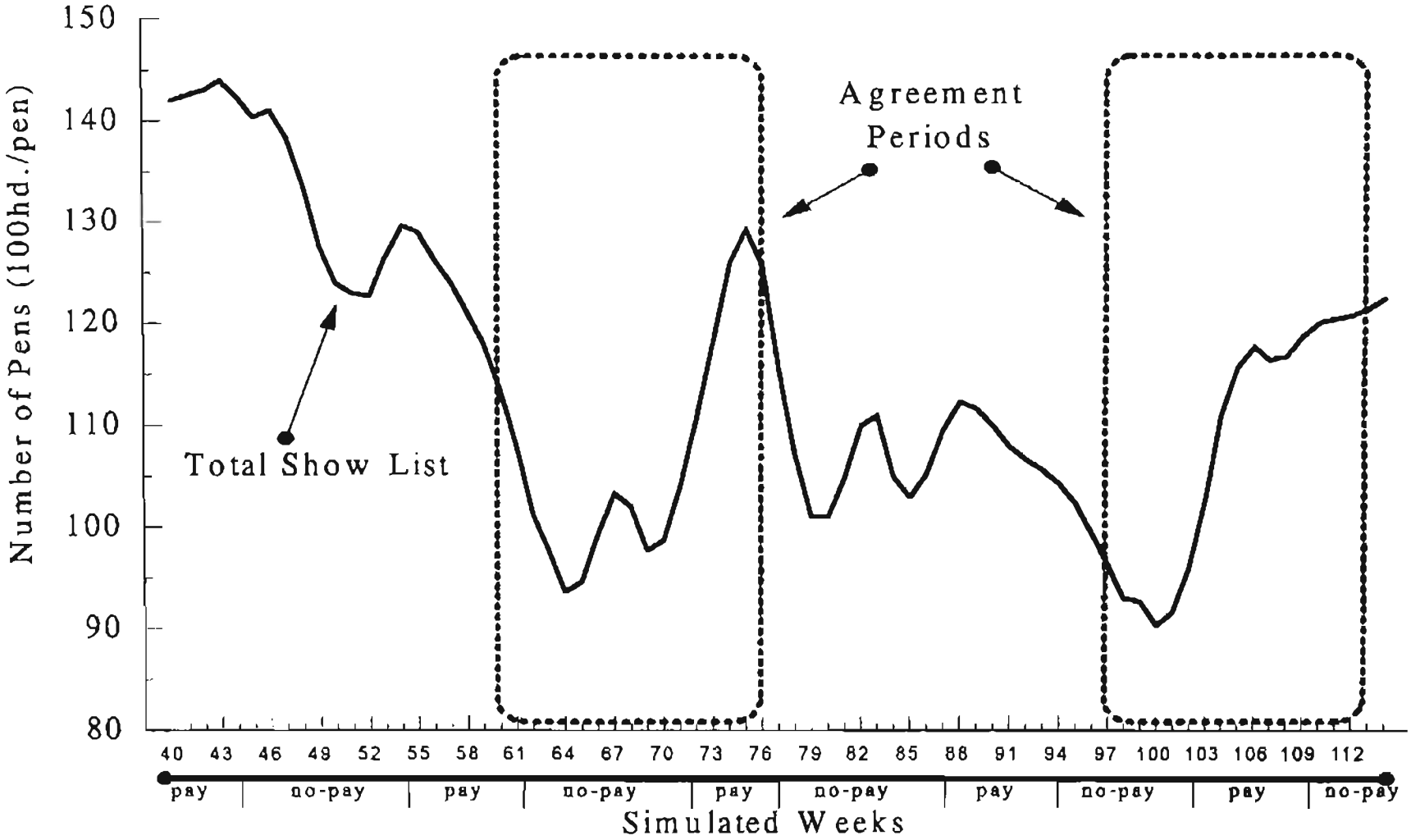


FIGURE 2: A COMPARISON OF LAGGED BOXED BEEF PRICES (BBP_{t-1}) TO THE WEEKLY MEAN OF TRANSACTION PRICES ($AVGPRC_t$) THROUGHOUT THE ENTIRE EXPERIMENTAL PERIOD

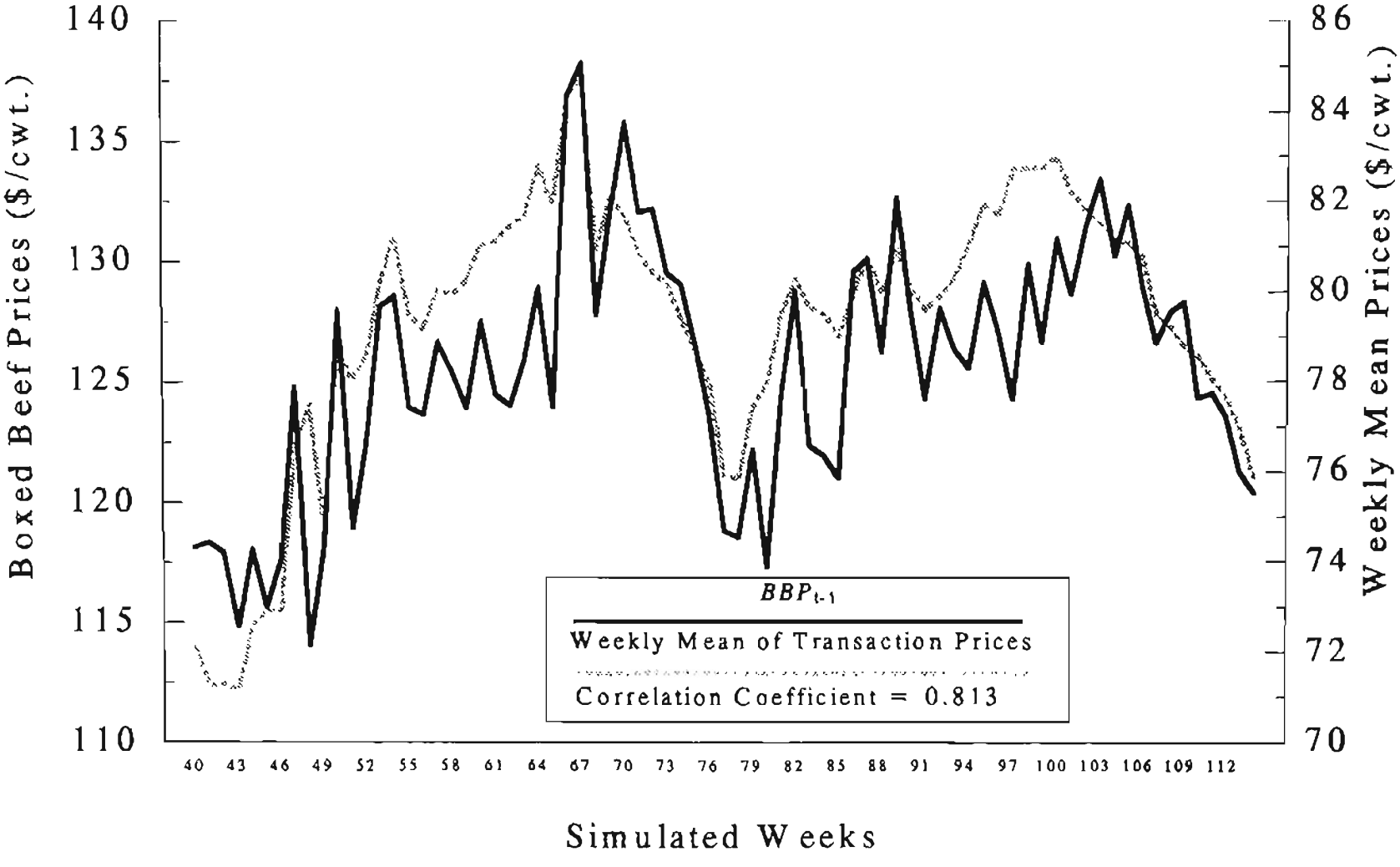


FIGURE 3: A COMPARISON OF LAGGED LIVE CATTLE FUTURES MARKET PRICES ($LCFMPP_{t-1}$) TO THE WEEKLY MEAN OF TRANSACTION PRICES ($AVGPRC_t$) THROUGHOUT THE ENTIRE EXPERIMENTAL PERIOD

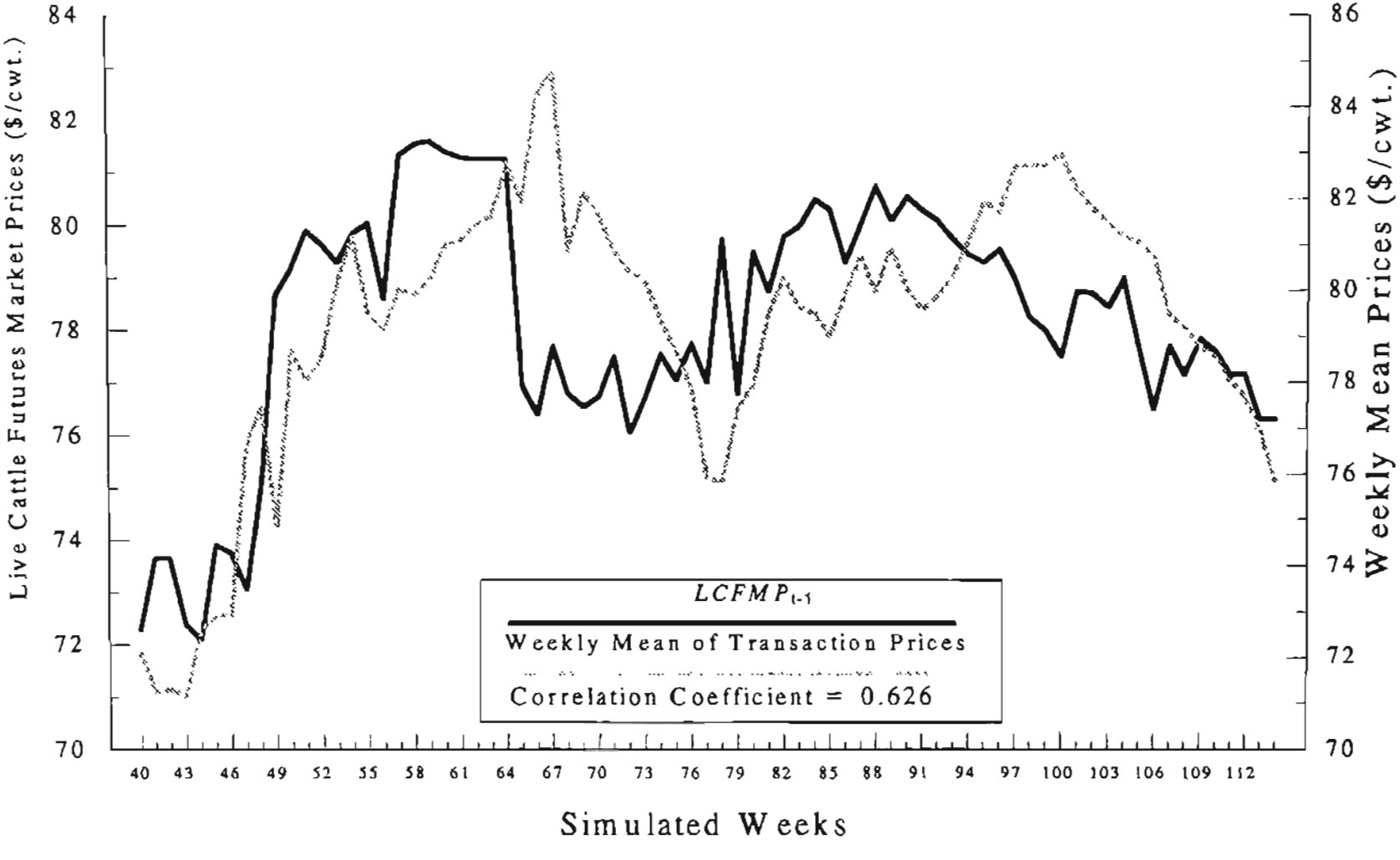


FIGURE 4: LAGGED TOTAL SHOWLIST (TSL_{t-1}) THROUGHOUT THE ENTIRE EXPERIMENTAL PERIOD

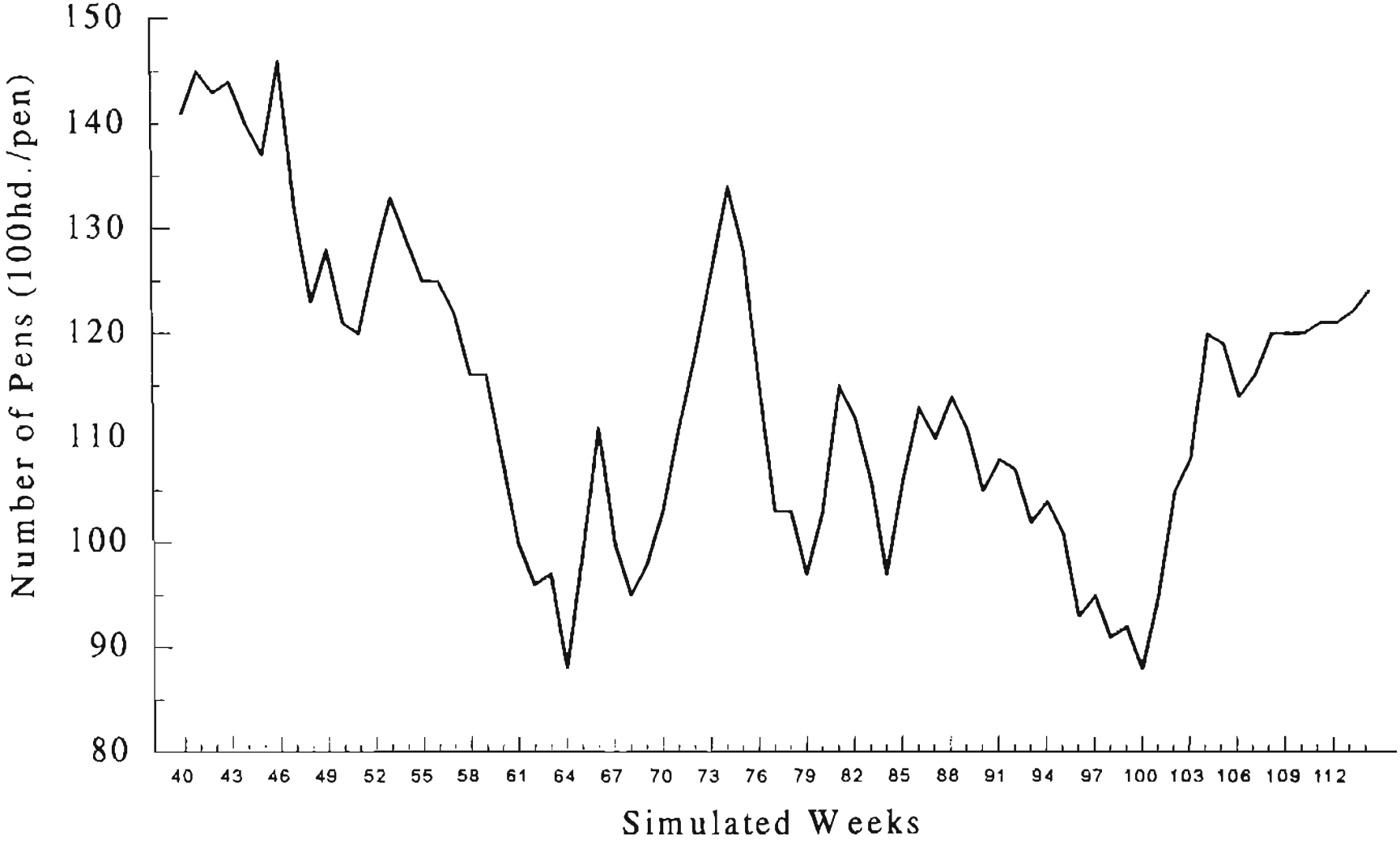


FIGURE 5: A COMPARISON OF LAGGED TOTAL SHOW LIST (TSL_{t-1}) TO LAGGED TOTAL MARKETINGS (TM_{t-1}) THROUGHOUT THE ENTIRE EXPERIMENTAL PERIOD

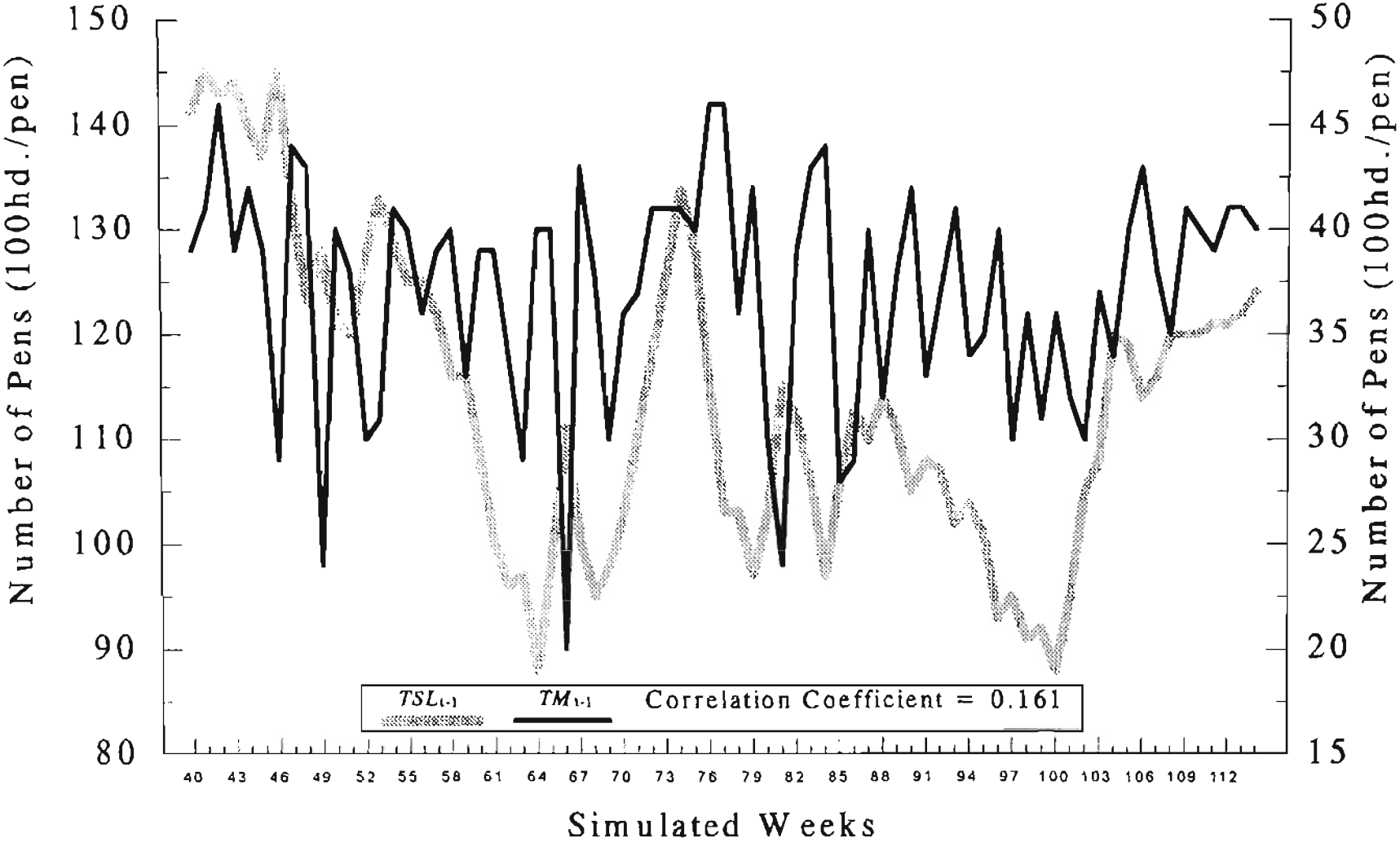


FIGURE 6: LAGGED TOTAL MARKETINGS ($TM_{(-1)}$) THROUGHOUT THE ENTIRE EXPERIMENTAL PERIOD

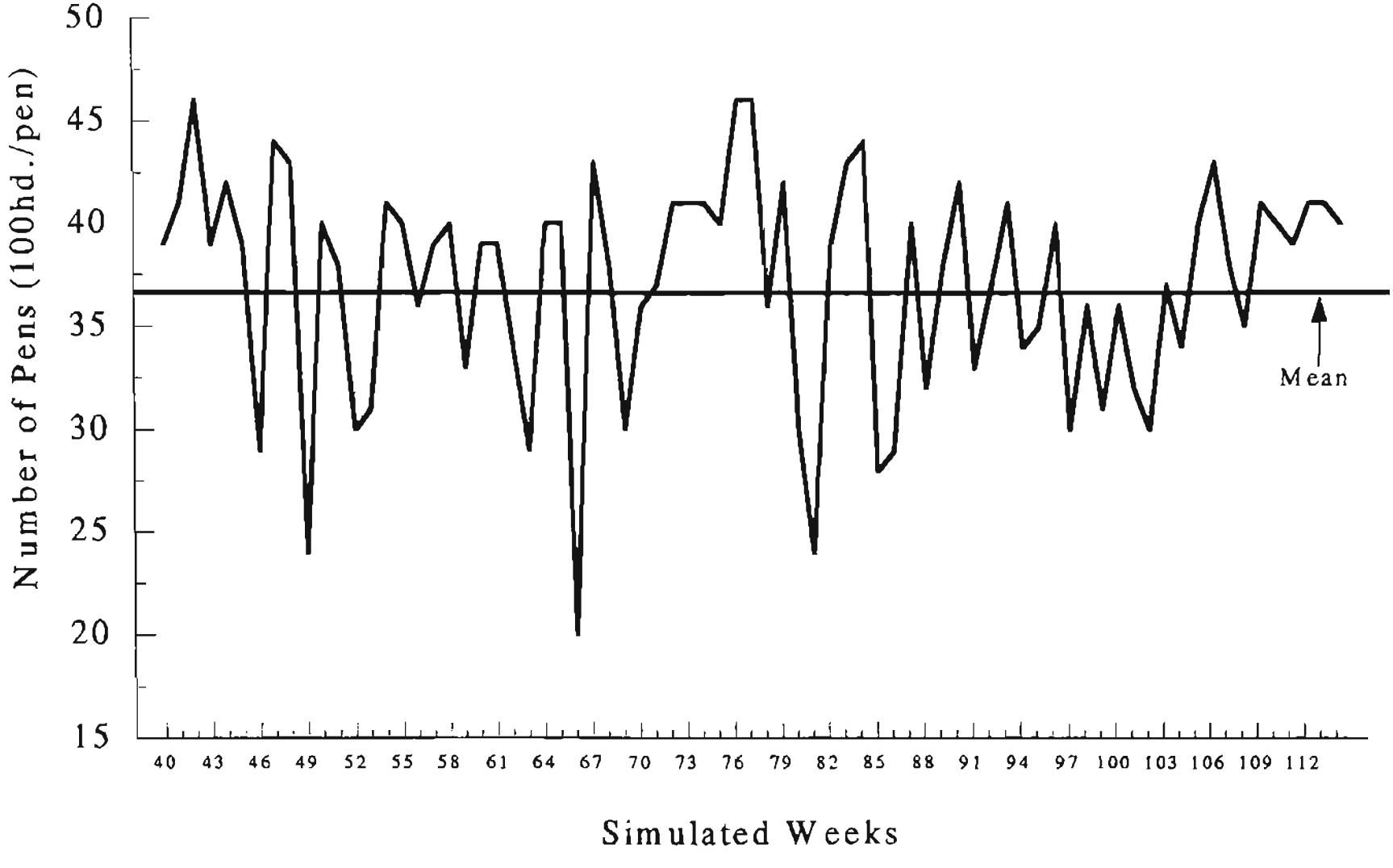


FIGURE 7: POTENTIAL PROFIT/LOSS (PPL_t) THROUGHOUT THE ENTIRE EXPERIMENTAL PERIOD

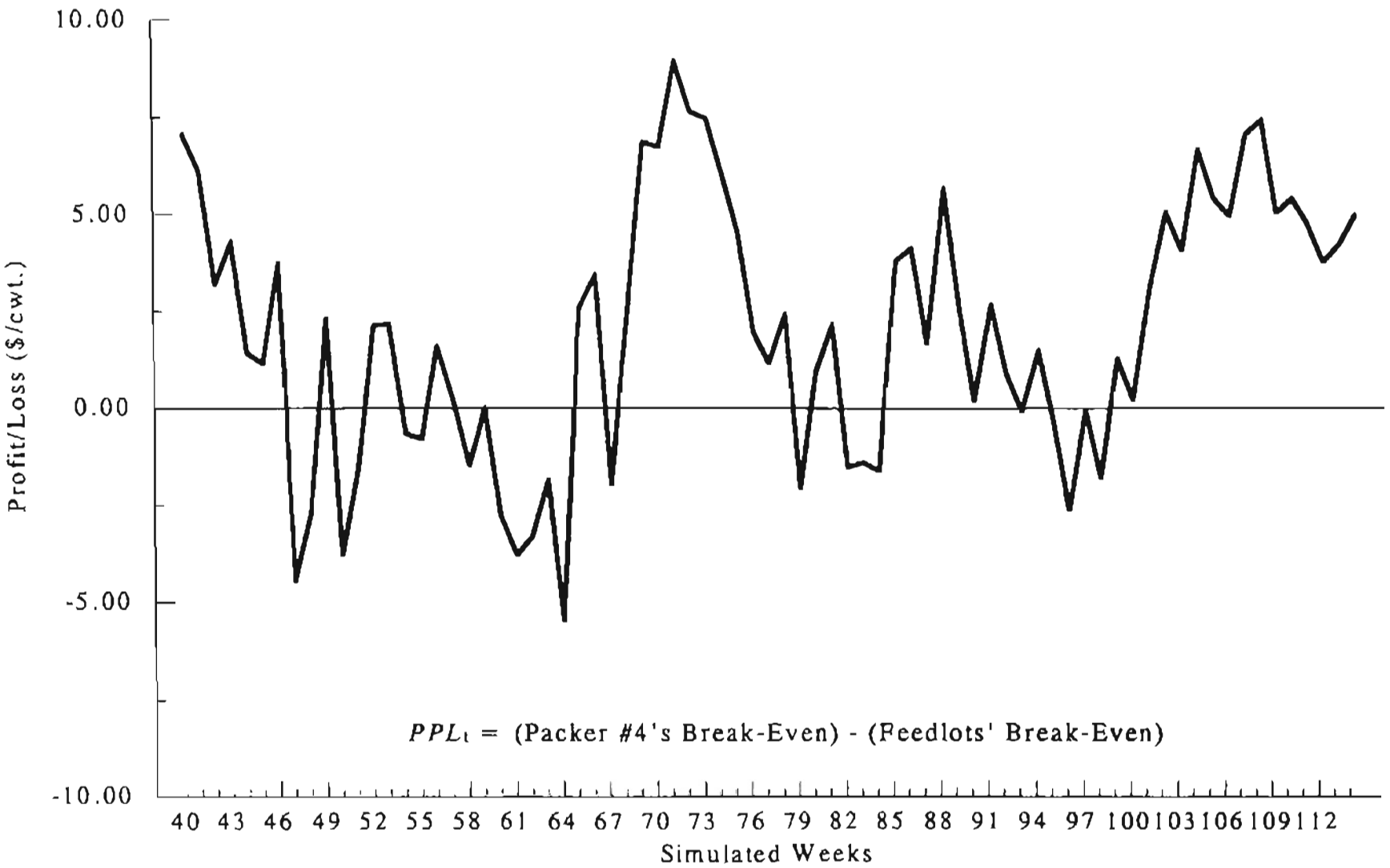


FIGURE 8: MEAN PRICES BY FEEDLOT FIRM DURING AGREEMENT AND NON-AGREEMENT PERIODS

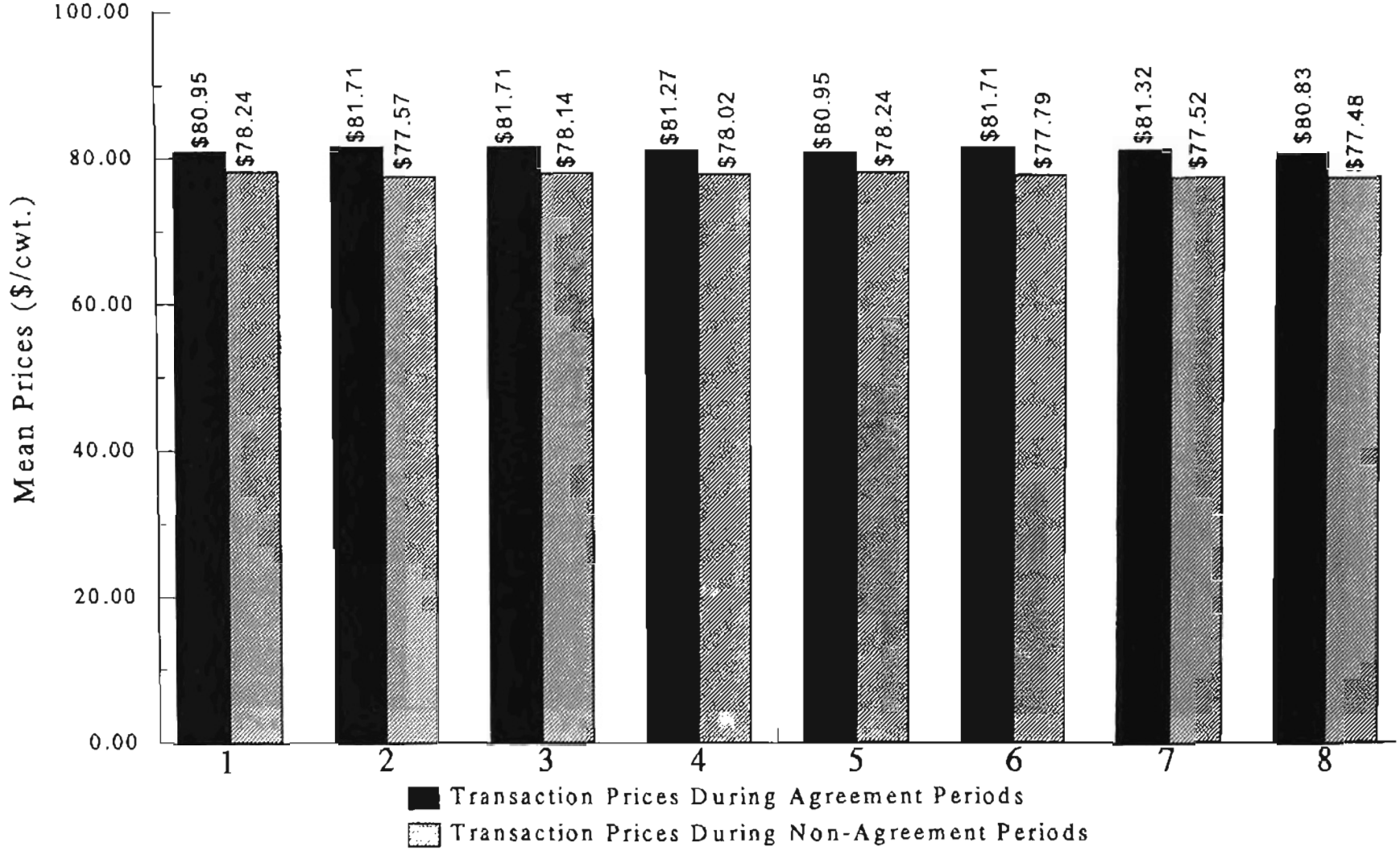


FIGURE 9: MEAN PRICES BY MEATPACKING FIRM DURING AGREEMENT AND NON-AGREEMENT PERIODS

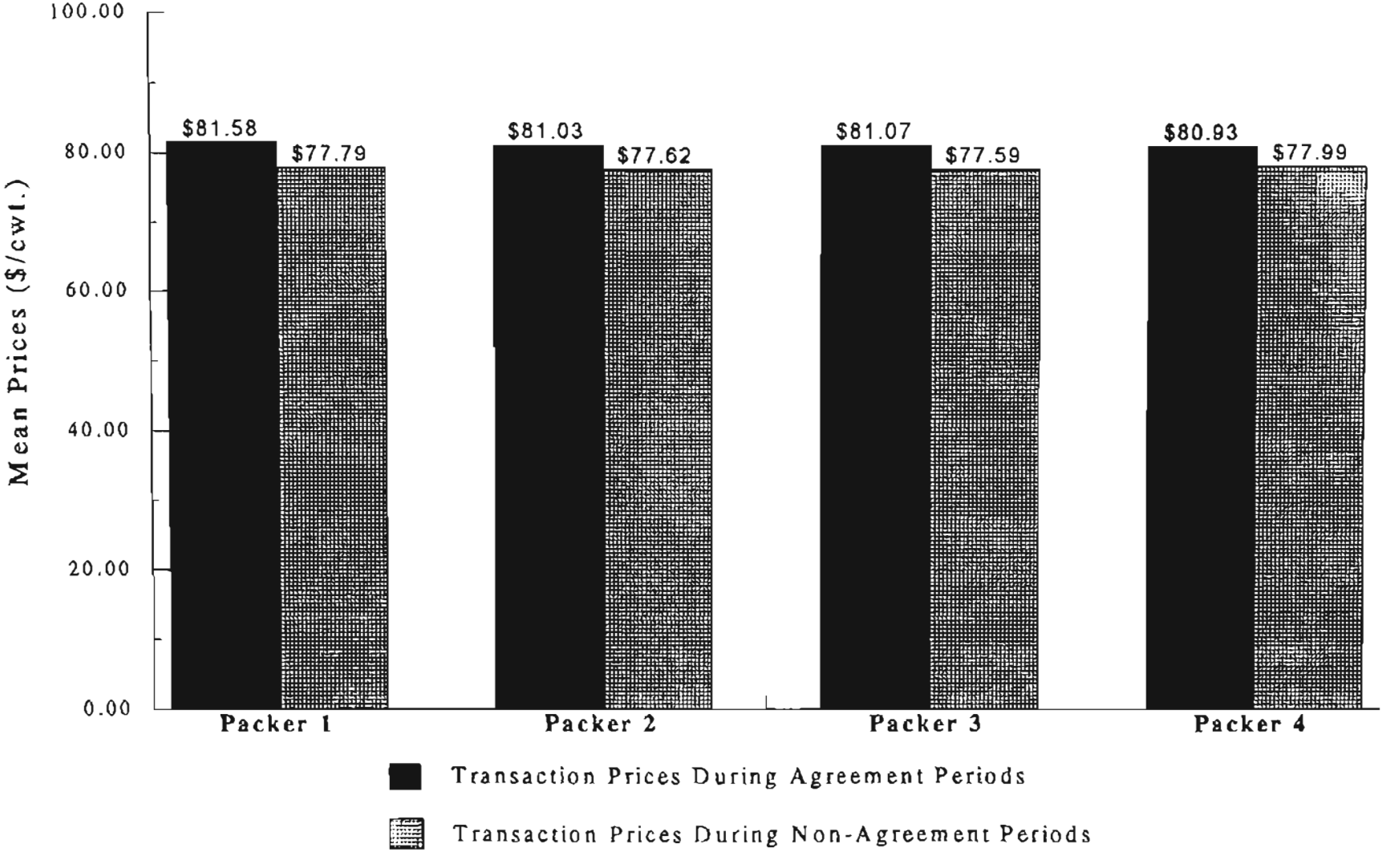


FIGURE 10: PARTICIPANT PRICES DURING AGREEMENT PERIODS

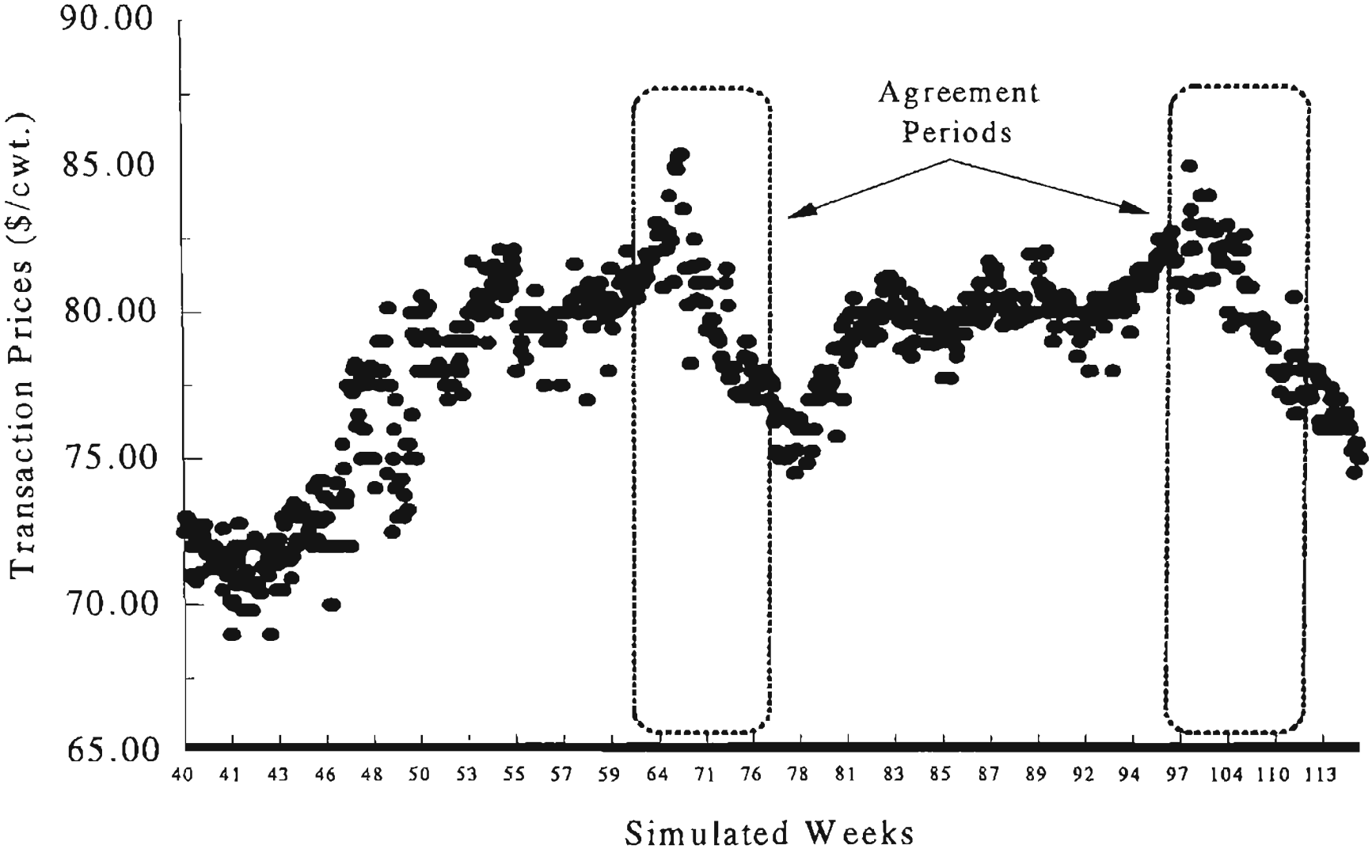


FIGURE 11: NON-PARTICIPANT PRICES DURING AGREEMENT PERIODS

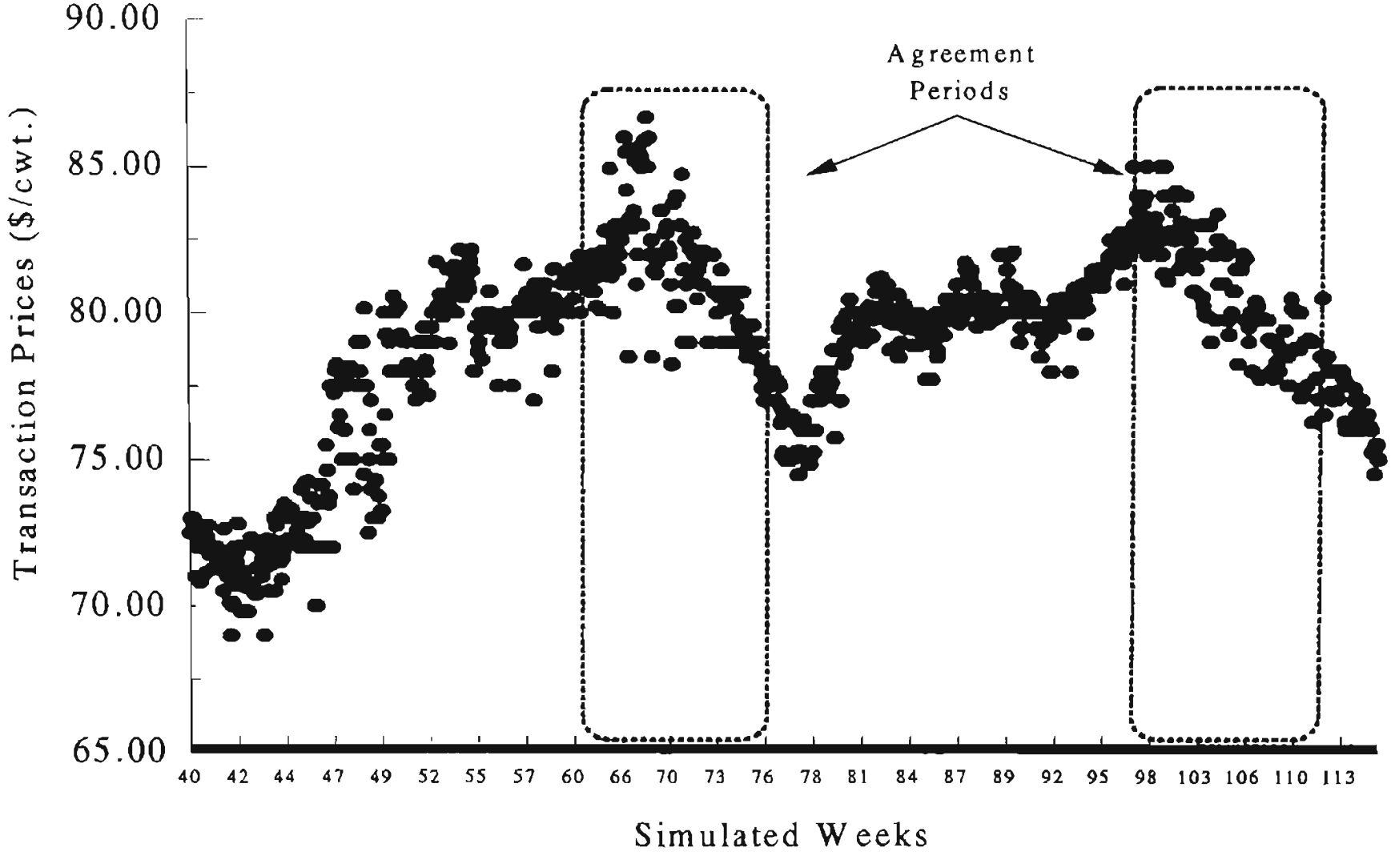


FIGURE 12: PARTICIPANT VARIANCE ESTIMATES DURING AGREEMENT PERIODS

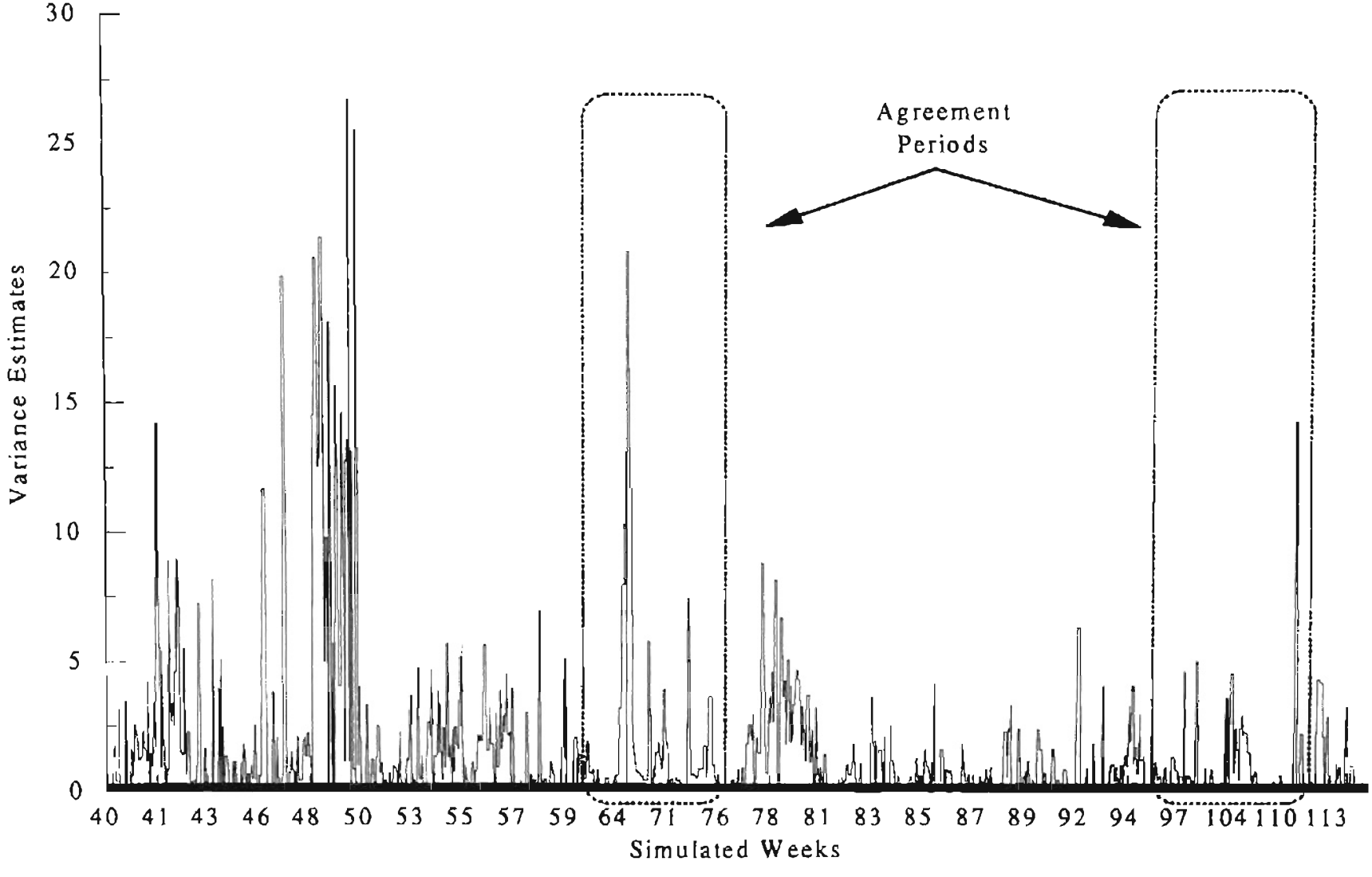


FIGURE 13: NON-PARTICIPANT VARIANCE ESTIMATES DURING AGREEMENT PERIODS

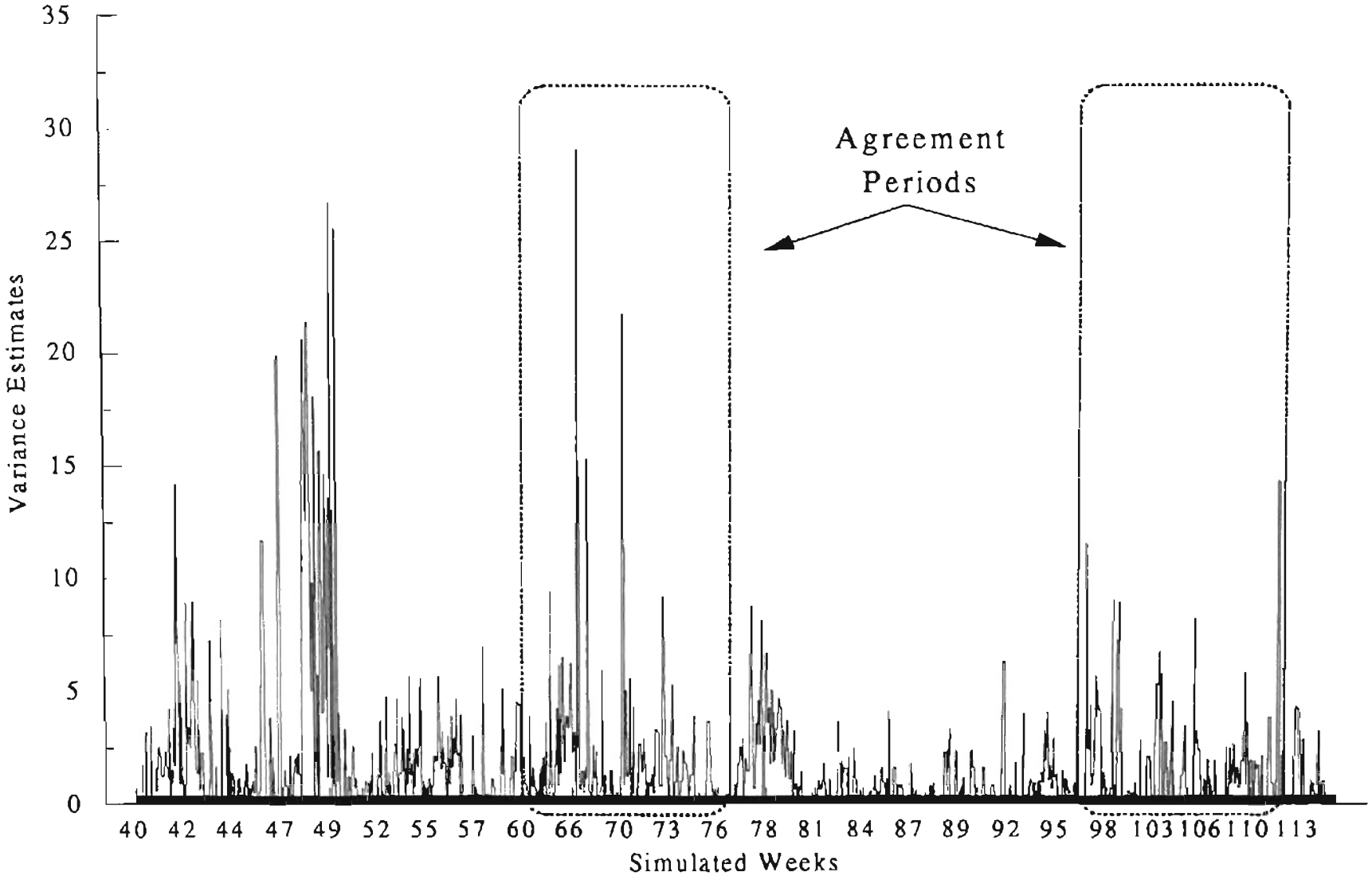


FIGURE 14: A COMPARISON OF FEEDLOT PROFITS TO INDUSTRY PROFITS THROUGHOUT THE ENTIRE EXPERIMENTAL PERIOD

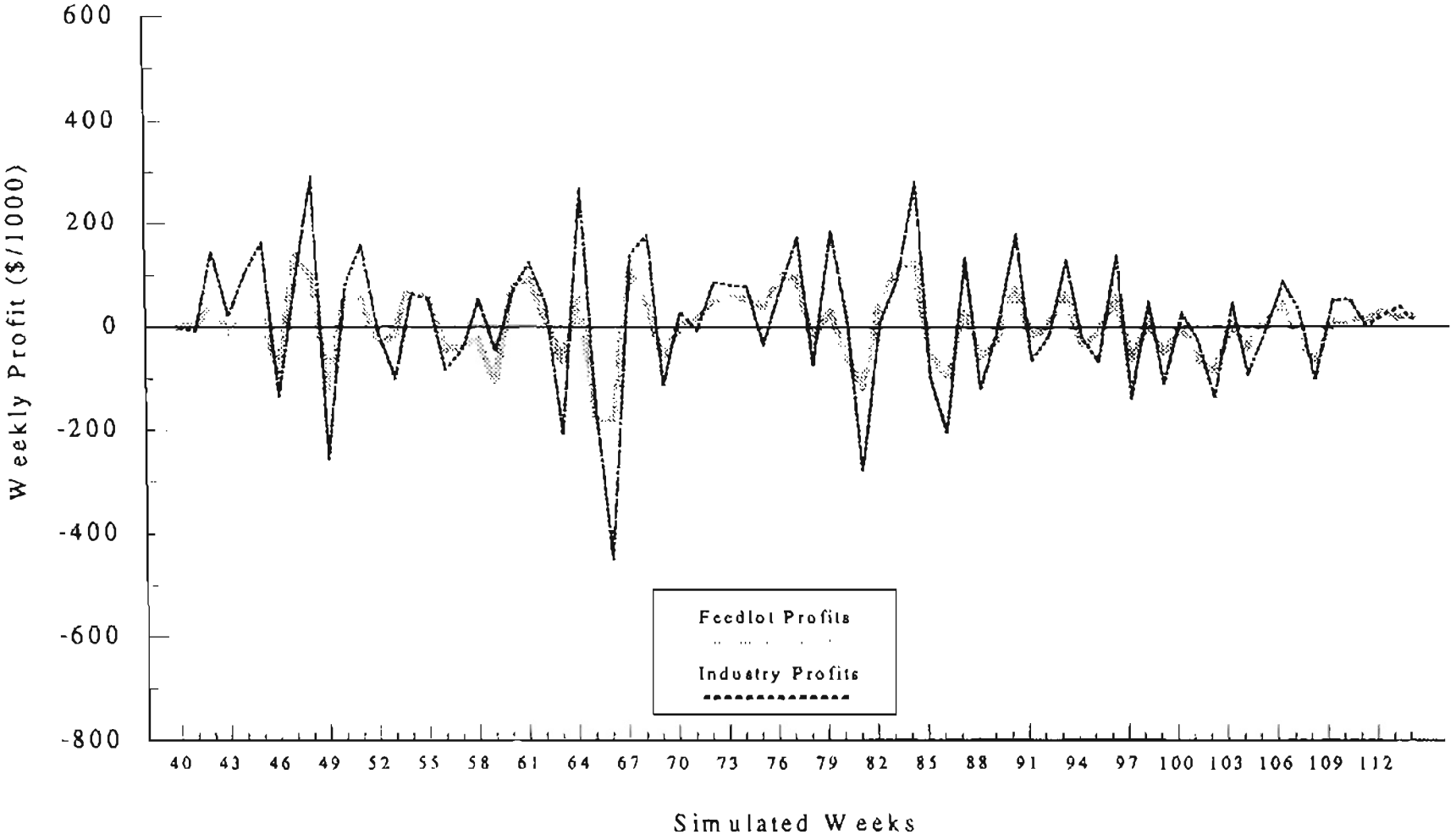


FIGURE 15: A COMPARISON OF MEATPACKER PROFITS TO INDUSTRY PROFITS THROUGHOUT THE ENTIRE EXPERIMENTAL PERIOD

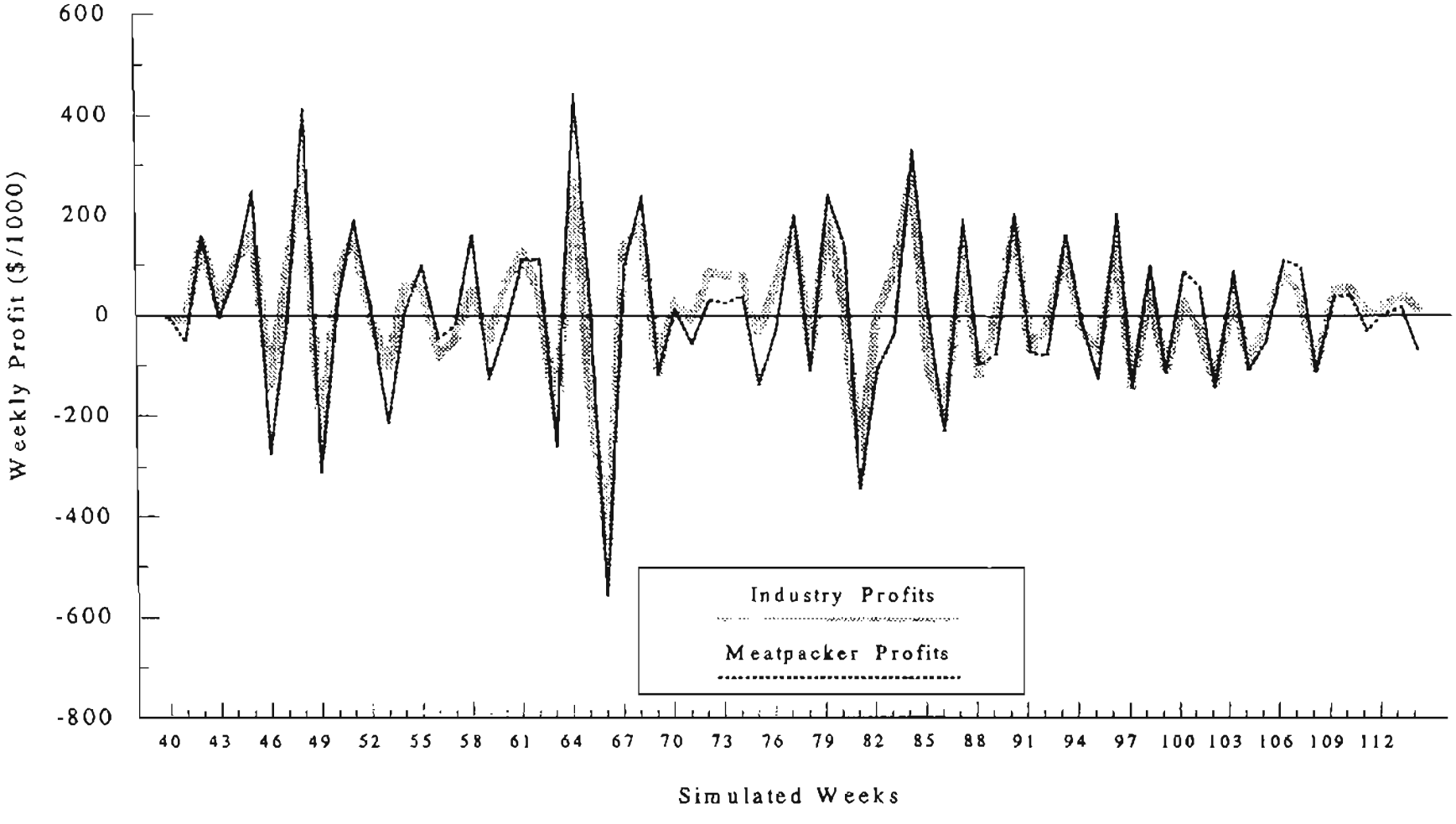
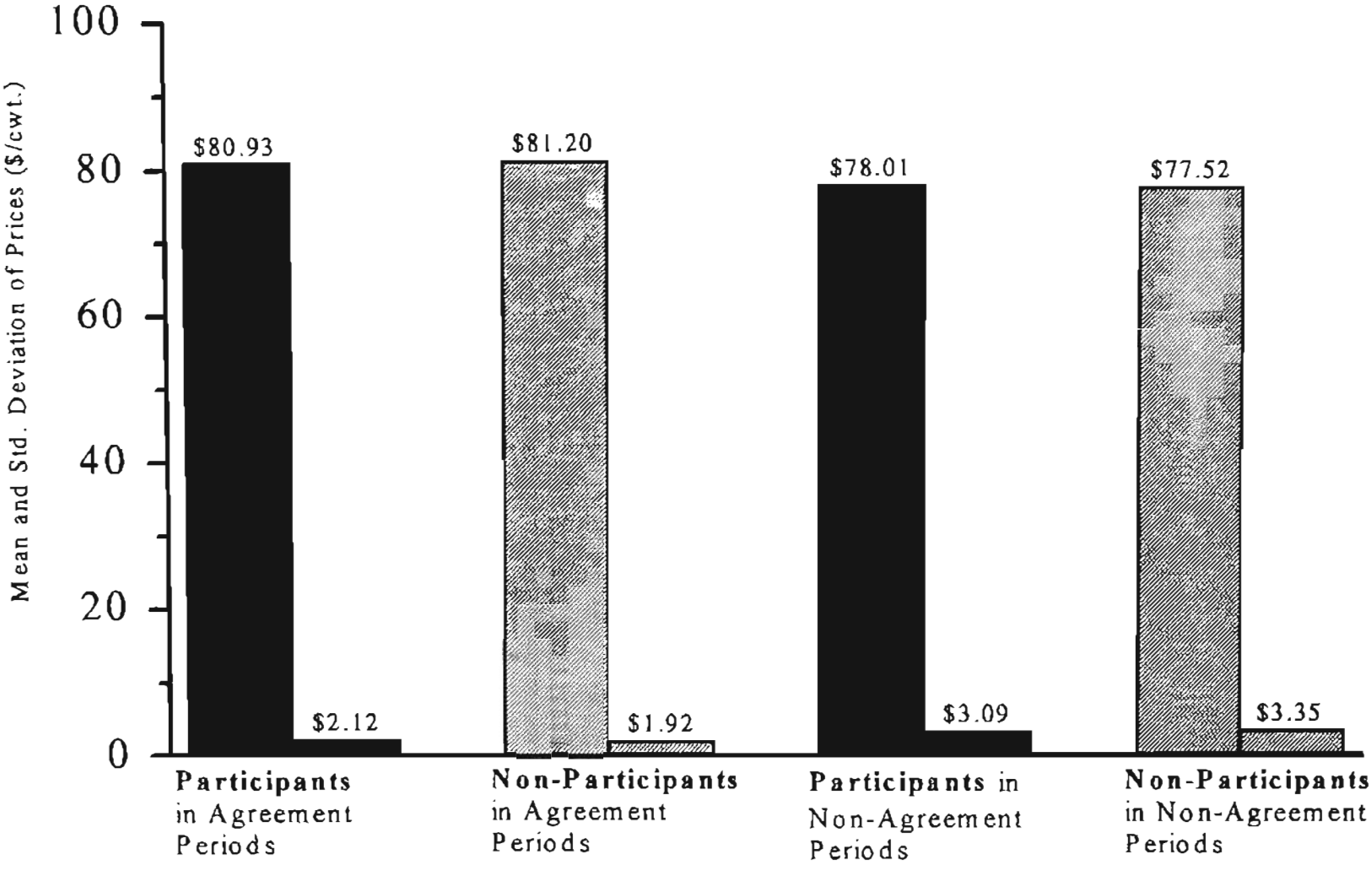
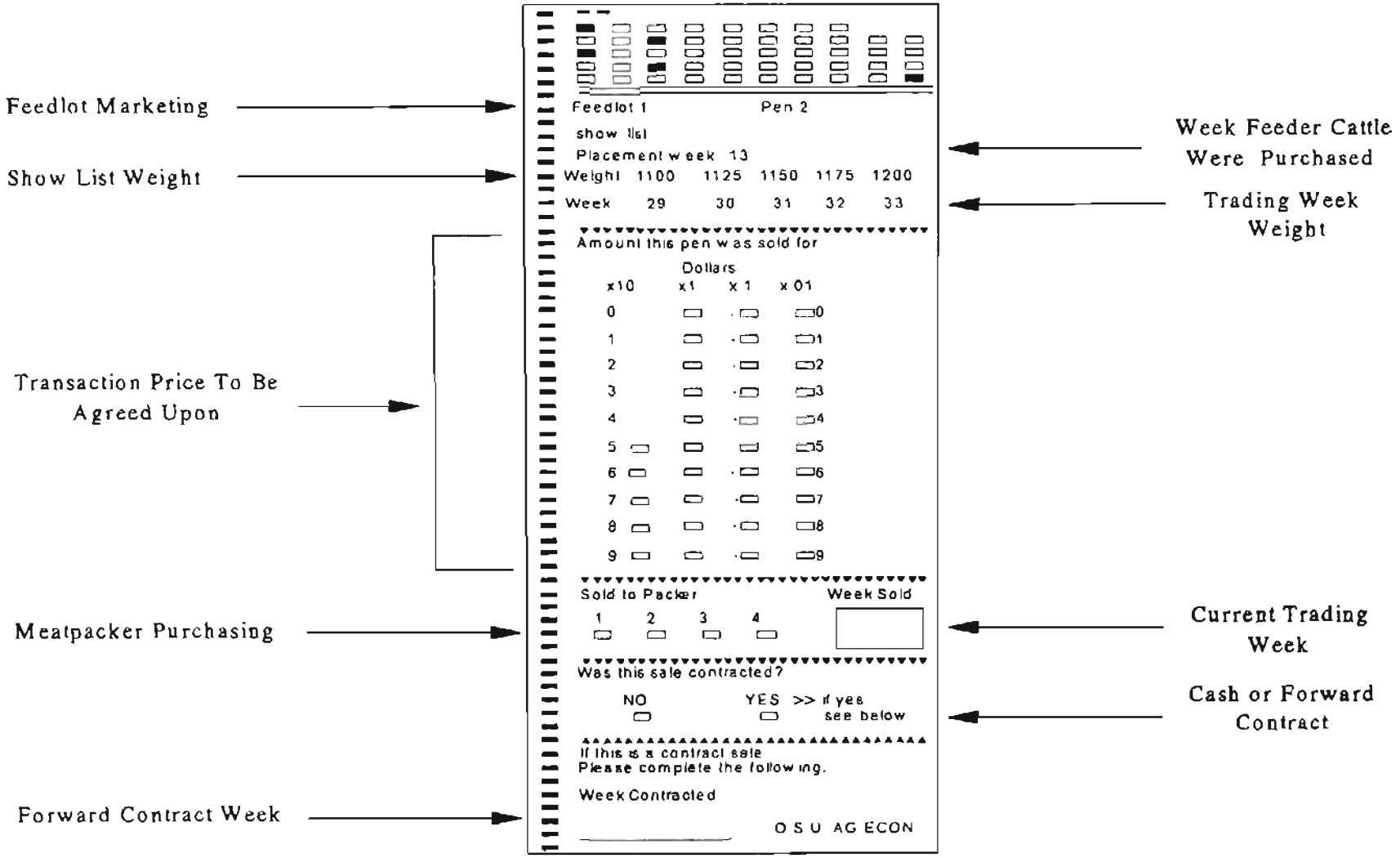


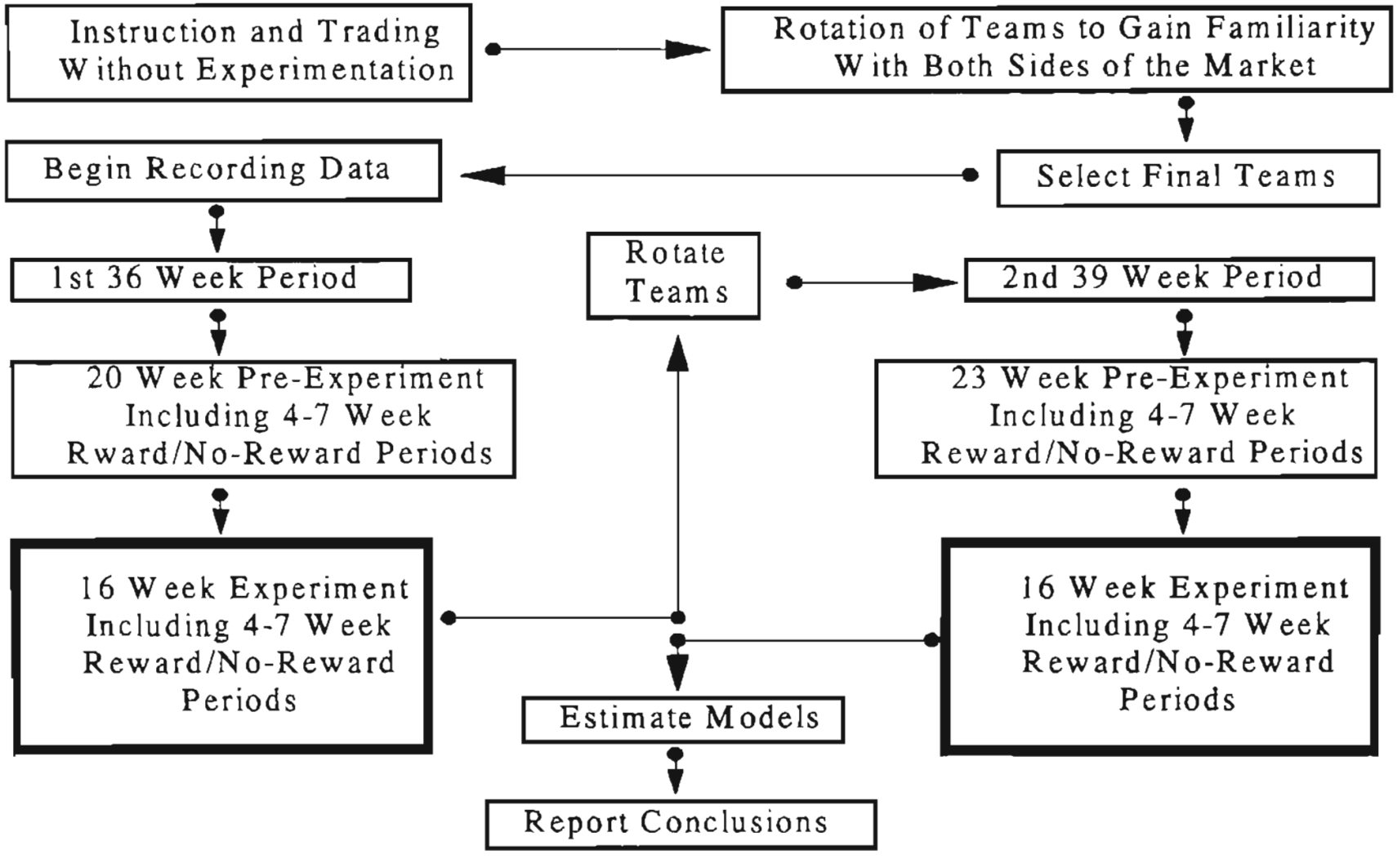
FIGURE 16: MEAN AND STANDARD DEVIATION OF PRICES FOR PARTICIPANTS AND NON-PARTICIPANTS



APPENDIX A: FCMS TRANSACTION CARD



APPENDIX B: OVERVIEW OF PROCEDURES



APPENDIX C: FCMS END OF WEEK FINANCIAL STATEMENTS

PACKER #4 -- WEEKLY FINANCIAL SUMMARY WEEK 94 O.S.U. AG Economics

CASH RECEIPTS AND EXPENDITURES

Receipts From Sale of Boxed Beef $ 1195872

Transaction summary

Weight	Adj. BB Price	Gross Rev.	Profit/Head	Trans. #
1125	125.30	97664	11.73	80922
1150	125.43	100652	21.54	80914
1125	125.30	97664	11.73	80924
1125	125.30	97664	11.73	80923
1125	125.30	97664	11.73	80921
1150	125.43	100652	14.07	70912
1150	125.43	100652	14.07	70911
1150	125.43	100652	14.07	70913
1150	125.43	100652	15.79	50911
1150	125.43	100652	15.79	50912
1150	125.43	100652	15.79	50913
1150	125.43	100652	15.79	50914
Avg.	Avg.	Avg.	Profit/Unit	
1141	125.39	99656	14.49	

Expenditures $1669927

Slaughter Cattle Purchased ..... $ 1595407

Feedlot	Weight	Price	Gross Cost	Trans.#
4	1175	81.00	95175	40914
4	1175	81.00	95175	40912
4	1175	81.00	95175	40913
4	1175	81.00	95175	40915
4	1175	81.00	95175	40911
7	1150	82.10	94415	70923
7	1150	82.10	94415	70922
7	1150	82.10	94415	70921
1	1150	81.00	93150	10923
6	1150	81.25	93438	60924
6	1150	81.25	93438	60925
6	1150	81.25	93438	90923
1	1150	81.00	93150	10922
1	1150	81.00	93150	10924
1	1150	81.00	93150	10921
8	1125	81.50	91688	80931
8	1125	81.50	91688	80932

Processing Cost ..... $ 74520

# Pens	Cost/Pen
12	3210

Receipts Minus Expenditures $ - 74056

Interest Income (Expense) $ - 1713

Net change in Cash Position $ -475768

BALANCE SHEET

Total Assets		$ 5195407
Cash Reserves	$ 0	
Cattle in Process (Purchase Value)	$ 1595407	
Total Liabilities		$ 1297787
Loans Payable	$ 1297787	
Net Worth		$ 297620
Maximum Credit Line Available (50% of Assets)		$ 148810
Residual Credit Available		$ -1148977

FEEDLOT #4 -- WEEKLY FINANCIAL SUMMARY WEEK 94 O.S.U. AG Economics

CASH RECEIPTS AND EXPENDITURES

Receipts From Sale of Cattle $ 941625

Transaction summary

Packer	Weight	Price	Profit/Hd.	Trans. #
4	1175	81.00	-3.14	40914
4	1175	81.00	-3.14	40912
4	1175	81.00	-3.14	40913
4	1175	81.00	-3.14	40915
4	1175	81.00	-3.14	40911
3	1150	81.00	-1.61	40925
3	1150	81.00	-1.61	40924
3	1150	81.00	-1.61	40922
3	1150	81.00	-1.61	40923
3	1150	81.00	-1.61	40921 Avg. Avg. Avg.
	1162	81.00	-2.38	

Expenditures $ 421795

Feeder Cattle Purchased.....$ 318115

# Pens	Weight	Price	Cost/Hd.
5	700	90.89	636.23

Feeding Cost.....$ 103680

# of Pens on Feed	Total lbs. Grained	Cost of Gain/lb.
86	215000	0.4822

Receipts Minus Expenditures $ 519830

Interest Income (Expense) $ 545

Net Change In Cash Position $ 520375

Balance Sheet

Total Assets		$ 6602593
Cash Reserves	$ 1043228	
Cattle on feed (at Purchase Value)	$ 5559365	
Total Liabilities		$ 0
Loans Payable	$ 0	
Net Worth		$ 6602593
Maximum Credit Line Available (50% of Assets)		$ 3301297
Residual Credit Available		$ 3301297

APPENDIX D: EXCLUSIVE MARKETING/PROCUREMENT AGREEMENT SURVEY

OKLAHOMA STATE UNIVERSITY
DEPARTMENT OF AGRICULTURAL ECONOMICS

Agricultural Economics 3990
Special Problems in Agricultural Economics
Spring 1995

Name _____ Team Number _____

The following questions pertain to forward contracts and marketing/purchasing agreements. Answer each question as accurately as possible based on your experience in the Fed Cattle Market Simulator.

NOTE: Everyone should complete Parts A, B, and C. Answer Part D if your team WAS NOT a participant in either of the marketing/purchasing agreements. Answer Part E if your team WAS a participant in either of the marketing/purchasing agreements.

Part A. Forward Contracting

1. What advantages were there for cattle feeders to forward contract fed cattle? (Rank the three most important factors, where 1 = most important, 2 = second most important, and 3 = third most important.)

		Rank
a.	Reduced price variability	_____
b.	Reduced basis variability	_____
c.	Guaranteed a buyer for cattle	_____
d.	Controlled marketing weight and cost of gain	_____
e.	Marketed cattle at higher prices	_____
f.	Other _____	

2. What advantages were there for packers to forward contract fed cattle? (Rank the three most important factors, where 1 = most important, 2 = second most important, and 3 = third most important.)

		Rank
a.	Reduced price variability	_____
b.	Reduced basis variability	_____
c.	Guaranteed a given quantity of cattle	_____
d.	Increased leverage in the cash market	_____
e.	Controlled timing of deliveries	_____
f.	Purchased cattle at lower prices	_____
g.	Other _____	

Part B. Exclusive Marketing/Purchasing Agreements

3. What advantages were there for cattle feeders who marketed fed cattle by marketing/purchasing agreements? (Rank the three most important factors, where 1 = most important, 2 = second most important, and 3 = third most important.)

		Rank
a.	Reduced price variability	____
b.	Reduced basis variability	____
c.	Guaranteed a buyer for cattle	____
d.	Controlled marketing weight and cost of gain	____
e.	Reduced profit variation	____
f.	Marketed cattle at higher prices	____
g.	Other _____	____

4. What advantages were there for packers who entered into marketing/purchasing agreements? (Rank the three most important factors, where 1 = most important, 2 = second most important, and 3 = third most important.)

		Rank
a.	Reduced price variability	____
b.	Reduced basis variability	____
c.	Guaranteed a given quantity of cattle	____
d.	Increased leverage in the cash market	____
e.	Controlled timing of deliveries	____
f.	Reduced profit variation	____
g.	Reduced quantity variation	____
h.	Purchased cattle at lower prices	____
i.	Other _____	____

Part C. Cash Market Procurement

5. In your opinion, which of the following statements are correct? Note: Captive supplies refer both to forward contracts and marketing/purchasing agreements.

		Check if correct
Captive supplies ...		
a.	Benefit the packers who use them	____
b.	Benefit the packers who do not use them	____
c.	Benefit the feeders who use them	____
d.	Benefit the feeders who do not use them	____
e.	Reduce market information	____
f.	Increase market information	____
g.	Reduce price or basis variability on the average	____
h.	Increase price or basis variability on the average	____
i.	Result in lower cash market prices on the average	____
j.	Result in higher cash market prices on the average	____
k.	Benefit packers more than feeders	____
l.	Benefit feeders more than packers.	____

Part D. Marketing/Purchasing Agreements: Non-Participants of Either Agreement

6. Check the response which most accurately completes the statement.

When the marketing agreement began, I (our team) ...

a. Noticed that our sale/purchase prices
Increased ___ Decreased ___ Remained the same ___

b. Noticed that variation in our prices
Increased ___ Decreased ___ Remained the same ___

c Noticed that competition for cattle
Increased ___ Decreased ___ Remained the same ___

d. Noticed that our trading with different packers/feeders
Increased ___ Decreased ___ Remained the same ___

e. Noticed that the amount of reported price information
Increased ___ Decreased ___ Remained the same ___

f. Noticed that the variation in trading volume
Increased ___ Decreased ___ Remained the same ___

g. Noticed that our extent of forward contracting
Increased ___ Decreased ___ Remained the same ___

h. Noticed that our profit/head
Increased ___ Decreased ___ Remained the same ___

7. Who benefitted most from the marketing/purchasing agreement?
Packers _____ Feeders _____

8. If you had the choice, would you enter into a marketing/purchasing agreement?
Yes _____ No _____

Part E. Marketing/Purchasing Agreements: Participants in Either Agreement

9. Check the response which most accurately completes the statement.

When the marketing agreement began, I (our team) ...

a. Noticed that our sale/purchase prices
Increased ___ Decreased ___ Remained the same ____

b. Noticed that variation in our prices
Increased ___ Decreased ___ Remained the same ____

c. Noticed that competition for cattle
Increased ___ Decreased ___ Remained the same ____

d. Noticed that variation in our profit/head
Increased ___ Decreased ___ Remained the same ____

e. Noticed that our profit/head
Increased ___ Decreased ___ Remained the same ____

f. Noticed that the amount of reported price information
Increased ___ Decreased ___ Remained the same ____

g. Noticed that the extent of forward contracting by other teams
Increased ___ Decreased ___ Remained the same ____

10. Who benefitted most from the marketing/purchasing agreement?
Packers _____ Feeders _____

11. If you had the choice, would you enter into another marketing/purchasing agreement?
Yes _____ No _ _____

APPENDIX E: ALTERNATIVE MODELS OF ROBUSTNESS ANALYSIS

Transaction Price Level Models

A1-1: $$TPFC_{it} = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 LCFMP_{t-1} + \alpha_3 TM_{t-1} + \alpha_4 TSL_{t-1} + \alpha_5 PPL_t + \sum_{j=1}^{8} \alpha_{6j} DFDLT_{ijt} + \sum_{j=1}^{4} \alpha_{7j} DPKR_{ijt} + \sum_{j=1}^{2} \alpha_{8j} DMPA_{ijt} + \sum_{j=1}^{2} \alpha_{9j} DRNR_{ijt} + \sum_{j=1}^{2} \alpha_{10j} DMAP_{ijt} + \sum_{j=1}^{2} \alpha_{11j} DNMP_{ijt} + v_{it}$$

A1-2: $$TPFC_{it} = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 TM_{t-1} + \alpha_3 TSL_{t-1} + \alpha_4 PPL_t + \sum_{j=1}^{8} \alpha_{5j} DFDLT_{ijt} + \sum_{j=1}^{4} \alpha_{6j} DPKR_{ijt} + \sum_{j=1}^{2} \alpha_{7j} DMPA_{ijt} + \sum_{j=1}^{2} \alpha_{8j} DRNR_{ijt} + \sum_{j=1}^{2} \alpha_{9j} DMAP_{ijt} + \sum_{j=1}^{2} \alpha_{10j} DNMP_{ijt} + v_{it}$$

A1-3: $$TPFC_{it} = \alpha_0 + \alpha_1 LCFMP_{t-1} + \alpha_2 TM_{t-1} + \alpha_3 TSL_{t-1} + \alpha_4 PPL_t + \sum_{j=1}^{8} \alpha_{5j} DFDLT_{ijt} + \sum_{j=1}^{4} \alpha_{6j} DPKR_{ijt} + \sum_{j=1}^{2} \alpha_{7j} DMPA_{ijt} + \sum_{j=1}^{2} \alpha_{8j} DRNR_{ijt} + \sum_{j=1}^{2} \alpha_{9j} DMAP_{ijt} + \sum_{j=1}^{2} \alpha_{10j} DNMP_{ijt} + v_{it}$$

A2-1: $$TPFC_{it} = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 LCFMP_{t-1} + \alpha_3 TM_{t-1} + \alpha_4 TSL_{t-1} + \sum_{j=1}^{8} \alpha_{5j} DFDLT_{ijt} + \sum_{j=1}^{4} \alpha_{6j} DPKR_{ijt} + \sum_{j=1}^{2} \alpha_{7j} DMPA_{ijt} + \sum_{j=1}^{2} \alpha_{8j} DRNR_{ijt} + \sum_{j=1}^{2} \alpha_{9j} DMAP_{ijt} + \sum_{j=1}^{2} \alpha_{10j} DNMP_{ijt} + v_{it}$$

A2-2: $$TPFC_{it} = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 TM_{t-1} + \alpha_3 TSL_{t-1} + \sum_{j=1}^{8} \alpha_{4j} DFDLT_{ijt} + \sum_{j=1}^{4} \alpha_{5j} DPKR_{ijt}$$

$$+ \sum_{j=1}^{2} \alpha_{6j} DMPA_{ijt} + \sum_{j=1}^{2} \alpha_{7j} DRNR_{ijt} + \sum_{j=1}^{2} \alpha_{8j} DMAP_{ijt} + \sum_{j=1}^{2} \alpha_{9j} DNMP_{ijt}$$

$$+ v_{it}$$

A2-3: $$TPFC_{it} = \alpha_0 + \alpha_1 LCFMP_{t-1} + \alpha_2 TM_{t-1} + \alpha_3 TSL_{t-1} + \sum_{j=1}^{8} \alpha_{4j} DFDLT_{ijt} +$$

$$\sum_{j=1}^{4} \alpha_{5j} DPKR_{ijt} + \sum_{j=1}^{2} \alpha_{6j} DMPA_{ijt} + \sum_{j=1}^{2} \alpha_{7j} DRNR_{ijt} + \sum_{j=1}^{2} \alpha_{8j} DMAP_{ijt}$$

$$+ \sum_{j=1}^{2} \alpha_{9j} DNMP_{ijt} + v_{it}$$

A3-1: $$TPFC_{it} = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 LCFMP_{t-1} + \alpha_3 TSL_{t-1} + \sum_{j=1}^{8} \alpha_{4j} DFDLT_{ijt} +$$

$$\sum_{j=1}^{4} \alpha_{5j} DPKR_{ijt} + \sum_{j=1}^{2} \alpha_{6j} DMPA_{ijt} + \sum_{j=1}^{2} \alpha_{7j} DRNR_{ijt} + \sum_{j=1}^{2} \alpha_{8j} DMAP_{ijt}$$

$$+ \sum_{j=1}^{2} \alpha_{9j} DNMP_{ijt} + v_{it}$$

A3-2: $$TPFC_{it} = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 TSL_{t-1} + \sum_{j=1}^{8} \alpha_{3j} DFDLT_{ijt} + \sum_{j=1}^{4} \alpha_{4j} DPKR_{ijt} +$$

$$\sum_{j=1}^{2} \alpha_{5j} DMPA_{ijt} + \sum_{j=1}^{2} \alpha_{6j} DRNR_{ijt} + \sum_{j=1}^{2} \alpha_{7j} DMAP_{ijt} + \sum_{j=1}^{2} \alpha_{8j} DNMP_{ijt}$$

$$+ v_{it}$$

A3-3: $$TPFC_{it} = \alpha_0 + \alpha_1 LCFMP_{t-1} + \alpha_2 TSL_{t-1} + \sum_{j=1}^{8} \alpha_{3j} DFDLT_{ijt} + \sum_{j=1}^{4} \alpha_{4j} DPKR_{ijt} +$$

$$\sum_{j=1}^{2} \alpha_{5j} DMPA_{ijt} + \sum_{j=1}^{2} \alpha_{6j} DRNR_{ijt} + \sum_{j=1}^{2} \alpha_{7j} DMAP_{ijt} + \sum_{j=1}^{2} \alpha_{8j} DNMP_{ijt}$$

$$+ v_{it}$$

A4-1: $$TPFC_{it} = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 LCFMP_{t-1} + \sum_{j=1}^{8} \alpha_{3j} DFDLT_{ijt} + \sum_{j=1}^{4} \alpha_{4j} DPKR_{ijt}$$

$$+ \sum_{j=1}^{2} \alpha_{5j} DMPA_{ijt} + \sum_{j=1}^{2} \alpha_{6j} DRNR_{ijt} + \sum_{j=1}^{2} \alpha_{7j} DMAP_{ijt} + \sum_{j=1}^{2} \alpha_{8j} DNMP_{ijt}$$

$$+ v_{it}$$

A4-2 $$TPFC_{it} = \alpha_0 + \alpha_1 BBP_{t-1} + \sum_{j=1}^{8} \alpha_{2j} DFDLT_{ijt} + \sum_{j=1}^{4} \alpha_{3j} DPKR_{ijt} + \sum_{j=1}^{2} \alpha_{4j} DMPA_{ijt} +$$

$$\sum_{j=1}^{2} \alpha_{5j} DRNR_{ijt} + \sum_{j=1}^{2} \alpha_{6j} DMAP_{ijt} + \sum_{j=1}^{2} \alpha_{7j} DNMP_{ijt} + v_{it}$$

A4-3: $$TPFC_{it} = \alpha_0 + \alpha_1 LCFMP_{t-1} + \sum_{j=1}^{8} \alpha_{2j} DFDLT_{ijt} + \sum_{j=1}^{4} \alpha_{3j} DPKR_{ijt} + \sum_{j=1}^{2} \alpha_{4j} DMPA_{ijt}$$

$$+ \sum_{j=1}^{2} \alpha_{5j} DRNR_{ijt} + \sum_{j=1}^{2} \alpha_{6j} DMAP_{ijt} + \sum_{j=1}^{2} \alpha_{7j} DNMP_{ijt} + v_{it}$$

Weekly Transaction Price Level Models

C1-1: $$AVGPRC_t = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 LCFMP_{t-1} + \alpha_3 TM_{t-1} + \alpha_4 TSL_{t-1} + \alpha_5 PPL_t +$$

$$\sum_{j=1}^{2} \alpha_{6j} DMPA_{jt} + \sum_{j=1}^{2} \alpha_{7j} DRNR_{jt} + e_t$$

C1-2: $$AVGPRC_t = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 TM_{t-1} + \alpha_3 TSL_{t-1} + \alpha_4 PPL_t + \sum_{j=1}^{2} \alpha_{5j} DMPA_{jt} + \sum_{j=1}^{2} \alpha_{6j} DRNR_{jt} + e_t$$

C1-3: $$AVGPRC_t = \alpha_0 + \alpha_1 LCFMP_{t-1} + \alpha_2 TM_{t-1} + \alpha_3 TSL_{t-1} + \alpha_4 PPI_t + \sum_{j=1}^{2} \alpha_{5j} DMPA_{jt} + \sum_{j=1}^{2} \alpha_{6j} DRNR_{jt} + e_t$$

C2-1: $$AVGPRC_t = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 LCFMP_{t-1} + \alpha_3 TM_{t-1} + \alpha_4 TSL_{t-1} + \sum_{j=1}^{2} \alpha_{5j} DMPA_{jt} + \sum_{j=1}^{2} \alpha_{6j} DRNR_{jt} + e_t$$

C2-2: $$AVGPRC_t = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 TM_{t-1} + \alpha_3 TSL_{t-1} + \sum_{j=1}^{2} \alpha_{4j} DMPA_{jt} + \sum_{j=1}^{2} \alpha_{5j} DRNR_{jt} + e_t$$

C2-3: $$AVGPRC_t = \alpha_0 + \alpha_1 LCFMP_{t-1} + \alpha_2 TM_{t-1} + \alpha_3 TSL_{t-1} + \sum_{j=1}^{2} \alpha_{4j} DMPA_{jt} + \sum_{j=1}^{2} \alpha_{5j} DRNR_{jt} + e_t$$

C3-1: $$AVGPRC_t = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 LCFMP_{t-1} + \alpha_3 TSL_{t-1} + \sum_{j=1}^{2} \alpha_{4j} DMPA_{jt} + \sum_{j=1}^{2} \alpha_{5j} DRNR_{jt} + e_t$$

C3-2: $$AVGPRC_t = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 TSL_{t-1} + \sum_{j=1}^{2} \alpha_{3j} DMPA_{jt} + \sum_{j=1}^{2} \alpha_{4j} DRNR_{jt} + e_t$$

C3-3: $$AVGPRC_t = \alpha_0 + \alpha_1 LCFMP_{t-1} + \alpha_2 TSL_{t-1} + \sum_{j=1}^{2} \alpha_{3j} DMPA_{jt} + \sum_{j=1}^{2} \alpha_{4j} DRNR_{jt} + e_t$$

C4-1: $$AVGPRC_t = \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 LCFMP_{t-1} + \sum_{j=1}^{2} \alpha_{3j} DMPA_{jt} + \sum_{j=1}^{2} \alpha_{4j} DRNR_{jt} + e_t$$

C4-2: $$AVGPRC_t = \alpha_0 + \alpha_1 BBP_{t-1} + \sum_{j=1}^{2} \alpha_{2j} DMPA_{jt} + \sum_{j=1}^{2} \alpha_{3j} DRNR_{jt} + e_t$$

C4-3: $$AVGPRC_t = \alpha_0 + \alpha_1 LCFMP_{t-1} + \sum_{j=1}^{2} \alpha_{2j} DMPA_{jt} + \sum_{j=1}^{2} \alpha_{3j} DRNR_{jt} + e_t$$

ESSAY TWO

MARKETING METHOD PRICE DIFFERENCES IN THE FED CATTLE MARKET: AN EXPERIMENTAL SIMULATION APPROACH

MARKETING METHOD PRICE DIFFERENCES IN THE FED CATTLE MARKET: AN EXPERIMENTAL SIMULATION APPROACH

Abstract

Changing marketing and procurement strategies in the fed cattle market over the last decade have involved marketing finished cattle through three alternative marketing methods. This study uses experimental simulation to examine transaction price level and variability differences between alternative marketing methods. Alternative methods consist of marketing or purchasing finished cattle through: (1) the cash bid and offer system, (2) cash forward contract arrangements, and (3) exclusive marketing/procurement agreements. Two sets of econometric models are specified and estimated to determine: (1) transaction price level and variance differences between each method and (2) transaction price level and variance differences between each method that are realized by individual firms. Results indicate that the exclusive marketing/procurement agreement method resulted in significantly lower mean price levels and significantly lower price variances than the cash marketing method. No significant price level differences were found between the cash marketing method and the cash forward contracting method. However, results suggest that the cash forward contracting marketing method had a significantly lower price variance than the cash marketing method. Significant positive and negative price level differences indicate that some of the individual firms observed price level differences while utilizing alternative marketing methods.

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Introduction

Problem

Price discovery research has examined the price discovery process by focusing on transactions made between the buyers and sellers in specified markets. These transactions often occur through different pricing arrangements (Farris). Tomek and Robinson note that pricing arrangements and pricing mechanisms are used interchangeably to denote the complex set of institutions and pricing methods that are used to price agricultural products. The pricing arrangements by which transactions occur in the fed cattle market have become a focal point for price discovery research over the last decade. These pricing arrangements are referred to as alternative marketing methods in recent fed cattle price discovery research (Ward et al. 1996a). The fed cattle market has evolved to include the negotiation of prices between meatpacking and feedlot firms for finished cattle using several different transaction or marketing methods.

Immense structural changes during the past ten to fifteen years in the livestock slaughtering industry have raised questions concerning the volatility of transaction prices in US beef, pork, and poultry markets. Meatpacking and feedlot firms have increased consolidation efforts and many of these large consolidated firms are utilizing alternative marketing methods that are unique to the cash bid and offer system or

pricing mechanism. Schroeder et al. described two alternative marketing methods that were identified as cash forward contracting and exclusive marketing/procurement agreements or formula based pricing arrangements.

Cash forward contracting involves cattle feeding firms agreeing to market finished cattle to beefpacking firms at an agreed upon price. Finished cattle are to be delivered to the packing facility at a designated point in the future. The time period between the point of sale and delivery is generally more than two weeks and can conceivably be two to four months (Ward et al. 1996a).

Exclusive marketing/procurement agreements involve written or verbal contracts held by one meatpacking firm and one or more feedlot firms which allow the participating firms to engage in formula based pricing strategies in relation to the sale and/or purchase of finished cattle. The formula based pricing strategies commonly employed in this type of marketing method often involve sharing available profits or losses during a given market period. Existing agreements have been structured so that additional firms cannot be included in the agreement and so that the details of the agreement are not made public.

Industry concerns range from the actual impact that these exclusive agreements and forward contracting arrangements have on cash market prices to how they affect the availability of market information. The analysis of these developments requires the evaluation of raw data collected from private firms that exist in today's fed cattle market. These firms rarely release data concerning their operations. Hence, collecting data from the relevant firms has become increasingly difficult as a direct result of the

consolidation and complex marketing method alternatives that have evolved within the industry. Farris notes that if two or more pricing mechanisms or marketing methods simultaneously occur for a given commodity, then it is possible to make comparisons. However, it is impossible to hold other things constant in a non-experimental setting or data collection period (Farris).

A Fed Cattle Market Simulator (FCMS) was developed and has been updated in order to realistically simulate the current fed cattle market (Ward et al. 1996b; Koontz et al. 1994a, 1994b, 1995a, 1995b, 1995c). This simulated market is a market where the alternative marketing methods described above can be utilized. Hence, research involving the evaluation of price differences between alternative marketing methods used by firms in the fed cattle market can be conducted using data collected from simulated trading periods within the FCMS.

Significance

Previous research has examined the impacts of forward contracting on fed cattle transaction prices (Schroeder et al.; Barkley and Schroeder; Ward et al. 1996a). One previous study has evaluated price differences between cash and forward contract prices considering the entire fed cattle market as well as price differences observed by each firm within the market relative to one other firm (Ward 1996b). This study evaluates price level and variability differences between three specific marketing methods that are observed in today's fed cattle market. This study differs from previous research by

focusing on the evaluation of price level and variability differences between each marketing method. Additionally, this study examines price level and variability differences between each marketing method experienced by individual firms. Each of these methods have been previously mentioned and they are described in relation to marketing or purchasing finished cattle based on cash transactions (Marketing Method 1), cash forward contracting (Marketing Method 2), and exclusive marketing/procurement agreements (Marketing Method 3).

Research Objectives

This study has one general objective and four specific objectives. The general objective is to determine the significance of price differences between alternative marketing methods used by feedlot and meatpacking firms in the fed cattle market. Specific objectives are: (1) to determine the extent of price level differences between specific marketing methods, (2) to determine whether specific marketing methods significantly affect the variability of market transaction prices, (3) to determine the extent of price level differences between specific marketing methods experienced by individual firms, and (4) to determine whether specific marketing methods significantly affect the price variability experienced by individual firms.

Contribution To Knowledge

Previous fed cattle price discovery research has examined differences in fed cattle transaction prices. Ward 1992 examined the differences in fed cattle prices among buyers and buyer groups following the mergers of the meatpacking firms in the late 1980's. The study used primary and secondary data from 173 commercial feedlot managers in the southern plains region. This region included 17 counties in southwest Kansas, 5 counties in southeast Colorado, 3 counties in the Oklahoma panhandle, and 36 counties in the Texas panhandle. The participating feedlot managers recorded data daily for each fed cattle sale lot marketed during June 1989. A total of 21.9% of the managers responded. The data requested included all aspects of any activity and all aspects of the cattle that were sold.

Ward 1992 then specified four cross-section and time series models to explain the variation in transaction prices for fed cattle. The theoretical development of the models was based on the pricing process that packers follow in determining bid prices for fed cattle and prior research using transaction price models. Ordinary Least Squares was used to estimate the models. The author found that buyer activity was highest on Monday, that there is a significant relationship between the transaction price and the number of days between purchase and delivery, that there were significant price differences among individual buyers and buyer groups, and that significantly lower prices were paid by the Big Three firms than those paid by other firms. He also found that the average prices paid by individual buyers and buyer groups differed within

subregions as well as within the southern plains region. Here, he pointed out that although the Big Three firms paid lower prices than other meatpacking firms considered, there was a significant difference in the prices paid within the Big Three group itself. He concluded by noting that subregion models reveal inter-firm price differences that regional models are unable to capture.

Ward and Bliss evaluated the extent of forward contracting in 1988 and assessed cattle feeders' perceptions of benefits to themselves and to packers, perceptions of potential pricing implications, and opinions regarding any proposed regulatory policies of the future. Data were collected through a questionnaire mailed to 3700 cattle feeders in the spring of 1989. These cattle feeders were from the 13 major cattle feeding states which included Arizona, California, Colorado, Idaho, Illinois, Iowa, Kansas, Minnesota, Nebraska, Oklahoma, South Dakota, Texas, and Washington. A total of 503 questionnaires were properly returned which reported the marketing of 6.1 million fed cattle in 1988 or about 26% of the total fed cattle marketing for 1988. Over 75 percent of the cattle marketed were from survey respondents representing feedlots that marketed 20,000 or more fed cattle.

The authors found that 754.6 thousand cattle were reported to be forward contracted in 1988 by the survey respondents. This total represented about 12.7 percent of the total fed cattle marketings reported by the respondents in 1988. Most of the contracting was found to be in Kansas and Texas which accounted for 63.4 percent of the total forward contracted cattle. The authors noted that the percentage of contracts was no higher among the larger feedlots than among the smaller feedlots.

They also found that, based on respondent estimates, the growth in future contacting during 1990 was projected to be around 2 percent above the 1988 reported contracting level. They also noted that forward contracting for fed cattle during 1990 was estimated to be about 15 percent of total marketings in the 13 cattle feeding states.

Ward and Bliss also evaluated questions concerning the type of contract and the characteristics of different contracts. They found that over two-thirds of the contracts were basis contracts and the remaining were flat price contracts. They also found that the number and percentage of contracted cattle was highest in April. Accordingly, 27.7 percent of the respondents reported forward contracting cattle more than 3 months prior to delivery. They note that the feeding firms forward contracting cattle 3 months or longer prior to delivery were likely marketing cattle by contract shortly after placing the cattle on feed. They also found that Excel was the most common buyer of contracted cattle among the respondents and that there were no other packers that were significant contracting parties other than the Big Three (IBP, ConAgra, and Excel).

Ward and Bliss also evaluated several statements within the questionnaire regarding the potential benefits of forward contracting cattle between cattle feeders and meatpackers. They found that the primary benefit to feeders, according to the respondents, from contracting cattle was that it enhanced their debt financing arrangements. On the other hand, they found that the primary benefit to packers perceived by cattle feeders from forward contracting was that it allowed them the ability to secure a given quantity of cattle for slaughter.

The last area of questions evaluated by Ward and Bliss from the questionnaire

focused on the impacts of forward contracting on transaction prices, the impacts of forward contracting on competition, and the suggested industry and government policies concerning the contracting of cattle. In regards to the impacts on prices, Ward and Bliss explain that forward contracts are found to change short-run supply and demand conditions for packers which alters their procurement and pricing strategies. As a result, this could cause prices to become uncertain for those packers who have no forward contracted cattle. They also found that the respondents to the questionnaire thought that forward contracting was not necessarily good for competition or the industry by evaluating their responses to several statements regarding how forward contracts affect different aspects of the fed cattle market. Lastly, they found that the most acceptable policy alternative among the respondents involved having the industry monitor the forward contracting of cattle in the fed cattle market. Conversely, the least acceptable policy alternative among the respondents involved government monitoring and government imposed limits on forward contracting.

Schroeder et al. evaluated the implications of captive supplies on several aspects of the fed cattle market. The authors specifically focused on how vertical integration within the fed cattle market has affected cattle prices, how vertical integration within the fed cattle market has impacted the market itself, the determinants of fed cattle transaction prices and their relationship to captive supplies, and the impacts of forward contracting on value based marketing strategies in the fed cattle market. They began by explaining captive supplies and noting that captive supplies may take any of three forms. The first form of captive supplies is packer fed cattle in either packer-owned

facilities or in custom feeding operations. The second form of captive supplies is cattle procured using forward contracts. The third form of captive supplies are cattle procured through exclusive marketing/procurement agreements (Schroeder et al.). The authors then reveal specific details concerning each of these forms of captive supplies and the most common form. They note that many figures reported by USDA indicate that the use of captive supplies are growing and they suggest that both packers and feeders benefit from using captive supplies.

Schroeder et al. also explains the findings of a forward contracting study where an informal survey of seven feedlot managers was conducted in March of 1992 to obtain information on the mechanics of forward contracting and contract specifications. All of the managers surveyed by the authors in this study operated in either Kansas or Colorado. First, the authors found that packers were more willing to waive contract specifications in the summer rather than during the winter. They noted that most managers indicated that if the packers were willing to waive one specification, then they were usually willing to waive all of the contract specifications except carcass weight. However, if they did not waive specifications, then the feedlot managers could expect the packers to stringently follow the price adjustment schedules within a given contract. The authors then evaluated questions concerning which entity was expected to exert the most control in waiving contract specifications. Here, they found that the respondents were evenly divided about whether feeders or packers had more control. Lastly, Schroeder et al. evaluated slaughter and delivery date questions within the survey. In most cases, the respondents thought it was better to allow the packer to

have scheduling flexibility so that each meatpacking firm could exert more control over contract specifications.

Schroeder et al. then examined the theoretical impacts that captive supplies have on prices in short run and long-run time periods. The authors explain that the major aspect of captive supplies in the long-run is that packers are able to secure cattle purchases well in advance of slaughter. Also, cattle feeders are able to secure a price and a buyer long before the cattle are ready for market. Therefore, both packers and feeders benefit from additional marketing flexibility and reduced market uncertainty from the existence of forward contracts or other captive supply strategies (Schroeder et al.). The authors suggest that in the long-run the average contracted price should be less than the average cash market price for fed cattle. Therefore, cattle feeders were willing to accept a lower price in return for reductions in the selling costs and other costs associated with price variability (Schroeder et al.). The authors then explain that in the short-run packers increase their ability to control slaughter schedules which increases the level of competition between beefpackers. They note that there are no observed increases in flexibility realized by cattle feeders in the short-run time period. However, they note that the relationship can only be precisely determined by evaluating results produced by empirical research.

The authors then review and compare several previous empirical studies that examine the impacts of captive supplies on fed cattle prices and proceeded to develop their own empirical study to investigate the short-run fed cattle price impacts from captive supplies. To do so, they specified a fed cattle transaction price model that

included explanatory variables that encompassed the demand for cattle characteristics and the number of cattle supplied to a regional market. They also included two separate sets of variables to determine how the level of captive supplies impact prices paid for fed cattle. Data used in the model were collected from individual transactions representing 1407 pens of cattle or 166,338 head from May 21, 1990 through November 24, 1990. Each transaction came from one of 13 feedyards in southwestern Kansas. All of the cattle quality variables (such as age, weight, sex, etc.) were found to have a positive impact on prices with the exception of two (Schroeder et al.). The coefficients measuring the price impacts that resulted from market factors (such as boxed beef prices, futures market prices, geographic region, etc.) were both positive and negative each being consistent with economic theory.

The variables explaining the impacts on prices resulting from captive supplies had a statistically significant negative influence on fed cattle prices. Over the period studied, captive supplies as a whole were found to reduce prices by $0.15/cwt. to $0.31/cwt. depending upon whether the measurement was by individual firms or by the aggregate of captive supplies in the market. The authors were careful to note that the estimates should not be interpreted as being valid for captive supply levels outside of the bounds of the data set. Schroeder et al. then discussed the limitations of the study and concluded by suggesting that their research shows that captive supplies have a negative impact on the price of fed cattle within the geographic market that they studied. However, they clearly point out that due to the extensive limitations from their data, policy recommendations in regard to captive supplies are uncertain at best.

Hayenga and O'Brien analyzed three important issues that have developed within the fed cattle market in recent years. These issues were the effect that a reduction in the number of buyers in a specified market area has on prices received by producers, the effect that captive supplies have on the level and variability of prices paid to livestock producers, and the relevant geographic market for fed cattle research that determines the impacts of consolidation and captive supplies on the prices of fed cattle. The authors noted that answers to the questions presented by these issues will be needed as policy makers reflect on the deregulation period of the 1980's and attempt to decide whether or not corrective action is needed.

To analyze these related issues Hayenga and O'Brien collected USDA Choice steer prices for 1100-1300 lb. animals from several different geographic markets. In addition, Cattle-Fax estimates of weekly forward contract cattle deliveries to packers from 4 states, USDA statistics on weekly state cattle slaughter, and USDA-FSIS statistics on the number of beef slaughter plants above 100,000 head of capacity in each state were collected. The period for which the data were collected ranged from 1988 to 1989 except for the USDA-FSIS statistics on the number of slaughter plants that operated above 100,000 head of capacity which covered the period 1973-1989. The states that were considered in this study are Colorado, Kansas, Texas, Nebraska, and Iowa. The authors noted that of these five states, Colorado had the greatest proportional decrease in both the number of large beefpacking plants and the number of owners of large plants. As a result, the authors indicated that Colorado was the state that presented the highest degree of concentration when compared to the other states

under consideration. Initially, the authors estimated the impacts of changes in the number of sellers and buyers through a series of quadratic models for the purpose of accommodating possible nonlinear relationships. They found that, in general, changes in the relative number of plant owners had no significant impact on prices among states in question. Seemingly unrelated regression (SUR) analysis was then carried out to examine the impact of structural changes on relative beef prices. This method was chosen to determine how changes in the supply of beef, changes in income, and changes in population impact fed cattle transaction prices. The authors found that the effects from per capita beef consumption were negative and significant at the 1% level of significance. They also found that disposable income had a small, positive, and significant effect on fed cattle prices.

Hayenga and O'Brien also measured the effect of captive supplies in the form of forward contracting by transforming the forward contract delivery estimates into percentages of state weekly slaughter values for Colorado, Texas, Nebraska, and Kansas. The authors computed correlation statistics between each state for weekly contract volumes which were found to be generally low. Here, the authors suggested that contract volumes had no statistically significant effects on price levels. The SUR analysis was used to estimate the effects of forward contracting on fed cattle prices for each state considering prices reported during the period October 1988 through December 1989. They found that forward contract deliveries in Kansas during the current week had a significant negative effect on Kansas fed cattle prices. Forward contract deliveries in other states were found to have no significant effects on fed cattle

prices these states. Therefore, the authors suggested that their results indicate there is not sufficient evidence to support the hypothesis that high levels of captive supplies bring significant negative pressure on fed cattle prices.

Next, the authors examined the problem of determining the correct geographic market area for fed cattle. In doing so, they detailed the characteristics of the market and the procurement areas that surround individual meatpacking firms. They note that the area in which the price reverberations from shocks to the system are quickly felt are the best candidates for the relevant geographic market. In relation, the authors point out that the speed and strength of geographic market price arbitrage is a good indicator of the relevant geographic market scope. Hayenga and O'Brien used econometric and vector autoregression techniques to analyze the speed and strength of geographic market price interactions among several states. The authors also used the augmented Dickey-Fuller test to determine whether daily and lagged fed cattle prices within eight different states were cointegrated. The authors point out that cointegration allowed them to determine the degree to which the fed cattle marketing regions are linked or spatially related. The authors found that the price behavioral results for primary cattle feeding states considered indicated that a significant amount of integration does exist among geographic markets. The speed and strength of price reactions analysis produced results that suggested that a single state is too small to be considered a relevant procurement market for fed cattle. Furthermore, the results indicated that the relevant market is larger than the procurement area for a particular firm because other firms can buy at the fringe of the procurement area and send lagged price responses

across a broad geographic area (Hayenga and O'Brien). The authors conclude by revealing that stronger lagged price linkages might deserve a more in-depth analysis in order to determine the relevant market area in antitrust cases or for research projects involving structural analysis.

Barkley and Schroeder used a theoretical model to determine how changes in market conditions and industrial structure affects fed cattle prices in both spot and forward markets. They indicated that forward contacting offers an element of certainty to an uncertain market environment which is considered to be the main advantage for both feeders and packers to engage in forward contracting. Barkley and Schroeder suggest that a form of risk-mitigation is offered by this fact which is an incentive for feedlot managers to offer and/or accept forward contracts. They note that this idea provides a foundation for theoretical models developed to estimate price impacts due to forward contracting.

Barkley and Schroeder proceeded to develop the theoretical model by specifying the feedlots objective function or profit maximization equation. The specific assumptions in relation to price variability were then incorporated into the profit function. Through differentiation of the adjusted equation, the authors derived the supply of forward contracts equation and the supply of cattle to the cash market equation. From these supply equations, the firm demand for forward contracts equation and the firm demand for spot cattle equation was derived and explained. The authors note that due to limited data on the quantity and price of contracted cattle, the motivation for packers to purchase cattle in forward markets requires further

investigation through future empirical research. Barkley and Schroeder note that the most commonly accepted motivation for packers is that forward contracts allow them to purchase cattle to meet plant capacity requirements from the source offering the lowest procurement costs. The authors proceed to equate the supply and demand equations in both the spot and forward markets to yield equilibrium prices for each market. Here, the authors develop comparative static equations that are capable of revealing price impacts from a shock to each of the exogenous variables which involve the variability of the spot market price, changes in the demand for fed cattle, and changes in feedlot capacity.

Barkley and Schroeder suggest that an important outcome of the model development process is that contract prices of cattle must be lower than the expected value of the spot market price. This theoretical finding is consistent with previous research considering the effects of forward contracting on price. Also, the model reveals incentives for both packers and feedlot firms to buy and sell cattle through forward contracts. The authors note that their fed cattle contracting model explicitly expresses the effects of forward contracts on prices in the fed cattle market. In general, the authors note that their model indicates that greater variability in spot market transaction prices result from an increased demand for forward contracts which increases contract prices relative to spot market prices. The authors conclude by suggesting that as more evidence accumulates on the motivation of packers to enter forward contracts, specific hypotheses generated from their theoretical model could be used in empirical research to provide further informational insights about the impacts of

forward contracts on fed cattle transaction prices.

Previous research has also evaluated alternative marketing methods other than those that relate specifically to pricing arrangements. Fausti and Feuz note that when cattle producers sell finished cattle to meatpacking firms, they choose to market cattle based on one of three alternatives. These alternatives are (1) dressed weight and grade, (2) dressed weight, and (3) live weight. Each of these methods are referred to by the authors as marketing alternatives.

After developing theoretical models explaining price disparity in the fed cattle market, Fausti and Feuz collected data on 218 pens of finished steers from the South Dakota Retained Ownership Demonstration Project over a three year period that started in April of 1991. Each pen of cattle was marketed based on the dressed weight and grade marketing alternative. The authors also collected market price data for the live and dressed markets in the same market area. From this data, the authors were able to consider the mean price differences between each of the three marketing alternatives.

The authors concluded from their study that significant price differences exist between the dressed weight and grade alternative compared to the live alternative. Specifically, their results suggest that higher mean prices are paid for the dressed weight and grade alternative. Fausti and Feuz also evaluated price difference between the dressed weight and live marketing alternatives. The authors concluded that meatpacking firms pay significantly higher prices for cattle that are marketed by the dressed weight alternative. The authors suggest that price differences between the specified marketing alternatives support the theory of factor price disparity.

Feuz et al. 1993 evaluated the pricing efficiency of alternative marketing methods for slaughter cattle. The authors note that producers who produce lean consistent carcasses do not receive price premiums and those who produce less desirable carcasses may not receive price discounts under the most commonly used marketing method. The mean profit levels, degree of price differentiation, and carcass quality variables that have the most significant impact on profit are compared for all four methods. The four marketing methods considered by Feuz et al. 1993 include marketing finished cattle through: (1) a live weight basis, (2) a dressed weight basis, (3) a dressed weight and grade basis, and (4) a value based marketing approach known as the Excel Muscle Scoring System.

Feuz et al. 1993 used 69 groups of 5 steer calves that represented 53 different producers as part of the South Dakota State University Retained Ownership Demonstration Project in October of 1990. The authors used the data to develop the appropriate hypothesis tests considering the impacts of increased information about product quality on producer profit variances. Feuz et al. 1993 also estimated profit models for producer profits under each of the four marketing methods.

The authors found that statistically significant mean profit differences do exist between the four alternative marketing methods considered. They suggest profits are lower when cattle are marketed on a live weight basis that under any other marketing method considered. Results indicated that the dressed weight marketing method was the most profitable but not significantly different from the dressed weight and grade marketing method. Regression results from the profit models allowed the authors to

conclude that feedlot production variables are more significant in explaining profit variation under the live weight marketing method. Feuz et al. 1993 notes that only when steers are marketed on a grade and yield or value based marketing basis do carcass characteristics become as important to profit as the feedlot production variables. The authors conclude by suggesting that the live and dressed weight methods do not effectively communicate the desires of consumers to the cattle producer through profits.

Feuz et al. 1995 evaluated the risk premiums associated with three cash marketing methods for U.S. slaughter cattle producers. The marketing methods considered by the authors include marketing finished cattle through: (1) a live weight basis, (2) a dressed weight basis, and (3) a dressed weight and grade basis. Feuz et al. 1995 classified cattle producers according to Pratt-Arrow risk-aversion coefficients into three categories which include: risk averse, risk neutral, and risk preferring. The authors used producer profits and the mentioned risk aversion categories to determine the effect of uncertainty associated with incomplete information across alternative marketing methods on the market price for slaughter cattle and on buyer and seller behavior.

Feuz et al. 1995 collected data from 69 pens of steer calves in 1991 and 84 pens of steer calves in 1992 as part of a retained ownership demonstration project. The steers represented more that 100 different operations and three different states. The authors used the data to calculate theoretical revenue equations under each of the marketing methods considered. From this the authors developed risk premium equations, solved for the absolute risk-aversion coefficients associated with marketing

cattle under each of the marketing methods, and tested the appropriate risk premium hypothesis.

From results of the hypothesis tests and risk-aversion coefficient analysis, the authors drew several conclusions about incomplete information impacts across marketing methods. Feuz et al. 1995 found that cattle buyers charge risk premiums for cattle that are marketed through the live and dressed weight marketing methods. Feuz et al. 1995 also note that empirical evidence indicates that risk premiums increase as the risk to buyers increase. Results from the risk-aversion coefficient analysis allowed the authors to suggest that the level of risk did not affect the level of risk aversion, but it did affect the magnitude of the risk premium charged by fed cattle buyers. Feuz et al. 1995 concluded by suggesting that the risk to sellers is the variability of returns which increases when fed cattle producers change marketing strategies from selling cattle on a live weight basis to a dressed weight basis to the dressed weight and grade basis. Hence, the live weight basis creates the lowest expected revenue and the grade and yield basis creates the highest expected revenue of the marketing methods considered.

Previous research has also considered price differences between marketing methods used for market livestock other than finished cattle. Ward and Hildebrand considered price differences between four alternative marketing methods for 828 sale lots of slaughter lambs during 1991. The marketing methods considered by their study consisted of marketing slaughter lambs through: (1) auction markets, (2) electronic markets, (3) direct marketing, and (4) pooled markets.

Ward and Hildebrand developed and estimated two slaughter lamb transaction price level models. The authors found that significant price differences exist between alternative marketing methods used by producers of slaughter lambs. OLS results indicated that slaughter lamb prices were significantly higher for lambs marketed through the electronic market than lamb prices marketed in the auction market method. Estimated results also indicated that slaughter lamb prices for lambs marketed by the direct marketing method were significantly higher than lamb prices in the auction market method.

Procedure

Methods

The methods used for this project consisted of six linear regression models that were estimated to test six statistical hypotheses. The statistical hypotheses considered in this study are presented in Table 1. The linear regression models focus on determining the extent to which price level and variation differences exist between alternative marketing methods. These models were estimated for the entire simulated fed cattle market period to consider the level and the variation in fed cattle transaction prices due to alternative marketing methods and other variables which influence market transaction prices.

Transaction Price Level Models

A combination of three econometric models were used to examine the transaction price level questions that are implied in the specific objectives for this study. The first econometric model is a transaction price level model (**Model A**) which was developed to explain how the specified marketing methods affect fed cattle transaction price levels within the fed cattle market. The initial transaction price level model (Model A) is specified and was estimated as follows:

$$(1) \quad TPFC_{it} = \beta_0 + \beta_1 BBP_{t-1} + \beta_2 LCFMP_{t-1} + \beta_3 TM_{t-1} + \beta_4 TSL_{t-1} + \beta_5 PPL_t + \sum_{j=1}^{8} \beta_{6j} DFDLT_{ijt} + \sum_{j=1}^{4} \beta_{7j} DPKR_{ijt} + \sum_{j=1}^{5} \beta_{8j} DWT_{ijt} + \sum_{j=1}^{3} \beta_{9j} DMETH_{ijt} + v_{it}$$

where, t = time in simulated weeks = 40, 42, 43, ..., 114; i = observations within a week = 1, 2, 3, ..., N_t; it = each transaction = 1, 2, 3, ..., 2770. The pooled cross-section time series model was estimated for unbalanced panel data because the number of transactions observed each week was not equal over the 75 week experimental period. The definition of each variable and the expected sign for each coefficient is presented in Table 2.

The second econometric model is a variation of Model A which was developed to determine how the specified marketing methods affect fed cattle transaction price levels for each feedlot firm within the simulated fed cattle market. The feedlot-method

transaction price level model (Model **B**) is specified and was estimated as follows:

$$(2)\quad TPFC_{it} = \beta_0 + \beta_1 BBP_{t-1} + \beta_2 LCFMP_{t-1} + \beta_3 TM_{t-1} + \beta_4 TSL_{t-1} + \beta_5 PPL_t + \sum_{j=1}^{8} \beta_{6j} DFDLT_{ijt} + \sum_{j=1}^{4} \beta_{7j} DPKR_{ijt} + \sum_{j=1}^{5} \beta_{8j} DWT_{ijt} + \sum_{j=1}^{3} \beta_{9j} DFINT1_{ijt} + \sum_{j=1}^{3} \beta_{10j} DFINT2_{ijt} + \sum_{j=1}^{3} \beta_{11j} DFINT3_{ijt} + \sum_{j=1}^{3} \beta_{12j} DFINT4_{ijt} + \sum_{j=1}^{3} \beta_{13j} DFINT5_{ijt} + \sum_{j=1}^{3} \beta_{14j} DFINT6_{ijt} + \sum_{j=1}^{3} \beta_{15j} DFINT7_{ijt} + \sum_{j=1}^{3} \beta_{16j} DFINT8_{ijt} + v_{it}.$$

where, the feedlot-method interaction variables ($DFINT1_{ijt}$ - $DFINT8_{ijt}$) were substituted for the marketing method variables ($DMETH_{ijt}$) in model **A**. The definition of the feedlot-method interaction variables are defined in Table 2.

The third econometric model is also a variation of Model **A** which was developed to determine how the specified marketing methods effect fed cattle transaction price levels for each meatpacking firm within the simulated fed cattle market. The meatpacker-method transaction price level model (Model **C**) is specified and was estimated as follows:

$$(3)\quad TPFC_{it} = \beta_0 + \beta_1 BBP_{t-1} + \beta_2 LCFMP_{t-1} + \beta_3 TM_{t-1} + \beta_4 TSL_{t-1} + \beta_5 PPL_t + \sum_{j=1}^{8} \beta_{6j} DFDLT_{ijt} + \sum_{j=1}^{4} \beta_{7j} DPKR_{ijt} + \sum_{j=1}^{5} \beta_{8j} DWT_{ijt} + \sum_{j=1}^{3} \beta_{9j} DPINT1_{ijt} + \sum_{j=1}^{3} \beta_{10j} DPINT2_{ijt} + \sum_{j=1}^{3} \beta_{11j} DPINT3_{ijt} + \sum_{j=1}^{3} \beta_{12j} DPINT4_{ijt} + v_{it}.$$

where, the meatpacker-method interaction variables ($DPINT1_{ijt}$ - $DPINT4_{ijt}$) were substituted for the marketing method variables ($DMETH_{ijt}$) in model **A**. The definition of the meatpacker-method interaction variables are defined in Table 2.

It is not statistically plausible to estimate Models **A**, **B**, and **C** as shown in their respective statistical equations (1, 2, and 3). A variable from each of the following binary groups must be excluded in the estimation process: DWT_{ijt}, $DFDLT_{ijt}$, $DPKR_{ijt}$, $DMETH_{ijt}$, $DFINT_{ijt}$, and $DPINT_{ijt}$. The variables that were not included will be referred to as "base" variables in subsequent tables and figures. The base variables are specified in Table 2.

Models **A**, **B**, and **C** are specified as a Weighted Random Effects Models (WREM) and each was estimated for unbalanced panel data. The WREM model specification was used in this study to correct for multiplicative heteroskedasticity in the error term (v_{it}) resulting from the two experiments that were applied to the simulated marketing period (Judge et al.). The WREM is an Estimated Generalized Least Squares (EGLS) regression model that assumes the error term (v_{it}) contains two components

(4) $\quad v_{it} = e_{it} + u_t$.

The first component is randomness of the transaction prices within each week which is known as white noise and the second component measures the random impact that is common to each simulated week of trading (Judge et al.). The component error term has disturbances ($\sigma_e^2 + \sigma_u^2$) that are equal to σ^2 and are assumed to be uncorrelated as follows:

(5) $E[u_t] = 0$,

(6) $Var[u_t] = \sigma_u^2$,

(7) $Cov[e_{it}, u_t] = 0$,

and

(8) $Var[e_{it} + u_t] = \sigma_e^2 + \sigma_u^2 = \sigma^2$.

However, for a given t, the disturbances are assumed to be correlated by virtue of their common component ($\rho = \sigma_u^2/\sigma^2$) as follows:

(9) $Corr[e_{it} + u_t, e_{is} + u_s] = \rho = \sigma_u^2/\sigma^2$.

Multiplicative heteroskedasticity was found among simulated weeks due to the randomized reward/non-reward and agreement/non-agreement periods. The random effects model was weighted (Wts_{it}) to correct for the multiplicative form of heteroskedasticity as follows:

(10) $Wts_{it} = 1/\exp(\hat{e}_{it}^2)$.

Where $\hat{e}_u^2$ represents the squared error or conditional variance for each observation. Each model yielded Estimated Generalized Least Squares estimates for the relevant economic variables using LIMDEP 6.0 software (Greene).

Ward et al. 1996b noted that many of the traditional economic variables of transaction price models found in previous research are accounted for or held constant by the FCMS. These variables generally include cattle quality characteristics such as age, weight, sex, quality grades, yield grades, etc. Reasons for the inclusion of these types of variables in transaction price models that explain fed cattle prices are well developed in Jones et al., Schroeder et al., Ward et al. 1996b, Ward 1981, Ward

1982, and Ward 1992. As a result, variable explanation at this juncture will focus on those variables that are specific to this study.

The price of boxed beef (*BBP*) was lagged one week (t-1) because the meatpacking firms (buying agents) base their procurement decisions on the market information that has been reported most recently. The price of boxed beef is reported at the conclusion of each simulated week and represents the price for which boxed beef is sold in that week. Therefore, the buying agents within the FCMS utilize boxed beef prices for fed cattle that were purchased in the previous week (i.e., buying agents purchase cattle in one week and sell beef produced by those cattle the following week). Lagged boxed beef prices were found in this study to be highly correlated ($r=0.813$) with the average price paid for fed cattle in each simulated week. The rationale for including the previous week's closing futures market price for the nearby live cattle contract ($LCFMP_{t-1}$) is much the same as the reason for including lagged boxed beef prices (BBP_{t-1}). The exception is that both the buying agents and the feedlot firms (selling agents) formulate marketing/procurement decisions that are based on the closing nearby live cattle futures market price.

Two different independent variables were used to represent the supply of fed cattle. The total number of fed cattle on the show list (*TSL*) for the previous week (t-1) is known by all firms within the FCMS. The number of cattle on the show list represents cattle that can be marketed in the current week (i.e., fed cattle that weigh between 1,100 lbs. and 1,200 lbs.). Previous research has indicated that this number is important in forecasting prices in the fed cattle market (Ward et al. 1996b; Bacon,

Trapp, and Koontz). The total number of pens marketed in the previous week (TM_{t-1}) is another supply variable that has been found to significantly affect prices paid for fed cattle (Schroeder et al.). These two variables were not found to be highly correlated with one another (r=0.161). An explanation for this is that the buying agents purchase fed cattle to fulfill a known low cost or optimal plant capacity during each week of trading. This causes total marketings (TM_{t-1}) to remain constant relative to the amount of cattle supplied to the market or on the total show list (TSL_{t-1}) from week to week.

When the buying and selling agents of the FCMS approach one another to agree upon a bid or ask price, they negotiate or bargain until a final transaction price is reached. The amount for which they negotiate revolves around how to split or share the available profits or losses in the market at the time of the trade. In order to do this, participants of the FCMS must estimate the feedlot and meatpacker break-even prices for fed cattle in each trading period. The difference between the largest meatpacker's break-even price for the 1150 lb. weight class and the feedlots' break-even price for the same weight class represents the profits or losses (PPL_t) that are available to the market in week t. This amount can be shared by the simulated firms in each trading period. The available profits or losses (PPL_t) in this study were used as a measure of the bargaining range or the distribution of profits or losses between the buying and selling agents of the FCMS.

Separate variables were included in the model to explain how each feedlot firm and each meatpacking firm within the FCMS affects transaction prices. Hence, there are eight variables which represent the feedlot firms ($DFDLT_{ijt}$) and four variables that

represent the meatpacking firms ($DPKR_{ij}$). Each of these are binary dummy variables which coincide with one another to represent the simulated firms involved in each transaction. These variables provide an indication of the overall effects that each firm has on fed cattle prices.

Ward et al. 1996b notes that a majority of the quality related variables considered in prior fed cattle price discovery research were accounted for or held constant by the FCMS. Within the FCMS, quality characteristics for each of the five weight groups (1100 lbs., 1125 lbs., 1150 lbs., 1175 lbs., and 1200 lbs.) were different. However, finished cattle quality characteristics were constant within each weight group. In this study, a set of five binary dummy variables (DWT_1 - DWT_5) were included to explain transaction price variation that is due to quality characteristics of finished cattle much like that which is found in real-world fed cattle transaction price data. Rationale for the inclusion of quality characteristic variables in fed cattle transaction price models is thoroughly developed in previous research (Ward et al. 1996a; Ward 1981, 1982, 1992; Jones et al.; Schroeder et al.). The quality characteristics specific to each of the five weight groups within the FCMS are presented in Tables 3 and 4.

Previous research has evaluated fed cattle transaction price differences between specific marketing methods. One previous study used a theoretical model to explain how expected forward contracting prices will be lower than cash transaction prices (Barkley and Schroeder). Schroeder et al. found negative price differences between forward contracts and cash transaction prices for 1,407 pens of fed cattle marketed by

13 feedlots in southwestern Kansas. Eilrich et al. estimated price differences between cash, futures market, and forward contracting prices for 68 pens of fed cattle from 1988 to 1990. The authors found that forward contracting and hedged prices for finished cattle are significantly less than live weight cash market prices. Ward et al. 1996a developed and estimated a fed cattle transaction price model that considered price differences between four procurement methods used by meatpacking firms. The methods considered by Ward et al. 1996a consist of meatpacking firms purchasing over 139,000 pens of finished cattle through: (1) forward contracting, (2) packer feeding operations, (3) marketing or purchasing agreements, and (4) cash market transactions. The authors found that transaction prices associated with forward contracting were significantly less than prices associated with cash transactions. Furthermore, the authors found that transaction prices associated with marketing or purchasing agreements were significantly higher than cash market prices. Ward et al. 1996b developed and estimated a fed cattle transaction price level model using FCMS data that considered price differences between cash and forward contracting marketing methods. The authors found that simulated spot market prices were significantly higher than forward contract prices.

In this study, binary dummy variables ($DMETH_{ij}$) were included in model A to determine price differences between three alternative marketing methods which are: (1) cash marketing, (2) cash forward contracting, and (3) exclusive marketing/procurement agreements. The type of marketing method used in each transaction was specified by the firms involved. Hence, each data record was

numerically coded for any one of the three marketing methods considered in this study by the FCMS data entry system.

Models **B** and **C** consider separate dummy variables related to the marketing method used by each simulated firm throughout the entire marketing period. Ward et al. 1996b found that significantly different, positive and negative price differences exist between forward contracting and cash prices observed by each firm. Ward and Bliss surveyed cattle feeders to determine reasons for the use of forward contracts. The authors found that cattle feeders use forward contracts for different reasons and that cattle feeding firms have different expectations about the reasons meatpacking firms engage in pricing arrangements that involve forward contracts. Model **B** of this study includes twenty-four feedlot-method interaction variables ($DFINT1_{ijt}$ - $DFINT8_{ijt}$). These variables were substituted for the marketing method variables ($DMETH_{ijt}$) in model **A** in order to consider the price differences observed by each of the eight simulated feedlot firms while utilizing each alternative marketing method. Similarly, marketing method variables ($DMETH_{ijt}$) of model **A** are substituted for in model **C** with twelve meatpacker-method interaction variables ($DPINT1_{ijt}$ - $DPINT4_{ijt}$). The meatpacker-method interaction variables ($DPINT1_{ijt}$ - $DPINT4_{ijt}$) allow the consideration of price differences between the three marketing methods observed by each meatpacking firm of the FCMS.

Transaction Price Variability Models

Another combined group of three econometric models was used to examine the transaction price variation questions that are implied in the specific objectives of this study. The first econometric model is a transaction price variability model (Model **D**) which was developed to explain how the specified marketing methods affect the variance of fed cattle transaction prices. The initial transaction price variability model (Model **D**) was specified and estimated as follows:

$$(11)\quad VTPFCA_{it} = \delta_0 + \delta_1 BBP_{t-1} + \delta_2 LCFMP_{t-1} + \delta_3 TM_{t-1} + \delta_4 TSL_{t-1} + \delta_5 PPL_t + \sum_{j=1}^{8} \delta_{6j} DFDLT_{ijt} + \sum_{j=1}^{4} \delta_{7j} DPKR_{ijt} + \sum_{j=1}^{5} \delta_{8j} DWT_{ijt} + \sum_{j=1}^{3} \delta_{9j} DMETH_{ijt} + v_{it}.$$

The second transaction price variability model is a variation of Model **D** which was developed to determine how the specified marketing methods affect the variation in fed cattle transaction prices for each feedlot firm within the simulated fed cattle market. The feedlot-method transaction price variability model (Model **E**) was specified and estimated as follows:

$$(12)\quad VTPFCB_{it} = \delta_0 + \delta_1 BBP_{t-1} + \delta_2 LCFMP_{t-1} + \delta_3 TM_{t-1} + \delta_4 TSL_{t-1} + \delta_5 PPL_t + \sum_{j=1}^{8} \delta_{6j} DFDLT_{ijt} + \sum_{j=1}^{4} \delta_{7j} DPKR_{ijt} + \sum_{j=1}^{5} \delta_{8j} DWT_{ijt} + \sum_{j=1}^{3} \delta_{9j} DFINT1_{ijt} + \sum_{j=1}^{3} \delta_{10j} DFINT2_{ijt} + \sum_{j=1}^{3} \delta_{11j} DFINT3_{ijt} +$$

$$\sum_{j=1}^{3} \delta_{12j} DFINT4_{ijt} + \sum_{j=1}^{3} \delta_{13j} DFINT5_{ijt} + \sum_{j=1}^{3} \delta_{14j} DFINT6_{ijt} +$$

$$\sum_{j=1}^{3} \delta_{15j} DFINT7_{ijt} + \sum_{j=1}^{3} \delta_{16j} DFINT8_{ijt} + v_{it} .$$

where, the feedlot-method interaction variables ($DFINT1_{ijt}$ - $DFINT8_{ijt}$) were substituted for the marketing method variables ($DMETH_{ijt}$) in model **D** (Table 2).

The third transaction price variability model is also a variation of Model **D** which was developed to determine how the specified marketing methods affect the variation of fed cattle transaction prices for each meatpacking firm within the simulated market. The meatpacker-method transaction price variability model (Model **F**) was specified and estimated as follows:

$$(13) \quad VTPFCC_{it} = \delta_0 + \delta_1 BBP_{t-1} + \delta_2 LCFMP_{t-1} + \delta_3 TM_{t-1} + \delta_4 TSL_{t-1} + \delta_5 PPL_t$$

$$+ \sum_{j=1}^{8} \delta_{6j} DFDLT_{ijt} + \sum_{j=1}^{4} \delta_{7j} DPKR_{ijt} + \sum_{j=1}^{5} \delta_{8j} DWT_{ijt} +$$

$$\sum_{j=1}^{3} \delta_{9j} DPINT1_{ijt} + \sum_{j=1}^{3} \delta_{10j} DPINT2_{ijt} + \sum_{j=1}^{3} \delta_{11j} DPINT3_{ijt} +$$

$$\sum_{j=1}^{3} \delta_{12j} DPINT4_{ijt} + v_{it} .$$

where, the meatpacker-method interaction variables ($DPINT1_{ijt}$ - $DPINT4_{ijt}$) were substituted for the marketing method variables ($DMETH_{ijt}$) in model **D**. Definitions of the meatpacker-method interaction variables can be found in Table 2.

Models **D**, **E**, and **F** were estimated using Ordinary Least Squares for unbalanced panel data considering traditional assumptions for the Classical Linear

Regression Model (CLRM). The model was employed by LIMDEP 6.0 econometric software (Greene). The definition of each variable and the expected sign for each coefficient is presented in Table 2. All transaction price variability models utilize the same independent variables and subscript notations that appear in models **A**, **B**, and **C**, respectively. The dependent variables ($VTPFCA_{it}$, $VTPFCB_{it}$, and $VTPFCC_{it}$) of the price variation models (**D**, **E**, and **F**) are represented by the natural logarithm of the squared residuals from models **A**, **B**, and **C**, respectively. The squared residuals serve as unbiased estimates of the variance about the conditional mean of the dependent variable (Judge et al.). In this case the squared residuals are estimates of the variance about the level of transaction prices. A more precise definition of $VTPFCA_{it}$, $VTPFCB_{it}$, and $VTPFCC_{it}$ can be found in Table 2.

Transaction price variability models **D**, **E**, and **F** yielded OLS estimates of impacts that the identified variables have on the variability of transaction price levels in the simulated fed cattle market. A fragility analysis was also considered by using the squared residuals from an OLS transaction price level model with the same independent variables as models **A**, **B**, and **C**, respectively. The resulting variance models were identical in specification and estimation with the exception of specifying OLS squared residuals as the dependent variable instead of the WREM squared residuals. The primary reason for this consideration is centered around the fact that the WREM model most likely does not produce residuals that are consistent estimates of the standard deviation around the conditional mean. This is due to the fact that the WREM corrects for multiplicative heteroskedasticity using the Estimated Generalized Least Squares

technique. However, the results from both types of residual variance models were similar and the conclusions about price variability differences between each marketing method derived from both specifications of variance as dependent variables were identical.

The rationale for including the independent variables of the transaction price level models (**A**, **B**, and **C**) in the residual variance models are similar to the rationale for each that has been discussed above (Table 2). The definition of each variable remains the same but their hypothesized impacts on the variability of transaction prices may be different. The theoretical reasoning behind using transaction price variables found in models **A**, **B**, and **C** of this study is that variables explaining levels of transaction prices are assumed to also explain the variability of transaction prices. Hence, discussion here is limited to the hypothesized transaction price variability differences between the alternative marketing methods considered by this study.

There have been numerous studies detailing the overall impacts of captive supply pricing arrangements or marketing methods on transaction prices, but none have considered the price variability differences due to these marketing methods. The marketing method variables ($DMETH_{ijt}$) used in model **A** are used in model **D** to determine how transaction price variances are different for each of the three different marketing methods considered. $DMETH_{ijt}$ was developed to explain the difference in transaction price variances between spot market prices, forward contracting prices, and exclusive marketing/procurement agreement prices.

Model **E** of this study includes twenty-four feedlot-method interaction variables

($DFINT1_{ijt}$ - $DFINT8_{ijt}$) which were considered by model **B**. These variables were substituted for the marketing method variables ($DMETH_{ijt}$) in model **D** in order to evaluate the price variability differences that were observed by each of the eight simulated feedlot firms due to the utilization of each marketing method. Similarly, in model **F** marketing method variables ($DMETH_{ijt}$) of model **D** were substituted for twelve meatpacker-method interaction variables ($DPINT1_{ijt}$ - $DPINT4_{ijt}$) which were also discussed relative to transaction price level differences in model **C**. The meatpacker-method interaction variables ($DPINT1_{ijt}$ - $DPINT4_{ijt}$) allow the consideration of price variability differences between each of the three marketing methods observed by four individual meatpacking firms of the FCMS.

Empirical Results and Discussion

Model Results

The transaction price level models (**A**, **B**, and **C**) considering price differences between marketing methods 1, 2, and 3 for the entire simulated market and for each simulated firm explained over 80 percent of the variation in fed cattle transaction prices (Table 5). Models **A**, **B**, and **C** were found to be highly significant yielding F-statistics of 584.55, 484.24, and 509.36, respectively. Models **A**, **B**, and **C** yielded estimates of the relevant economic variables and accounted for multiplicative heteroskedasticity within each week and serial correlation throughout the weeks considered by the experimental trading periods. The random effects in model **A**, **B**, and **C** were found to

be highly significant in relation to the specification of the statistical model. In general, this reduced the significance of the independent variables that remained constant within each week of the experimental trading period. The transaction price variability models (**D**, **E**, and **F**) exhibited expectedly low explanations of the variation in the conditional variance estimates (Table 6). However, the models were found to be significant with F-statistics of 11.80, 11, and 12.20, respectively (Table 6). The estimated results for each coefficient form models **A**, **B**, **C**, **D**, **E**, and **F** are also presented in Tables 5 and 6.

Summary Statistics

Descriptive statistics were computed to indicate sample differences in transaction prices arrived at within each marketing method. The statistics take into account the entire marketing period which experienced both high and low levels of cattle being supplied to the market, as well as varying levels of cattle being marketed from week to week. Each of the descriptive statistics are summarized in Table 7. Initially, it is apparent that the exclusive marketing/procurement method (marketing method 3) had the lowest mean price by $0.60/cwt. lower than the cash forward contract method (marketing method 2). Accordingly, cash transactions (marketing method 1) exhibits the highest mean price, also by more than $1/cwt. over marketing method 2 and less than $3/cwt. over marketing method 3.

The variance of transaction prices were also different across the three marketing

methods. Marketing method 1 experienced the highest variance of the three methods which follows a hypothesis found in previous literature concerning the reasoning behind feedlot and meatpacking firms moving from cash marketing or procurement to other forms of marketing or procurement in today's fed cattle market. In addition, marketing method 3 exhibited the lowest overall variance in transaction prices throughout the marketing period. This finding is also in accordance with hypotheses that are found in previous captive supply studies which imply that cattle feeding firms are able to further reduce price variability risk by utilizing alternative marketing methods. It is also apparent that marketing method 3 had the lowest variance of the three methods considered by this study (Table 7). This finding is also helpful in determining possible benefits to cattle feeding firms by utilizing alternative marketing methods.

Descriptive statistics were also computed to evaluate marketing method price differences during the experimental periods of this study (Table 7). During non-agreement periods, the mean price difference between methods 1 and 2 was $0.11/cwt. which can be interpreted as a small difference when compared to the price difference between methods 1 and 2 during the agreement periods. Descriptive statistics computed during the agreement periods also indicate that method 3 has a relatively small price difference when compared to method 2. However, the mean price difference between methods 1 and 3 indicates that method 3 had a lower mean price by $0.69/cwt. during the agreement periods. Descriptive statistics between the agreement and non-agreement periods of this study additionally indicate that the amount of method 2 transactions increased significantly from 2.53% to 5.27% of the total number of

transactions (i.e., 2,770 pens of finished cattle) during the agreement periods. This suggests that marketing strategies were adjusted during the agreement periods in response to the reduction of the supply of fed cattle that were available to the market.

Traditional Price Discovery Variables

The lagged boxed beef price (BBP_{t-1}) has been found in previous research to be significantly related to fed cattle transaction prices (Ward et al. 1996b). In this study, the coefficient for BBP_{t-1} was found to be significant and positive in its relationship to simulated fed cattle transaction prices in each of the three price level models (**A**, **B**, and **C**). Specifically, fed cattle transaction prices were found to be positively impacted by \$0.38/cwt., \$0.37/cwt., and \$0.38/cwt. in models **A**, **B**, and **C**, respectively (Table 5). These findings are consistent with relevant economic theory concerning derived demand and are parallel to findings in previous research (Schroeder et al.; Ward et al. 1996b; Ward 1992). Lagged live cattle futures market prices ($LCFMP_{t-1}$) have also been found in previous research to have significant positive impacts on fed cattle transaction prices (Schroeder et al.; Ward 1981, 1982). Lagged live cattle futures market prices in this study were also found to be positive and significant. Fed cattle transaction prices were found to be positively impacted by \$0.20/cwt., \$0.21/cwt., and \$0.20/cwt. in models **A**, **B**, and **C**, respectively (Table 5).

The relationships between the two cattle supply related variables used in this study and fed cattle transaction prices are consistent with one another and with

economic theory about how changes in the quantity supplied impacts prices within a given market. The total supply of cattle in the market window or the number of cattle available for purchase within a given week is known as the number of cattle on the show list. This type of information is not publicly reported in the real-world market. However, private organizations often attempt to collect show list data from the members of those organizations (Ward et al. 1996b). The total number of pens of cattle (100 hd./pen) on the show list for the previous week (TSL_{t-1}) has been found in a previous studies to have a negative and significant relationship with fed cattle transaction prices (Ward et al. 1996b; Bacon, Trapp, and Koontz). Here, the coefficient for TSL_{t-1} is also negative and significant in its relationship to fed cattle transaction prices in each of the three price level models considered by this study (**A**, **B**, and **C**). Specifically, simulated fed cattle transaction prices are found to be negatively impacted by \$0.06/cwt. in models **A**, **B**, and **C**, (Table 5). The number of cattle marketed by feedlots or slaughtered by meatpackers has been considered in two previous studies. Schroeder et al. found that the number of cattle marketed or slaughtered significantly affects fed cattle transaction prices. However, Ward et al. 1996b did not find that the total number of cattle marketed in each simulated week significantly impacted fed cattle transaction prices. In the FCMS setting, this number is reported at the end of each week. As a result, the subjects are allowed to use the total number of marketings from the previous week (TM_{t-1}) to formulate and arrive at bid or ask prices for pens of finished cattle during the current week or trading period. In this study, TM_{t-1} is found to have a negative and significant relationship to fed cattle

transaction prices which is similar to the impact of TSL_{t-1}. The coefficient in models **A**, **B**, and **C** indicates that simulated fed cattle transaction prices decrease by $0.76/cwt. with a one pen increase in the number of pens marketed for the previous week (Table 5).

Ward et al. 1996b notes that a specific type of firm behavior is commonly observed in the FCMS setting which is related to the manner in which meatpacking firms and feedlot firms share available profits. The authors suggest that feedlot firms are more often willing to be satisfied with a targeted profit margin that can be realized by feeding and marketing finished cattle. The authors also suggest that meatpacking firms more often attempt to gain the profits available to the market within a given time period that are produced by purchasing finished cattle and selling the beef produced by those cattle. As a result, when there are known profits to be shared in the fed cattle market, meatpacking firms commonly attempt to capture the largest portion of the amount to be negotiated. Much like in the real world, the subjects of the FCMS are able to calculate the meatpacker and feedlot break-even price for 1150 lb. cattle from week to week. The difference in the largest meatpacking firm's break-even price for 1150 lb. cattle and the feedlot firms' break-even price for 1150 lb. cattle is a proxy in this study for the amount of profits or losses to be shared in a particular week or the bargaining range. This amount will be referred to as the potential profit/loss for each week (PPL_t). Previous research results have indicated that there is a negative and significant relationship between PPL_t and fed cattle transaction prices (Ward 1996b; Ward 1981). Results found in this study (models **A**, **B**, and **C**) are consistent with

previous findings in that a $1/cwt. increase in the potential profit/loss for each week is associated with a $0.13/cwt. decrease in fed cattle transaction prices.

Differences in managerial and negotiation skills have been found to exist between individuals within the firms that participate in most markets. These differences become collective for each firm as the individuals work together to accomplish a common set of goals. Previous research has indicated that these collective differences result in different types of market behavior and performance which is often linked to the price differences among competing firms (Ward et al. 1996b; Carlton and Perloff). Previous research findings using the FCMS suggest that significant price differences do indeed occur between the simulated meatpacking and feedlot firms (Ward et al. 1996b). In this study, several of the simulated feedlot firms ($DFDLT_1$ - $DFDLT_8$) received significantly higher prices for the cattle marketed than other feedlot firms. Accordingly, three of the simulated meatpacking firms ($DPKR_1$ - $DPKR_4$) received lower prices for the cattle that were purchased than the other meatpacking firm. These results are consistent with previous findings that consider price differences among firms (Jones et al.; Schroeder et al.; Ward 1982, 1992, 1996b). Significant feedlot price differences found here range from $0.68/cwt. to $0.25/cwt. higher than the mean price received by Feedlot #1 in models **A**, **B**, and **C**. Significant price differences among the meatpacking firms range from $0.47/cwt. to $0.28/cwt. lower that the mean price paid for Meatpacker #1. These results are not consistent with economies of size theory due to the fact that the smallest meatpacker (#1) paid the highest price on average. Economies of size studies typically suggest that

the largest meatpacking firm can pay the highest price given that there is adequate inter-firm competition within the market (Ward 1993). Similar results were found by Ward et al. 1996b where the authors suggested that these results may be due to differences in managerial skills of the individuals operating the simulated firms.

Significant transaction price differences were found in relation to cattle quality characteristics. Ward et al. 1996b found that simulated fed cattle weights representing constant quality characteristics significantly affected fed cattle transaction prices. These findings are parallel to previous research considering cattle quality characteristics (Jones et al.; Ward 1981, 1982, 1992; Schroeder et al.). In this study, results from models **A**, **B**, and **C** indicate that heavier weight classes (DWT_4 and DWT_5) are more severely discounted by meatpackers than lighter weight classes compared to the optimal weight class (DWT_3). Mean break-even prices for each weight class realized by each firm indicate that the 1150 lb. weight class provides simulated firms with the largest amount of profits to be shared (Figure 1). These results parallel hypothesized break-even price relationships for each simulated firm in the FCMS (Koontz et al 1994a). An optimal weight class is considered in this study to be a weight class of cattle that allows individual meatpacking and feedlot firms to share the greatest amount of profits or minimize losses (Figure 1). The quality characteristics of each weight group are described in Table 3. Significant price differences for heavy weight classes (DWT_4 or DWT_5) range from \$0.40/cwt. (model **B**) to \$0.32/cwt. (model **C**) lower than the optimal weight class (DWT_3). Results from models **D**, **E**, and **F** indicate that prices are more variable for lighter and heavier weight classes than for the optimal weight class.

Descriptive statistics computed for each weight group reinforce model results by indicating a general mean price level decrease as simulated firms moved from marketing the lightest weight class to the heaviest weight class (Table 8 and Figure 2).

Marketing Method Variables

Specific types of captive supplies have been found in previous research to have a negative relationship with fed cattle transaction prices (Schroeder et al.; Barkley and Schroeder; Ward et al. 1996a). This study examines two types of captive supplies, cash forward contracting and exclusive marketing/procurement agreements. This study determines the price differences between two captive supply pricing arrangements or marketing methods and cash market prices. Results from model **A** suggest that significant price differences did not occur between cash market prices (marketing method 1) and cash forward contracts (marketing method 2). Previous research results concerning the price difference between these two methods have been mixed (Ward et al. 1996a and Schroeder et al.). However, model **A** results do suggest there is a negative and significant price difference between the exclusive marketing/procurement marketing method (marketing method 3) and method 1 ($DMETH_3$). Specifically, the mean price for method 3 ($DMETH_3$) was \$0.73/cwt. lower on average than the mean price realized by the firms that utilized marketing method 1 ($DMETH_1$). In addition to different mean prices, the method 3 coefficient ($DMETH_3$) for model **D** suggests that prices were significantly less variable \$0.54/cwt. on average than the price variance for

marketing method 1 ($DMETH_1$). The method 2 coefficient ($DMETH_2$) in model **D** indicates that method 2 had a significantly lower price variance by \$0.63/cwt. lower than the price variance of method 1 ($DMETH_1$). Price differences between method 1, method 2, and method 3 are presented in Figure 3.

This study also considers the price differences between marketing methods 1, 2, and 3 that are realized by individual meatpacking and feedlot firms. Descriptive statistics for the methods considered by each firm are presented in Table 9 and price differences realized by each firm are presented in Figures 4, 5, and 6. Results from model **B** indicate that Feedlot #4 and Feedlot #8 received significantly different prices for method 2 transactions ($DFINT4_2$ and $DFINT8_2$) by \$0.81/cwt. and \$0.49/cwt. lower than method 1 prices, respectively. Results from model **B** also indicate that Feedlot #1 received significantly higher prices for method 2 transactions ($DFINT1_2$) by \$0.44/cwt. higher than method 1. The participating firms of the exclusive marketing/procurement agreements in this study include Feedlot #2, Feedlot #5, and Meatpacker #4. Results from model B indicate that Feedlot #2 and Feedlot #5 received significantly different prices for method 3 transactions than for method 1 transactions. Specifically, results indicate that Feedlot #2 and Feedlot #5 received prices for method 3 transactions ($DFINT2_3$ and $DFINT5_3$) that were \$0.45/cwt. and \$0.63/cwt. lower than method 1 prices, respectively. Results from model **C** indicate that Meatpacker #2 and Meatpacker #4 received significantly different prices for method 2 transactions ($DPINT2_2$ and $DPINT4_2$) by \$0.59/cwt. and \$0.30/cwt. lower than method 1 prices, respectively. In addition to lower method 2 prices, Meatpacker #4 was found to

receive significantly lower prices for method 3 transactions. Specifically, results indicate that Meatpacker #4 received prices for method 3 transactions ($DPINT4_3$) that were \$0.66/cwt. lower than those received for method 1 transactions.

This study also extends beyond previous captive supply studies by evaluating price variance differences for three marketing methods that are realized by individual firms of the FCMS (Table 9). Results from model **E** indicate that price variability differences were not realized by a majority of the simulated cattle feeding firms while utilizing either marketing method 2 or marketing method 3. Specifically, Feedlot #5 was the only cattle feeding firm with a significantly different price variance for method 2 transactions ($DFINT5_3$) by \$5.15/cwt. higher than the price variance for method 1 transactions. An unexpectedly high variance difference between method 1 and method 2 could possibly be a result of the fact that Feedlot #5 used a small amount of forward contracting in its marketing strategy relative to the number of forward contracts used by the other cattle feeding firms. In contrast, results from model **F** indicate that significant price variance differences between marketing methods 1 and 2 were realized by meatpacking firms. Specifically, model **F** results indicate that meatpacking firms #1, #3, and #4 realized significantly higher price variances for method 2 transactions ($DPINT1_2$, $DPINT3_2$, and $DPINT4_2$) by \$1.23/cwt., \$0.82/cwt., and \$5.38/cwt. higher, respectively than the price variances realized for marketing method 1 transactions.

Summary, Implications, and Conclusions

This study focused on cash, forward contracting, and exclusive marketing/procurement pricing arrangements which are recognized as alternative marketing methods used by cattle feeding and meatpacking firms in fed cattle markets. Each of the three methods were observed within an experimental simulation setting. These methods have evolved to become common components of the marketing and procurement strategies used by large meatpacking and cattle feeding firms in the current fed cattle market. As a result of structural changes in the fed cattle market over the past decade, large firms limit the amount of price discovery data that are available to the public. These data are imperative to economic research that attempts to adequately answer industry and market questions about price differences between alternative marketing methods in the fed cattle market. The Fed Cattle Market Simulator (FCMS) was developed to provide a realistic market framework and institutional structure which allows market participants to complete decision making processes in an experimental simulation setting (Ward et al. 1996b). This setting was used to evaluate the price level and variability differences between cash transactions, forward contracting, and exclusive marketing/procurement agreements. By allowing each of the firms within the simulated market to utilize each marketing method, many real-world data limitations are overcome.

Data for this study were provided by university junior and senior level agricultural economics and animal science students who were participants of the FCMS

during the Spring 1995 semester at Oklahoma State University. Transaction price level and variability models were employed to determine the manner in which fed cattle transaction prices differ between three different marketing methods. Over 75 weeks of trading were evaluated which provided 2,770 independent transactions throughout the entire experimental trading period.

Several economic variables were found to be generally consistent with a prior FCMS study (Ward et al. 1996b) and other research projects dealing with fed cattle transaction prices (Jones et al.; Schroeder et al.; Ward 1981, 1982, 1992). These variables include boxed beef prices from the previous week, live cattle futures market prices from the previous week, the potential profit/loss within each week, total marketings/slaughter from the previous week, the number of cattle on the show list from the previous week, the individual feedlot firms, and the individual meatpacking firms. Results indicate a significant positive relationship exists between fed cattle transaction prices and both lagged boxed beef prices and lagged live cattle futures market prices. The number of head on the total show list and the number of cattle marketed each week were consistent with economic theory in that they had significant negative impacts on fed cattle transaction prices as supply variables. The amount of potential profit/loss to be shared by the meatpacking firms and feedlot firms was found to have a significant and negative effect on fed cattle transaction prices. This is parallel to findings in a previous study that relates the inverse relationship of the bargaining range to the cost-plus strategy that is believed to be followed by cattle feeding firms (Ward 1996b).

Differences in the prices paid by meatpacking firms and the prices received by cattle feeding firms were found to be inconsistent with economies of size theory (Ward 1993) but consistent with previous research (Ward et al. 1996b). An explanation that is commonly offered for this discrepancy is that managerial skills differ among individuals within each firm. These differences are magnified as a group of individuals cooperate to achieve similar goals which affects the way a feedlot or meatpacking firm or team behaves within a market. Hence, behavioral differences can be attributed to the manner in which prices were different between the simulated firms in this study. The behavioral differences among firms are associated with different marketing or procurement strategies utilized by each firm which yield price differences among firms during a given market period.

The central question to be answered by this study is centered around price level and variability differences between three specific and commonly used marketing methods used by cattle feeding and meatpacking firms in the fed cattle market. Research findings indicate that there are significant price level and variability differences between cash, forward contracting, and exclusive marketing/procurement agreements in the fed cattle market. Results indicate that meatpacking and cattle feeding firms experience significantly lower price levels while utilizing the marketing/procurement agreement marketing method relative to the cash marketing method. Furthermore, results indicate significantly lower price variances are realized by meatpacking and cattle feeding firms while utilizing the marketing/procurement agreement marketing method relative to the cash marketing method. Significantly

different price levels for forward contracting transactions were not found relative to cash transactions in this study. This finding is not parallel to recent studies such as Schroeder et al., Ward et al. 1996a, and Ward et al. 1996b. However, results suggest that significantly lower price variances are realized for firms utilizing the forward contracting marketing method relative to the cash transaction method. Implications from these findings are: (1) cattle feeding firms are willing to accept lower prices and subsequently lower profits in order ensure that cattle inventories are kept current and (2) both cattle feeding and meatpacking firms potentially benefit from less variable market prices for cash forward contract transactions.

Future research involving the use of experimental simulation is possible provided that an adequate market and institutional structure is developed. The FCMS is an example of an experimental simulation setting that allows its participants to learn from the consequences of different types of decisions that are made in the fed cattle price discovery process. This creates a realistic relationship between the simulated cattle feeding and meatpacking firms which can be experimentally evaluated by the application of experimental models of real-world occurrences in the fed cattle market. The FCMS offers an opportunity to extend the topic considered in this study to determining the effectiveness of the three marketing methods specified in reducing risk and stabilizing profits for cattle feeding and meatpacking firms in the fed cattle market. Beyond price difference issues within the fed cattle market, there are growing numbers of fed cattle market questions that could be adequately addressed using experimental simulation approaches within the FCMS.

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TABLE 1: SUMMARY OF MEAN AND VARIANCE HYPOTHESIS TESTS CONSIDERED FOR EACH MARKETING METHOD

Value Considered	Null Hypothesis (H_o)	Alternative Hypothesis (H_a)
Mean Prices Between Methods		
Method 1 vs. Method 2	The mean price[a] of method 2 is equal to the mean price of method 1 $(\bar{x}_1 - \bar{x}_2 = 0)$.	The mean price of method 2 is not equal to the mean price of method 1 $(\bar{x}_1 - \bar{x}_2 \neq 0)$.
Method 1 vs. Method 3	The mean price of method 3 is equal to the mean price of method 1 $(\bar{x}_1 - \bar{x}_3 = 0)$.	The mean price of method 3 is not equal to the mean price of method 1 $(\bar{x}_1 - \bar{x}_3 \neq 0)$.
Mean Firm Prices Between Methods		
Method 1 For Each Firm vs. Method 2 For Each Firm	The mean price of method 2 is equal to the mean price of method 1 for each firm $(\bar{x}_1 - \bar{x}_2 = 0)$.	The mean price of method 2 is not equal to the mean price of method 1 for each firm $(\bar{x}_1 - \bar{x}_2 \neq 0)$.
Method 1 For Each Firm vs. Method 3 For Each Firm	The mean price of method 3 is equal to the mean price of method 1 for each firm $(\bar{x}_1 - \bar{x}_3 = 0)$.	The mean price of method 3 is not equal to the mean price of method 1 for each firm $(\bar{x}_1 - \bar{x}_3 \neq 0)$.
Variance of Prices Between Methods		
Method 1 vs. Method 2	The price variance of method 2 is equal to the price variance of method 1 $(\sigma_1^2 - \sigma_2^2 = 0)$.	The price variance of method 2 is not equal to the price variance method 1 $(\sigma_1^2 - \sigma_2^2 \neq 0)$.

TABLE 1: CONTINUED

Value Considered	Null Hypothesis (H_o)	Alternative Hypothesis (H_a)
Variance of Prices Between Methods		
Method 1 vs. Method 3	The price variance of method 3 is equal to the price variance of method 1 ($\sigma_1^2 - \sigma_3^2 = 0$).	The price variance of method 2 is not equal to the price variance method 1 ($\sigma_1^2 - \sigma_3^2 \neq 0$).
Variance of Firm Prices Between Methods		
Method 1 For Each Firm vs. Method 2 For Each Firm	The price variance of method 2 is equal to the price variance of method 1 for each firm ($\sigma_1^2 - \sigma_2^2 = 0$).	The price variance of method 2 is not equal to the price variance method 1 for each firm ($\sigma_1^2 - \sigma_2^2 \neq 0$).
Method 1 For Each Firm vs. Method 3 For Each Firm	The price variance of method 3 is equal to the price variance of method 1 for each firm ($\sigma_1^2 - \sigma_3^2 = 0$).	The price variance of method 2 is not equal to the price variance method 1 for each firm ($\sigma_3^2 - \sigma_3^2 \neq 0$).

[a] All prices are reported in $/cwt.

TABLE 2: VARIABLE DEFINITIONS FOR MODELS A, B, C, D, E, AND F WITH EXPECTED SIGNS

Variables	Definition of Variable	Expected Sign
Dependent Variables		
$TPFC_{it}$	i^{th} transaction price for one pen of fed cattle ($/cwt.) in week t	N/A
$VTPFCA_{it}$	The natural log of the i^{th} transaction price variance estimate ($/cwt.) calculated from model **A** in week t	N/A
$VTPFCB_{it}$	The natural log of the i^{th} transaction price variance estimate ($/cwt.) calculated from model **B** in week t	N/A
$VTPFCC_{it}$	The natural log of the i^{th} transaction price variance estimate ($/cwt.) calculated from model **C** in week t	N/A
Independent Variables		
BBP_{t-1}	The boxed beef price ($/cwt.) for Choice Yield Grades 1-3 550-700 lb. carcasses, lagged one week	Positive
$LCFMP_{t-1}$	The live cattle futures market closing price ($/cwt.) for the nearby contract period, lagged one week	Positive
TM_{t-1}	The total number of pens marketed or slaughtered (100hd./pen), lagged one week	Negative
TSL_{t-1}	The total number of pens of cattle (100hd./pen) on the market ready show list, lagged one week	Negative
PPL_t	The potential profit or loss in week t which is the largest meatpacker's break-even price ($/cwt.) for 1,150 lb. cattle less the mean feedlot break-even price ($/cwt.) for 1,150 lb. cattle	Negative
$DFDLT_{ijt}$	Binary dummy variables distinguishing each individual feedlot firm, j=1-8, 1=FDLT1 (Base), 2=FDLT2, 3=FDLT4, 4=FDLT4, 5=FDLT5, 6=FDLT6, 7=FDLT7, and 8=FDLT8	Pos./Neg.
$DPKR_{ijt}$	Binary dummy variables distinguishing each individual meatpacking firm, j=1-4, 1=PKR1 (Base), 2=PKR2, 3=PKR4, and 4=PKR4	Pos./Neg

TABLE 2: CONTINUED

Variables	Definition of Variable	Expected Sign
Independent Variables		
DWT_{ijt}	Binary dummy variables distinguishing the 5 different weight classes, j = 1-5, 1=1100 lbs., 2=1125 lbs., 3=1150 lbs. (Base), 4=1175 lbs. , and 5=1200 lbs.	Pos./Neg.
$DMETH_{ijt}$	Binary dummy variables distinguishing the alternative marketing methods, j=1-3, 1=Marketing Method 1 (Base), 2=Marketing Method 2, and 3=Marketing Method 3	Pos./Neg.
$DFINT1_{ijt}$	Binary dummy variables distinguishing the feedlot-marketing method interaction variables for feedlot #1, j=1-3, 1=Marketing Method 1 (Base), 2=Marketing Method 2, and 3=Marketing Method 3	Pos./Neg.
$DFINT2_{ijt}$ [a]	Binary dummy variables distinguishing the feedlot-marketing method interaction variables for feedlot #2, j=1-3, 1=Marketing Method 1 (Base), 2=Marketing Method 2, and 3=Marketing Method 3	Pos./Neg.
$DFINT3_{ijt}$	Binary dummy variables distinguishing the feedlot-marketing method interaction variables for feedlot #3, j=1-3, 1=Marketing Method 1 (Base), 2=Marketing Method 2, and 3=Marketing Method 3	Pos./Neg.
$DFINT4_{ijt}$	Binary dummy variables distinguishing the feedlot-marketing method interaction variables for feedlot #4, j=1-3, 1=Marketing Method 1 (Base), 2=Marketing Method 2, and 3=Marketing Method 3	Pos./Neg.
$DFINT5_{ijt}$ [a]	Binary dummy variables distinguishing the feedlot-marketing method interaction variables for feedlot #5, j=1-3, 1=Marketing Method 1 (Base), 2=Marketing Method 2, and 3=Marketing Method 3	Pos./Neg.

TABLE 2: CONTINUED

Variables	Definition of Variable	Expected Sign
Independent Variables		
$DFINT6_{ijt}$	Binary dummy variables distinguishing the feedlot-marketing method interaction variables for feedlot #6, j=1-3, 1=Marketing Method 1 (Base), 2=Marketing Method 2, and 3=Marketing Method 3	Pos./Neg.
$DFINT7_{ijt}$	Binary dummy variables distinguishing the feedlot-marketing method interaction variables for feedlot #7, j=1-3, 1=Marketing Method 1 (Base), 2=Marketing Method 2, and 3=Marketing Method 3	Pos./Neg.
$DFINT8_{ijt}$	Binary dummy variables distinguishing the feedlot-marketing method interaction variables for feedlot #8, j=1-3, 1=Marketing Method 1 (Base), 2=Marketing Method 2, and 3=Marketing Method 3	Pos./Neg.
$DPINT1_{ijt}$	Binary dummy variables distinguishing the meatpacker-marketing method interaction variables for meatpacker #1, j=1-3, 1=Marketing Method 1 (Base), 2=Marketing Method 2, and 3=Marketing Method 3	Pos./Neg.
$DPINT2_{ijt}$	Binary dummy variables distinguishing the meatpacker-marketing method interaction variables for meatpacker #2, j=1-3, 1=Marketing Method 1 (Base), 2=Marketing Method 2, and 3=Marketing Method 3	Pos./Neg.
$DPINT3_{ijt}$	Binary dummy variables distinguishing the meatpacker-marketing method interaction variables for meatpacker #3, j=1-3, 1=Marketing Method 1(Base), 2=Marketing Method 2, and 3=Marketing Method 3	Pos./Neg.

TABLE 2: CONTINUED

Variables	Definition of Variable	Expected Sign
Independent Variables		
$DPINT4_{ijt}$ [b]	Binary dummy variables distinguishing the meatpacker-marketing method interaction variables for meatpacker #4, j=1-3, 1=Marketing Method 1(Base), 2=Marketing Method 2, and 3=Marketing Method 3	Pos./Neg.

[a] Feedlot #2 and feedlot #5 were the only cattle feeding firms that utilized marketing method 3. Hence, marketing method 3 variables will not be reported in subsequent tables for all cattle feeding firms except feedlot #2 and feedlot #5.

[b] Meatpacker #4 was the only meatpacking firm that utilized marketing method 3. Hence, marketing method 3 variables will not be reported in subsequent tables for all meatpacking firms except meatpacker #4.

TABLE 3: FCMS CATTLE QUALITY CHARACTERISTICS BY WEIGHT CLASS

Weight Class	Carcass Weight	Dressing Percentage	Choice %/Pen	Select %/Pen	Yield Grade 1-3 %/Pen	Yield Grade 4-5 %/Pen	Light Carcass %/Pen	Heavy Carcass %/Pen
DWT_1 [a]	682 [b]	62.0	59	41	98.5	1.5	10	0
DWT_2	703	62.5	63	37	97.0	3.0	5	0
DWT_3	724	63.0	67	33	95.5	4.5	0	0
DWT_4	746	63.5	71	29	93.5	6.5	0	5
DWT_5	768	64.0	75	25	91.0	9.0	0	10

[a] All variable definitions and their respective units of measure are presented in table 2.
[b] Carcass weights are reported in pounds.

TABLE 4: FCMS QUALITY RELATED PRICE DISCOUNTS

	Price Discounts
Select Quality Grade or Below	($5.00/cwt.) * (Select %/Pen)
Yield Grade (YG) 4's and 5's	($10.00/cwt.) * (YG 4-5 %/Pen)
Light Carcasses	($2.00/cwt.) * (Light Carcass %/Pen)
Heavy Carcasses	($2.00/cwt.) * (Heavy Carcass %/Pen)

TABLE 5: ESTIMATED IMPACTS OF THE RELEVANT ECONOMIC VARIABLES ON THE LEVEL OF FED CATTLE TRANSACTION PRICES

	Transaction Price Level Models		
Explanatory Variable	Model **A**	Model **B**	Model **C**
Intercept	28.9780 *** [a]	29.0860 ***	28.9210 ***
	(4.701) [b]	(5.043)	(4.732)
BBP_{t-1}	0.3757 ***	0.3721 ***	0.3753 ***
	(14.834)	(15.173)	(14.949)
$LCFMP_{t-1}$	0.1733 ***	0.1750 ***	0.1745 ***
	(2 777)	(2.999)	(2.820)
TM_{t-1}	-0.0718 ***	-0.0717 ***	-0.0656 ***
	(-3.325)	(-3.547)	(-3.064)
TSL_{t-1}	-0 0651 ***	-0.0647 ***	-0.0672 ***
	(-6.380)	(-6.780)	(-6.650)
PPL_t	-0.1239 ***	-0.1310 ***	-0.1171 ***
	(-3.004)	(-3.400)	(-2.864)
$DFDLT_1$	Base	Base	Base
$DFDLT_2$	0.2617 ***	0.3160 ***	0.2504 ***
	(3.058)	(3.122)	(3.004)
$DFDLT_3$	0.4843 ***	0.6537 ***	0.4694 ***
	(5.904)	(7.018)	(5.720)
$DFDLT_4$	0.3545 ***	0.5762 ***	0.3678 ***
	(4.441)	(6.365)	(4.691)
$DFDLT_5$	0.4016 ***	0.5356 ***	0.3497 ***
	(4.794)	(5.579)	(4.333)
$DFDLT_6$	0.2907 ***	0.4661 ***	0.2858 ***
	(3.581)	(5.218)	(3.605)
$DFDLT_7$	0 1447 *	0 37177 ***	0.1982 **
	(1.730)	(3.973)	(2.415)
$DFDLT_8$	0.0609	0.2400 ***	0.0764
	(0.756)	(2.706)	(0.983)
$DPKR_1$	Base	Base	Base
$DPKR_2$	-0.3232 ***	-0.4155 ***	-0.2557 ***
	(-5.300)	(-6.923)	(-4.180)

TABLE 5: CONTINUED

	Transaction Price Level Models		
Explanatory Variable	Model **A**	Model **B**	Model **C**
$DPKR_3$	-0.3695 ***	-0.3037 ***	-0.3327 ***
	(-6.881)	(-5.360)	(-6.363)
$DPKR_4$	-0.1037 *	-0.1440 **	-0.1246 **
	(-1.860)	(-2.471)	(-2.293)
DWT_1	0.2615	0.3478	0.2092
	(0.551)	(0.680)	(0.446)
DWT_2	-0.1294 *	-0.0711	-0.1734 **
	(-1.810)	(-0.986)	(-2.436)
DWT_3	Base	Base	Base
DWT_4	-0.3578 ***	-0.3563 ***	-0.3205 ***
	(-5.047)	(-4.716)	(-4.517)
DWT_5	-0.3703	-0.3974 *	-0.3586
	(-1.630)	(-1.676)	(-1 586)
$DMETH_1$	Base	N/A[c]	N/A[d]
$DMETH_2$	-0.1328		
	(-1.583)		
$DMETH_3$	-0.7301 ***		
	(-8.775)		
$DFINT1_1$	N/A[c]	Base	
$DFINT1_2$		0.4378 ***	
		(2.840)	
$DFINT2_1$		Base	
$DFINT2_2$		-0.3267	
		(-0.834)	
$DFINT2_3$		-0.4515 ***	
		(-4.217)	
$DFINT3_1$		Base	
$DFINT3_2$		0.1833	
		(0.956)	
$DFINT4_1$		Base	

TABLE 5: CONTINUED

	Transaction Price Level Models		
Explanatory Variable	Model **A**	Model **B**	Model **C**
$DFINT4_2$		-0.8104 ***	
		(-4.943)	
$DFINT5_1$		Base	
$DFINT5_2$		0.4586	
		(1.454)	
$DFINT5_3$		-0.6281 ***	
		(-5.936)	
$DFINT6_1$		Base	
$DFINT6_2$		[f]	
$DFINT7_1$		Base	
$DFINT7_2$		-0.1910	
		(-0.665)	
$DFINT8_1$		Base	
$DFINT8_2$		-0.4868 ***	
		(-4.740)	
$DPINT1_1$			Base
$DPINT1_2$			0.1014
			(0.299)
$DPINT2_1$			Base
$DPINT2_2$			-0.5851 ***
			(-4.439)
$DPINT3_1$			Base
$DPINT3_2$			-0.3932 *
			(-2.273)
$DPINT4_1$			Base

TABLE 5: CONTINUED

Explanatory Variable	Transaction Price Level Models		
	Model **A**	Model **B**	Model **C**
$DPINT4_2$			-0.3000 ***
			(-5.254)
$DPINT4_3$			-0.6622 ***
			(-8.024)
Model Statistics			
N	2770	2770	2770
Adjusted R^2	0.8171	0.8318	0.8166
$F_{[21, 2748]}$ [g]	584.5470 ***		
$F_{[28, 2741]}$		484.2402 ***	
$F_{[24, 2745]}$			509.3609 ***

[a] Significance levels are denoted as follows:
*** significant @ the 1% level of significance,
** significant @ the 5% level of significance,
and * significant @ the 10% level of significance.

[b] All figures presented in parenthesis are the calculated t-statistics for each coefficient.

[c] Model **B** replaced marketing method variables with feedlot-marketing method interaction variables

[d] Model **C** replaced marketing method variables with meatpacker-marketing method interaction variables.

[e] Feedlot-marketing method and meatpacker-marketing method variables were not included in model **A**.

[f] Feedlot #6 did not utilize marketing method 2.

[g] The F-statistic in this study was used in a hypothesis test which is structured as follows:

Null Hypothesis (H_o):	The estimated coefficients in the respective model (**A**, **B**, or **C**) are equal to zero.
Alternative Hypothesis (H_a):	At least one of the estimated coefficients in the respective model (**A**, **B**, or **C**) is significantly different from zero.

TABLE 6: ESTIMATED IMPACTS OF THE RELEVANT ECONOMIC VARIABLES ON THE VARIABILIY OF FED CATTLE TRANSACTION PRICES

	Transaction Price Variability Models		
Explanatory Variable	Model **D**	Model **E**	Model **F**
Intercept	25.963 [a] *** [b]	25.392 ***	27.809 ***
	(3.666) [c]	(7.106)	(7.549)
BBP_{t-1}	0.0143	0.0099	0.0068
	(0.937)	(0.667)	(0.444)
$LCFMP_{t-1}$	-0.2832 ***	-0.2651 ***	-0.2978 ***
	(-7.708)	(-7.397)	(-8.069)
TM_{t-1}	-0.4502 ***	-0.0358 ***	-0.0308 **
	(-3.522)	(-2.875)	(-2.398)
TSL_{t-1}	-0 0094	-0.0153 **	-0.0123 *
	(-1.421)	(-2.362)	(-1.842)
PPL_t	-0.0974 ***	-0.0782 ***	-0 0916 ***
	(-3.811)	(-3.138)	(-3.560)
$DFDLT_1$	Base	Base	Base
$DFDLT_2$	-1.1410 ***	-1.1628 ***	-1.2867 ***
	(-4 001)	(-3.719)	(-4.470)
$DFDLT_3$	-2 0749 ***	-2.0034 ***	-2.1458 ***
	(-7.541)	(-7.100)	(-7.706)
$DFDLT_4$	-1.7327 ***	-1.6375 ***	-1.8265 ***
	(-6.535)	(-5.835)	(-6.813)
$DFDLT_5$	-0.9105 ***	-1.1834 ***	-1 1487 ***
	(-3.236)	(-3.756)	(-3.997)
$DFDLT_6$	-0.7818 ***	-0.7095 ***	-0.8338 ***
	(-2.961)	(-2.644)	(-3.127)
$DFDLT_7$	-0.9700 ***	-0.8873 ***	-0.9876 ***
	(-3.686)	(-3.201)	(-3 731)
$DFDLT_8$	-1.7853 ***	-1.7079 ***	-1.7869 ***
	(-6.756)	(-6.232)	(-6.699)
$DPKR_1$	Base	Base	Base
$DPKR_2$	0.2677	0.1807	0.4270 **
	(1.309)	(0.907)	(1.977)

TABLE 6: CONTINUED

Explanatory Variable	Transaction Price Variability Models		
	Model **D**	Model **E**	Model **F**
$DPKR_3$	0.1182	0.1257	0.1595
	(0.599)	(0.651)	(0.786)
$DPKR_4$	0.2248	0.0873	0.2694
	(1.084)	(0.432)	(1.277)
DWT_1	-0.1389	-0.4627	-0.1109
	(-0.123)	(-0.421)	(-0.098)
DWT_2	0.6281 ***	0.5886 **	0.6825 ***
	(2.617)	(2.519)	(2.829)
DWT_3	Base	Base	Base
DWT_4	1.3569 ***	1.4859 ***	1.3989 ***
	(6.337)	(7 114)	(6.516)
DWT_5	2.2326 ***	2.2776 ***	2.3245 ***
	(4.894)	(5.125)	(5.099)
$DMETH_1$	Base	N/A[d]	N/A[e]
$DMETH_2$	-0.6288 **		
	(-2.433)		
$DMETH_3$	-0.5440 *		
	(-1.838)		
$DFINT1_1$	N/A[f]	Base	
$DFINT1_2$		0.0867	
		(0.204)	
$DFINT2_1$		Base	
$DFINT2_2$		-0.2361	
		(-0.222)	
$DFINT2_3$		-0.4556	
		(-1.211)	
$DFINT3_1$		Base	
$DFINT3_2$		-0.5556	
		(-0.551)	
$DFINT4_1$		Base	
$DFINT4_2$		-0.1621	
		(-0.285)	

TABLE 6: CONTINUED

	Transaction Price Variability Models		
Explanatory Variable	Model **D**	Model **E**	Model **F**
$DFINT5_1$		Base	
$DFINT5_2$		5.1510 ***	
		(7.786)	
$DFINT5_3$		-0.1937	
		(-0.494)	
$DFINT6_1$		Base	
$DFINT6_2$		[8]	
$DFINT7_1$		Base	
$DFINT7_2$		0.5155	
		(0.803)	
$DFINT8_1$		Base	
$DFINT8_2$		-0.5091	
		(-0.690)	
$DPINT1_1$			Base
$DPINT1_2$			1.2283 *
			(1.866)
$DPINT2_1$			Base
$DPINT2_2$			0.1441
			(0.396)
$DPINT3_1$			Base
$DPINT3_2$			0.8236 *
			(1.796)
$DPINT4_1$			Base
$DPINT4_2$			5.3816 ***
			(5.388)
$DPINT4_3$			-0.3167 *
			(-1.658)

TABLE 6: CONTINUED

Explanatory Variable	Transaction Price Variability Models		
	Model **D**	Model **E**	Model **F**
Model Statistics			
N	2770	2770	2770
Adjusted R^2	0.0827	0.1010	0.0964
$F_{[21, 2748]}$ [h]	11.8036 ***		
$F_{[28, 2741]}$		10.9965 ***	
$F_{[24, 2745]}$			12.2024 ***

[a] All coefficient results are reported as the exponential value of the estimated coefficient.

[b] Significance levels are denoted as follows:
*** significant @ the 1% level of significance,
** significant @ the 5% level of significance,
and * significant @ the 10% level of significance.

[c] All values presented in parenthesis are the calculated t-statistics for each coefficient.

[d] Model **E** replaced marketing method variables with feedlot-marketing method interaction variables.

[e] Model **F** replaced marketing method variables with meatpacker-marketing method interaction variables.

[f] Feedlot-marketing method and meatpacker-marketing method variables were not included in model **D**.

[g] Feedlot #6 did not utilize marketing method 2

[h] The F-statistic in this study was used in a hypothesis test which is structured as follows:

Null Hypothesis (H_o): The estimated coefficients in the respective model (**D**, **E**, or **F**) are equal to zero.

Alternative Hypothesis (H_a): At least one of the estimated coefficients in the respective model (**D**, **E**, or **F**) is significantly different from zero.

TABLE 7: DESCRIPTIVE STATISTICS FOR MARKETING METHODS 1, 2, AND 3 DURING AGREEMENT AND NON-AGREEMENT PERIODS

Variables	Mean	Standard Deviation	Minimum	Maximum	Percent of Total Marketings	N
Entire Marketing Period						
$DMETH_1$ [a]	80.73	3.36	69.00	86.67	81.41	2255
$DMETH_2$	79.52	2.59	71.25	85.00	7.80	216
$DMETH_3$	78.92	2.11	77.10	88.45	10.79	299
Agreement Periods						
$DMETH_1$	81.42	1.94	76.25	86.67	25.74	713
$DMETH_2$	80.41	1.72	77.50	85.00	5.27	146
$DMETH_3$	78.92	2.11	77.10	88.45	10.79	299
Non-Agreement Periods						
$DMETH_1$	77.76	3.25	69.00	82.75	55.67	1542
$DMETH_2$	77.65	3.06	71.25	80 50	2.53	70
$DMETH_3$	N/A[b]					

[a] All variable definitions and their respective units of measure are presented in table 5.

[b] Marketing method 3 was only allowed during two 16-week experimental periods.

TABLE 8: DESCRIPTIVE STATISTICS FOR EACH WEIGHT CLASS DURING AGREEMENT AND NON-AGREEMENT PERIODS

Variables	Mean	Standard Deviation	Minimum	Maximum	N
Agreement Periods					
DWT_1 [a]	81.50	1.78	78 50	83.25	9
DWT_2	81.13	1.75	77 30	84.15	137
DWT_3	81.04	1.99	76.25	88.45	939
DWT_4	81.75	2.03	78.50	86.00	54
DWT_5	82.53	2.87	80.00	86.67	19
Non-Agreement Periods					
DWT_1	N/A [b]				
DWT_2	78.74	2.63	71.00	82.75	103
DWT_3	77.97	3.08	70.10	82.00	1167
DWT_4	76.69	3.64	69.00	81.60	296
DWT_5	77.07	3.96	72.00	82.15	46

[a] All variable definitions and their respective units of measure are presented in table 5.

[b] There were no 1100 lb. cattle marketed or purchased during the non-agreement periods.

TABLE 9: DESCRIPTIVE STATISTICS FOR FIRM PRICES UNDER EACH ALTERNATIVE MARKETING METHOD

Variables	Mean	Standard Deviation	Minimum	Maximum	N
Marketing Method 1					
$DFDLT_1$ [a]	78.38	3.57	70.00	86.00	270
$DFDLT_2$	79.48	3.37	70.40	82.00	196
$DFDLT_3$	79 54	3.35	71.75	86.67	311
$DFDLT_4$	79.19	3 24	69.80	85.35	292
$DFDLT_5$	79.52	2.57	71.00	81.90	195
$DFDLT_6$	79.31	3.46	69.00	85.90	345
$DFDLT_7$	79.05	3.44	69.00	85.50	306
$DFDLT_8$	79.07	3.22	70.50	85.50	340
$DPKR_1$	80.29	3.31	71.10	86.67	493
$DPKR_2$	79.93	3.49	70.00	86.67	498
$DPKR_3$	79.87	3.41	69.00	85.90	685
$DPKR_4$	79.65	3.19	70.40	85.35	579
Marketing Method 2					
$DFDLT_1$	80.21	2.02	72.80	85.00	79
$DFDLT_2$	79 44	0.28	79.00	79.65	10
$DFDLT_3$	81.14	1.89	78.75	82.50	11
$DFDLT_4$	80.13	2.01	78.00	83.10	38
$DFDLT_5$	76.30	3.63	71.25	80.15	28

TABLE 9: CONTINUED

Variables	Mean	Standard Deviation	Minimum	Maximum	N
Marketing Method 2					
$DFDLT_6$	N/A[b]				
$DFDLT_7$	80.18	1.45	77.55	82.42	29
$DFDLT_8$	78.38	2.35	72.00	80.00	21
$DPKR_1$	81.11	1.97	77.50	85.00	29
$DPKR_2$	79.13	2.40	71.25	82.50	115
$DPKR_3$	80.35	1.71	78.00	83.10	60
$DPKR_4$	75.22	3.66	72.00	80.15	12
Marketing Method 3					
$DFDLT_2$[c]	78.74	2.02	77.22	87.03	161
$DFDLT_5$	79.13	2.19	77.10	88.45	138
$DPKR_4$	78.92	2.11	77.10	88.45	299

[a] All variable definitions and their respective units of measure are presented in table 2.

[b] Feedlot #6 did not utilize marketing method 2.

[c] The simulated firms that utilized marketing method 3 are Feedlot #2, Feedlot #5, and Packer #4.

FIGURE 1: A GRAPHICAL DEPICTION OF MEAN BREAK-EVEN AND TRANSACTION PRICES BY WEIGHT CLASS

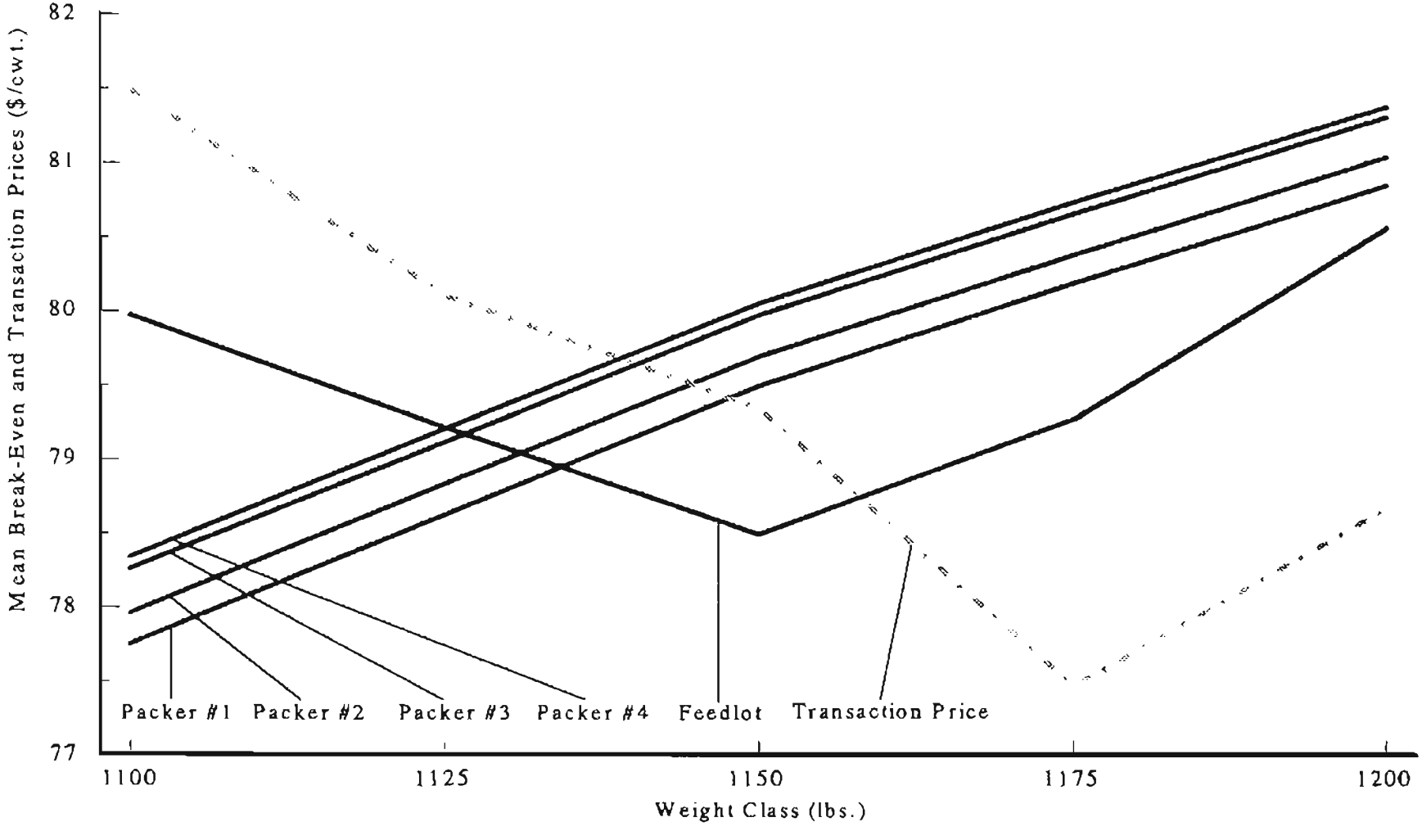
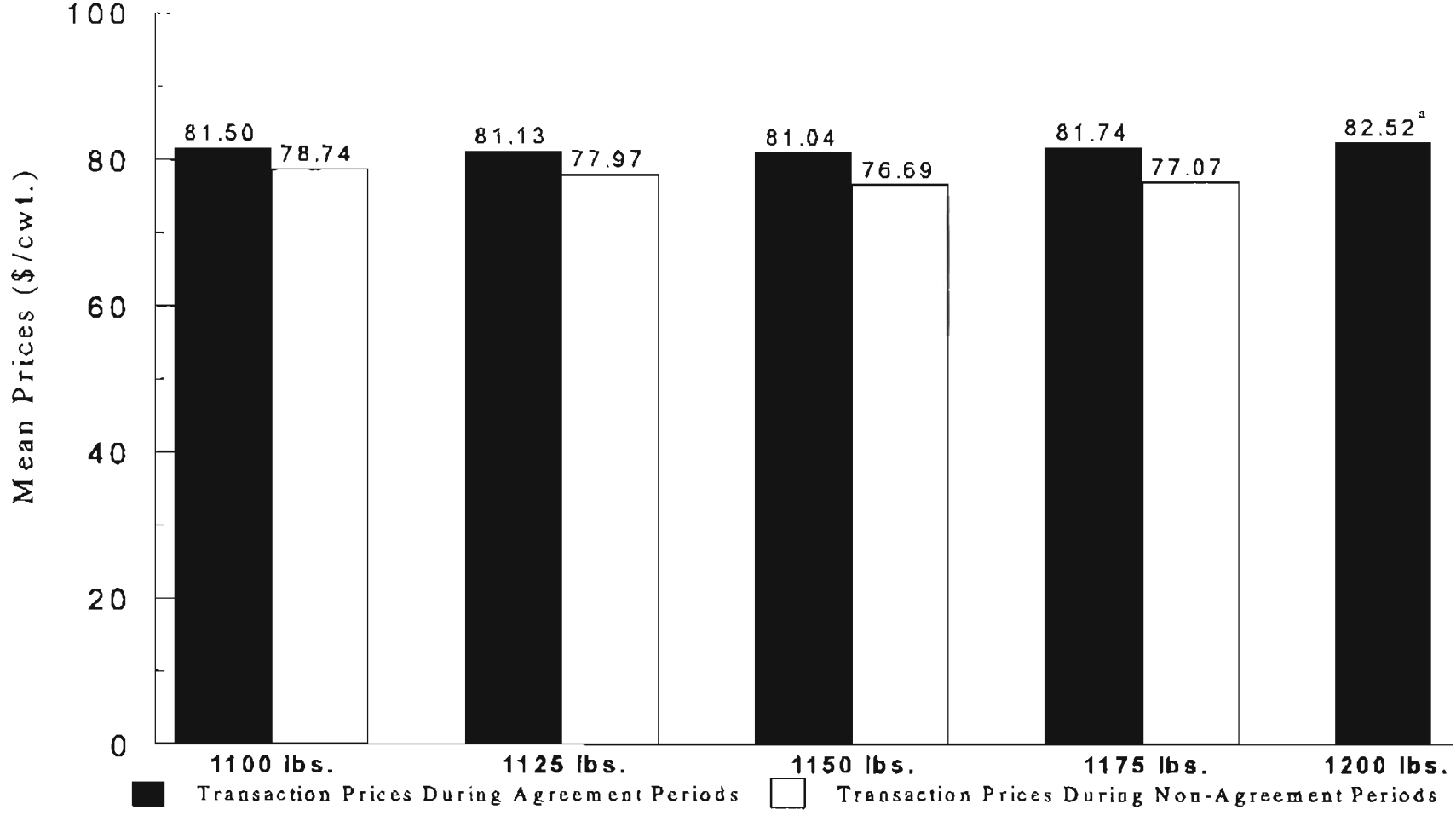
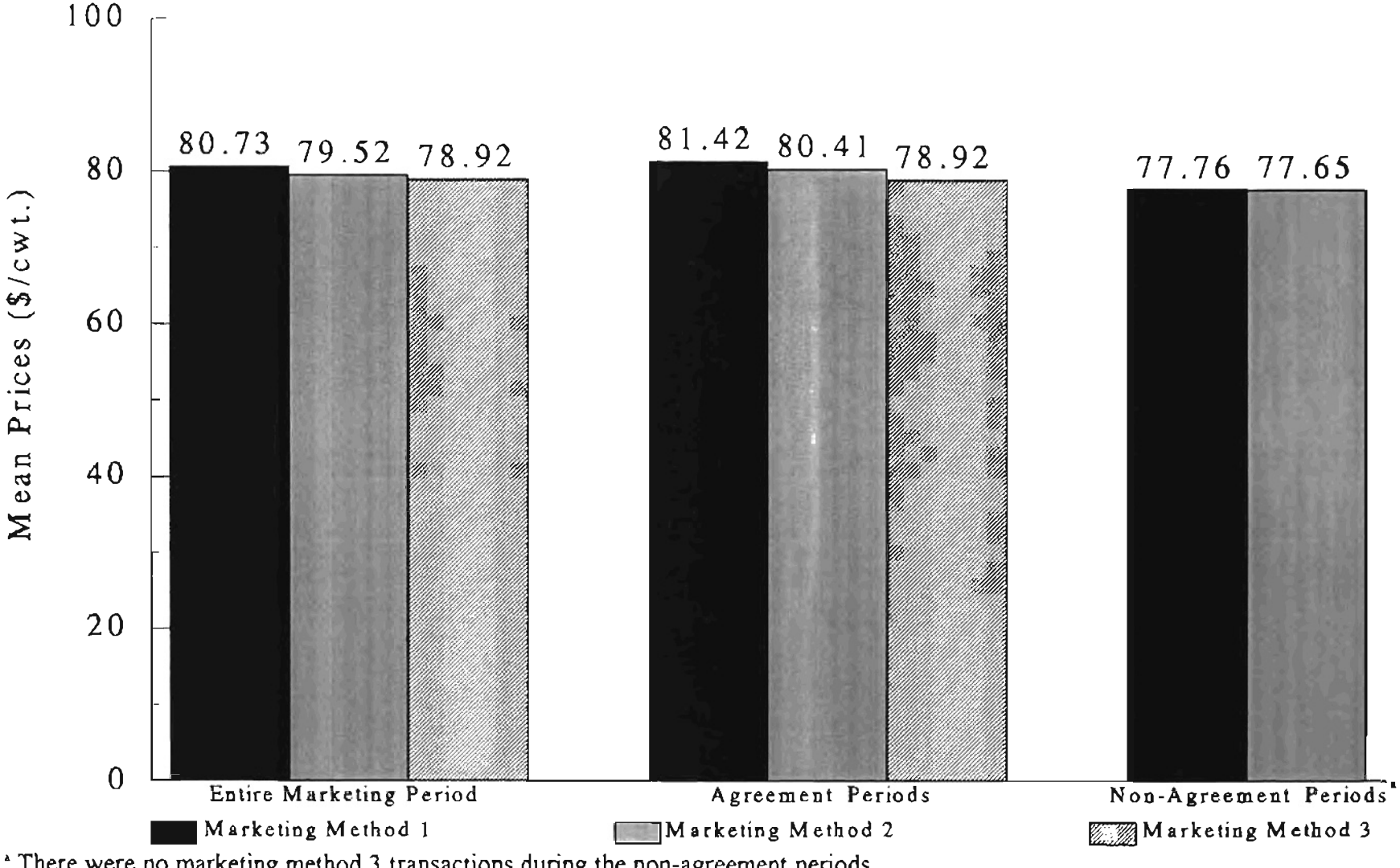


FIGURE 2: MEAN PRICES BY WEIGHT GROUP DURING AGREEMENT AND NON-AGREEMENT PERIODS



[a] There were no 1200 lb. cattle marketed during the agreement periods.

FIGURE 3: MEAN PRICES BY MARKETING METHOD DURING DIFFERENT EXPERIMENTAL PERIODS



* There were no marketing method 3 transactions during the non-agreement periods.

FIGURE 5: MEAN PRICES BY MARKETING METHODS 1 AND 2 FOR EACH MEATPACKING FIRM

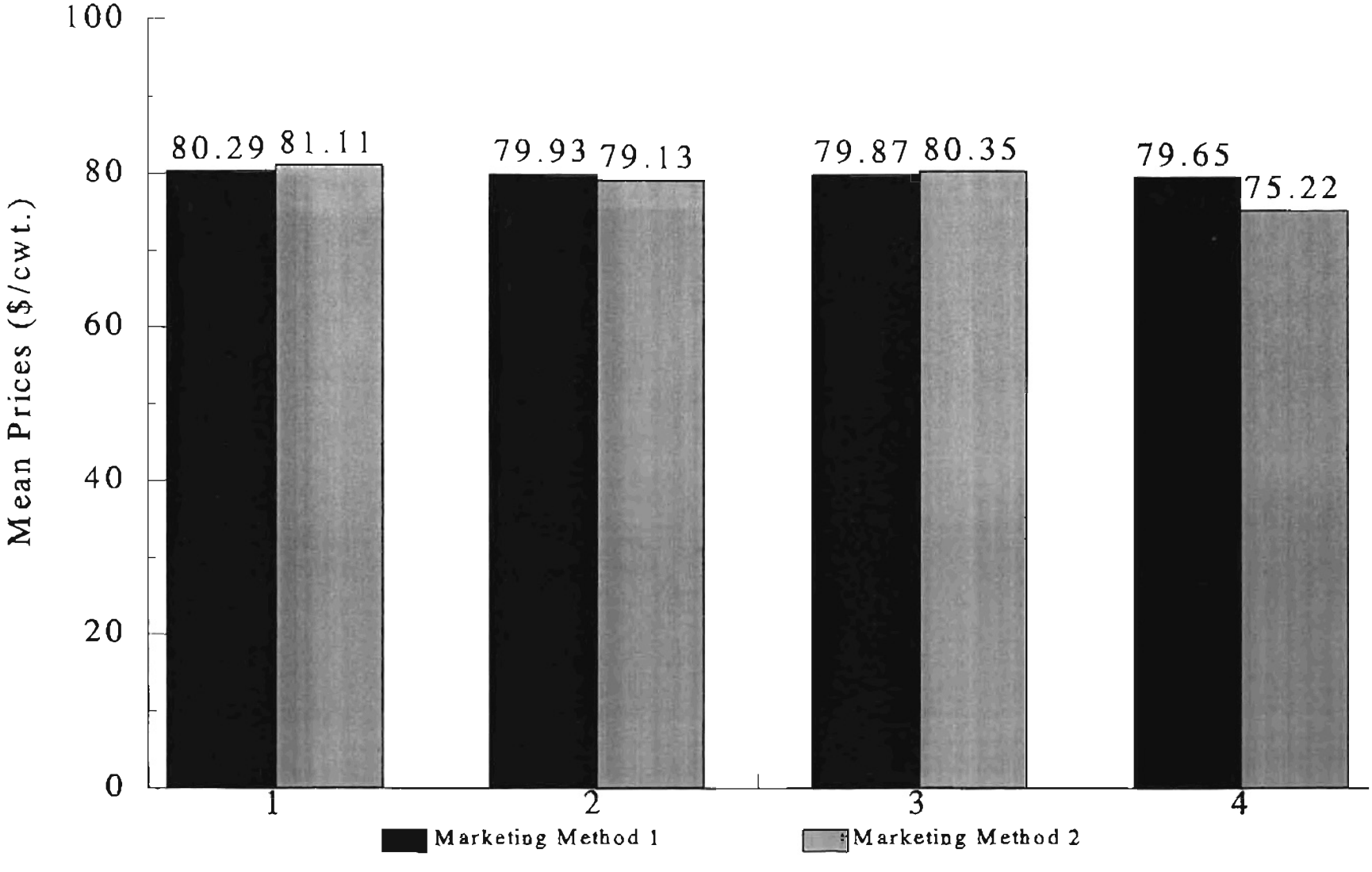
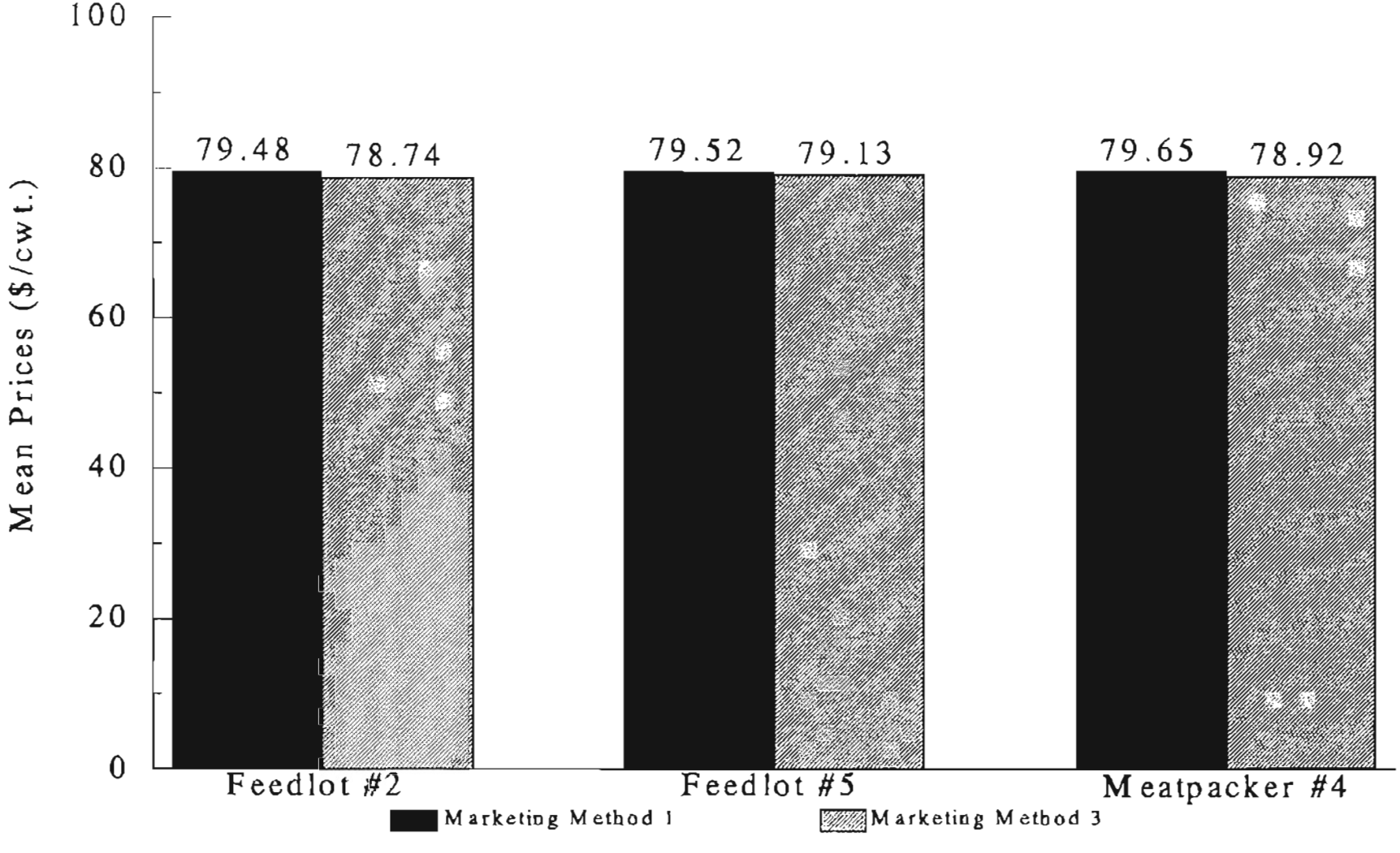


FIGURE 6: MEAN PRICES BY MARKETING METHODS 1 AND 3 FOR FEEDLOT #2, FEEDLOT #5, AND MEATPACKER #4



VITA

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Master of Science

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OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 01-26-95 **IRB#:** AG-95-008

Proposal Title: MARKETING AGREEMENT IMPACTS ON CASH CATTLE PRICES: AN EXPERIMENTAL ECONOMICS APPROACH

Principal Investigator(s): Clement Ward, Tracy Dowty

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

APPROVAL STATUS SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING.
APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
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Chair of Institutional Review Board