The Influence of Specific Trader Groups on Price Discovery

in the Live Cattle Futures Market

by

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(ABSTRACT)

The purpose of this research was to quantify the relative contribution of various types of traders on the price discovery process in live cattle futures. This work was based on a conceptual model where traders select the information deemed most relevant for forecasting future prices and then make use of a translating mechanism to condense this information into a price expectation. A trader's price expectation taken along with his/her willingness to act on that expectation results in a trading behavior. It is the interaction between the behaviors of all traders that determines price.

A quantitative measure of the pressure exerted on price by six distinct groups of traders was developed from daily data on reporting traders in live cattle at the Chicago Mercantile Exchange. Interrelationships between the price pressures were examined with statistical techniques. The mean squared error (MSE) of a futures price series was used to measure the price discovery performance of the market. Quadratic programming models were constructed to minimize the MSE of a simulated price series produced by allowing changes in the price pressure of each of the six trader groups. Shadow prices

from the programming models were used to indicate the relative contributions of each group to price discovery.

Results indicated that, on average from 1983 to 1987, large commercial traders and a group composed of commodity pool operators and program traders were the most harmful to price discovery. The behavior of small traders did the most to improve price discovery, on average. Medium-sized commercial traders improved price discovery. In the delivery period, actions of large commercial traders were the most beneficial to price discovery. The results did not, however, reveal a consistent pattern of influence by any trader group.

These results suggest that traders who are more likely to focus on forming short-term price expectations are less beneficial to price discovery than those that rely on long-term price expectations. Also, since no trader group consistently outperformed the others with respect to price discovery, these findings suggest that consistent price discovery gains through policy manipulation of trader mix would be difficult to achieve.

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INTRODUCTION

1.1 Introduction

The large quantity of resources dedicated to the study of agricultural futures markets over the years is a testament to their economic importance. It is generally recognized that the most important economic functions of futures markets are risk transfer, price discovery and storage allocation. Producers and users of many different agricultural commodities use futures markets to transfer price risk to speculators. For storable commodities, trade in futures facilitates the allocation of storage providing for smooth, year-round marketing of the raw product. The discovery of forward prices is a major function of futures markets for non-storable commodities such as livestock.

Traders in futures markets may or may not have some involvement with the underlying cash commodity. Participants who do not hold a cash position in the commodity are always considered futures market speculators. Those traders involved in the production, processing or trade of the commodity who take futures positions designed to reduce the price risk associated with their cash position are called hedgers. When traders with a commercial interest take futures positions that do not reduce the price risk associated with their cash activities, they are considered speculators.

A fundamental benefit arising from trade in futures is that, through hedging, those involved with the cash commodity can reduce uncertainty about future prices. Producing, processing and delivering agricultural products to end consumers takes time at each step. The decision to undertake one of these activities is thus temporally separated from the realization of cash product prices. Uncertainty of future input or output prices complicates production decisions of firms utilizing or producing these agricultural products. Economic theory suggests that the introduction of price risk reduces output and is harmful to societal welfare, *ceteris paribus*.[1] While hedging with futures cannot completely eliminate price risk for these firms, it has the potential to greatly reduce it.

Although buyers and sellers of futures contracts are not explicitly linked (because of clearinghouse intervention), one can envision that the parties to any individual trade might be two speculators, two hedgers or one hedger and one speculator. Risk transfer in futures markets is commonly portrayed as a trade between those who wish to avoid price risk (hedgers) and those who seek to profit from it (speculators). However, when one party to the contract seeks to sell the commodity at a future date and the other seeks to purchase it, futures trading can be viewed as a type of forward contract. Here risk is reduced for both agents, but no risk is "transferred". If neither party to the contract has a commercial interest in the commodity, then futures trading is a vehicle that allows the agents to attempt to profit from their expectation of prices in the future. In all of these scenarios, it is price expectations that motivate participation in the futures market. Hedgers must expect that there is a significant probability that prices will move adverse

[1]Under the reasonable assumption of risk aversion.

to their cash position and speculators must expect that there is a significant probability that, in time, prices will be different from the current price.

A price expectation reflects all of the information about future prices that the agent holding it considers relevant. Whether the information arises from a single source or many different sources, the agent must employ some mechanism for translating the information into a conviction about the future price of the commodity. One intuitive way of representing this conviction is to say that the agent formulates a probability density function for prices in a future time period. The mechanism for forming the probability density of future price may be objective, such as is the case when econometric models alone are used to predict price; or it may be subjective, as occurs when a trader bases future price expectations on feelings or insight gained in previous market experience.

By taking a futures positions, traders are transmitting their price expectations to the market. In a large sense, then, the futures market is simply a clearinghouse for price expectations. The market condenses the price expectations of many traders into an observable price movement. The weight given to any individual trader's price expectation is determined by the trader's willingness to act on his/her price expectation. Willingness to act is influenced by a number of factors such as size of cash position (if any), financial resources, risk preference, and the perceived accuracy of the expectation.

Trading behavior reflects both the trader's price expectation and his/her willingness to act. Since the price expectation is a result of the trader's information sources and the mechanism used to weight the information, trading behavior is a reflection of these things as well. Thus, assigning value to the market behavior of a trader is an indirect method of valuing the bundle of components that define it for that trader (i.e., information sources, translating mechanism, cash position size, financial resources, risk attitude, etc.). Quite often, trading behavior is much more observable than any of its individual components.

Price discovery is the process by which actual market prices converge to the price determined by the economic forces of supply and demand in a particular commodity market. Price discovery in futures markets differs from price discovery in cash markets. To begin with, the two markets involve different commodities. Cash markets offer a commodity on the "spot" (i.e, in the current time period) while futures markets offer contracts on a commodity to be delivered in the future and discover a price for that future time period. In cash markets, the price discovery process ends when the buyer and seller reach a market-clearing price and the commodity changes hands. The same can be said of futures markets if the item transacted is interpreted to be the contract. Alternatively, if the transacted item is assumed to be the underlying commodity, then the price discovery process is technically not complete until the futures contract reaches maturity. From this prospective, the futures market spends months discovering the market-clearing price and the daily closing prices are just points in the market's movement toward equilibrium. There still exists some overall price that is *determined* by the economic forces of supply and demand; however, it is less visible to the market participants because it is a result of *future* supply and demand, forces not easily discerned by any individual trader.

Futures market price discovery is enhanced by trading behavior consistent with the determined price. This means that traders whose information sources and translating mechanisms produce accurate expectations of the determined price and whose other characteristics give them a high propensity to act on these expectations will have greater value to the price discovery process than other traders.

Futures markets which perform the price discovery role more efficiently are socially desirable for several reasons. Futures markets provide highly visible prices which can be used as information in the development of price expectations by producers and users of the commodity. Firms that utilize these prices are able to make better resource allocation decisions when futures prices are accurate reflections of true end-of-period supply and demand conditions. When new information is quickly and completely registered in market prices, the potential for over- or under- reaction by agricultural producers in the form of a supply response is reduced. The result is more stable commodity prices and better resource allocation. Improved price discovery resulting from more accurate supply/demand information and less noise (caused by traders with inaccurate price expectations) can also work to reduce price variability.

1.2 Problem Statement

Traders and potential traders in futures markets react to changes in their economic environment in many different ways. Those reactions often will involve changes in the trader's level of market participation (i.e., willingness to act on price expectations). When traders decrease their presence in a futures market, that market is deprived of the information embodied by their expectation of future prices. Conversely, increases in market presence will lend more weight to a given trader's price expectation in the overall price discovery process.

Access to and the quality of information is directly responsible for market performance. Markets which attract traders who have a high willingness to act on accurate expectations of the determined price will perform the price discovery process better than those markets that attract traders with inaccurate and/or imprecise (because of low quality information) price expectations.

Thus, some traders are more valuable (socially) to the futures market than others and this characteristic may extend to broad groups of traders such as either large commercial or speculative interests. When policies are enacted that adversely affect these broad classes of traders and they respond to the policy by decreasing or ceasing their futures market activities, information quality suffers in that market and the price discovery process is potentially damaged. Detrimental effects on price discovery can also occur when policy changes attract increases in market activity by groups that act on inaccurate price expectations.

Therefore, in order to properly evaluate a policy change, it is important to have data on the value to price discovery of the trader groups likely to be impacted. Little is known about the relative value of the market behavior of the various groups that trade in live cattle futures. As a result, it is difficult to assess how changes in the trader mix in this market will affect the price discovery process.

This research provides a method for measuring the value to price discovery of several types of live cattle futures traders. Analysis of the price discovery process under altered participation levels is completed by simulation techniques. Through these methods, the accuracy of trader group price expectations can be evaluated and inferences can be drawn regarding the social value of their information sources and their translating mechanisms.

1.3 Justification

Policies enacted and enforced by futures exchanges and governmental agencies have the potential to impact the trader composition in futures markets. Some policies may result from the explicit desire of policy makers to attract certain types of traders to the market or, alternatively, to block or discourage other trader groups. Other policies may be enacted for reasons unrelated to the mix of trader types in futures markets, yet they change the economic circumstances for certain types of traders forcing them to alter their market participation patterns. Often, price discovery improvement is not a primary objective of policy formulation. Still, in order to make informed decisions, policy makers should consider any information regarding the potential impact on price discovery of a change in policy.

Recently, changes in the tax policy of the Internal Revenue Service (IRS) caused may agricultural producers to reconsider using futures to hedge price risk. As a result of the Supreme Court decision in *Arkansas Best Corp. v. Commissioner*, IRS agents began to disallow ordinary deductions for losses incurred in futures trades that producers had theretofore considered hedging transactions. Losses generated by these hedging transactions had been treated as ordinary, not capital, losses. Because of the limited deductibility of capital losses, this policy change toward a more restrictive definition of a hedge increased a potential hedger's tax risk. As a result of this increased risk, it is hypothesized that some hedgers left the market, finding the cost of controlling their price risk with futures too high. A survey by Purcell found that the fear of having losses on futures positions considered as capital losses, with their limited deductibility, was an important factor affecting cattle feeders' decisions concerning participation in the futures market.

Other policies can directly influence the conditions under which traders operate and thereby alter the participation incentives of particular trader groups. For example, lower margin requirements and the lack of position limits for commercial interests can result in an increased presence of these trader types relative to speculators. Recently, the Commodity Futures Trading Commission (CFTC) has permitted large increases in the speculative position limits in many of the agricultural futures markets. This has increased participation by large commodity funds and raised concerns among some analysts that prices in these markets will be less reliable indicators of underlying supply/demand conditions (Taylor and Behrmann).

Changes in the trader composition in a futures market, regardless of whether it occurs purposefully or inadvertently, has the potential to change the information flow into that market and alter the price discovery process. Prices originating in futures markets are sources of information to producers and users of the commodity. Thus, the efficiency of the price discovery process in a futures market has important welfare implications for society.

Although some research has been undertaken to investigate the relationship between price changes in futures markets and positions held by certain groups of traders (Petzel; Rowsell; Yun), there has been no empirical effort to document the effect of different groups of traders on the price discovery process in these markets. Without such information, policy makers must rely on subjective estimates of the price discovery effects of their policies. Given the welfare effects for society of price discovery in futures markets, empirical research is important. This study seeks to provide that empirical documentation for one agricultural commodity, live cattle, recognizing that the framework developed here will be useful for future research on other commodities.

1.4 Objectives

The overall objective of this research is to evaluate the contribution of several different types of traders to the price discovery process in the live cattle futures market.

The specific objectives of this research are to:

1. develop a conceptual model to describe the price discovery process in terms of the actions of identifiable market participants;

2. develop a method to empirically measure the individual contributions of different trader groups to daily movements in live cattle futures prices;

3. identify and analyze any structural interrelationships that might exist between the measures formulated in objective two;

4. utilize the statistics developed in objective two and the relationships identified in objective three to simulate, *ex post*, changes in trader composition and assess how these changes impact prices in the live cattle futures market; and

5. identify those trader groups, if any, whose market presence is consistently beneficial or detrimental to the price discovery process.

1.5 Overview

This dissertation proceeds as follows. Chapter 2 reviews the literature on research regarding information and futures markets. Particular attention is given to studies that focus on the price discovery and price formation process in livestock futures markets. Chapter 3 develops the theoretical model to relate the contribution of various groups of traders to the price discovery process. A criterion to objectively evaluate the price discovery performance of futures markets is presented and supported with theoretical arguments. The concepts behind the empirical tools used in this study are also reviewed in this chapter.

Data used in the empirical analysis are described in Chapter 4 and a thorough analysis of the data transformations is presented. The actual empirical models used in this research effort are detailed and explained. Results are presented and interpreted in Chapter 5. The final chapter, Chapter 6, draws conclusions about the contribution of various trader types in the price discovery process in live cattle futures. Implications for policy formulation are developed. Finally, limitations of the research are discussed and suggestions are given for the direction of future work in this area.

Chapter 2

LITERATURE REVIEW

2.1 Functions of Futures Markets

Any investigation into the effect of changes in futures markets should be preceded by a clear identification of the purposes that these markets serve. This enables the research to focus on those aspects of futures trading that are most important socially. While some functions are common to all futures markets, their relative importance may vary due to differences in the nature of the commodity. This section reviews work which identifies the functions of all agricultural futures markets and emphasizes the functions served by live cattle futures.

Risk avoidance and risk shifting have long been ranked among the most important functions of futures markets. Early work characterized futures trading as a means by which those holding or expecting to hold cash positions in a commodity could acquire protection against unfavorable price movement (Blau, 1945). It was recognized that there certainly would be occasions where the number of commercial interests desiring to be long in a futures market would not equal those desiring to be short and that another class of traders, speculators, would need to step in to assume these "excess risks". From this originated the concept of futures markets serving to transfer price risk from hedgers to speculators. The larger the disparity between long and short hedgers in a futures market, the more important is the risk transfer function that is made possible by speculator participation.

Taking a futures position does not provide commercial traders with complete insulation from price changes. They no longer need to worry about changes in the absolute level of prices, but must still be concerned with changes in basis, the relationship between local cash prices and futures prices. For futures markets to function as a means of price risk avoidance for hedgers, futures prices need to be highly correlated with cash prices, or, at a minimum, the basis should behave predictably.

Working (1953), in his early work, clarified the use of futures markets by hedgers. He characterized hedging as an activity whereby commercial interests attempt to profit from information rather than as a straight-forward purchase of protection against unfavorable price movement. Because of their cash position, only hedgers may profit from basis movements. Thus, expectations of a change in the basis can prompt hedging activity. Recognizing this, Working (1962) advanced the idea that hedging was more an activity related to loss avoidance rather than risk avoidance. He described four different categories of hedging:

> 1) Carrying-Charge Hedging: While holding cash positions in storage, hedgers attempt to profit from changes in the basis.
>
> 2) Operational Hedging: The price of the cash transaction is quoted relative to a futures price. Firms then hedge to protect against adverse price movement.
>
> 3) Selective Hedging: (Loss avoidance hedging). Firms holding cash positions hedge only at times when their price expectations signal a significant probability of adverse price movement in the cash market.
>
> 4) Anticipatory Hedging: This is like selective hedging but is performed with respect to anticipated commodity needs or output such as taking a long position in futures in "anticipation" of expected and subsequent cash purchases.

Of these four types of hedging, only the operational hedge involves strict risk avoidance. The other three forms of hedging involve attempts to profit from price expectations by restricting losses. Operational hedging is most often observed in grain futures markets such as corn and wheat. In these markets, cash transaction prices are often quoted relative to the price of a particular futures contract.

The ability to transfer risk is essential to every type of hedging. While it is obvious that the ability to transfer risk is essential to risk avoidance, it is also essential to the profit-seeking (i.e., loss avoidance) activity of hedgers acting on price expectations.

Another widely recognized feature of futures markets is the efficient allocation of storage for agricultural commodities. Again, Working was a pioneer in this area of futures market functions. He was the first to recognize that, for storable commodities, spot and futures prices are closely connected by carrying charges (Working, 1949). Further, futures markets function to determine the price of storage for the commodities they represent. Spreads between contract months in futures markets indicate the minimum return that can be expected from storing the cash commodity. These spreads, then, can send signals which help assure that the proper amount of a commodity gets stored. Large positive spreads between contract months indicate that the commodity is currently plentiful relative to what is expected in future months and thus storage should be undertaken. Negative spreads (or inverse carrying charges) signal a greater current need for the commodity and such spreads will work to draw the commodity out of storage and discourage or constrain storage (Working, 1948).

The price system serves to coordinate economic activity solving what Hayek called the fundamental problem of society—utilizing information not given to any one individual in its totality. Futures markets function as clearinghouses of information. The relatively low cost of participation in futures markets compared to cash markets makes them much more accessible to all types of traders, each of whom provides information embedded in their trading behavior. Price discovery is the formal term used to describe the process by which buyers and sellers transmit their perceptions of the economic conditions (supply and demand) enroute to a market-clearing price.

The function of price discovery is often under-emphasized in futures research. Much work has been done to evaluate the informational efficiency of futures markets, but rarely is the connection made between informational efficiency and price discovery. The price discovery process is the vehicle by which information is transmitted to a market. A poorly performing price discovery mechanism may distort or exclude incoming information and damage the informational efficiency of the market thereby reducing the effectiveness of the market in its allocative and risk transfer roles.

Providing forecasts of future prices for a commodity is a social function of futures markets. If futures markets render accurate forecasts of unknown future prices, then this will allow firms to more efficiently allocate resources to future production (Carlton, 1984). Goss and Stein (1992) show the importance of accurate forecasts of unknown future prices in avoiding social loss. Forecasts of later prices can be obtained from a number of sources, including cash markets. However, futures markets, because of their centralized nature, high visibility, and low transactions costs may accelerate the price discovery process and thus provide better forecasts than alternative forecasting sources.

The efficiency of the price discovery process is positively related to the speed at which a market incorporates new information. If two markets exist for essentially the same commodity, yet one incorporates new information more quickly than the other, it discovers price first and the participants in the second market can use the price signals arising from the first to improve the efficiency of the second market. Garbade and Silber (1983) developed a model to measure the relative importance of the futures market in the price discovery process for several storable commodities. They found that, for corn and wheat, the futures market incorporates new information into prices ahead of cash markets in more than 75 percent of the time period studied. They also found evidence that lower-volume (less liquid) futures markets were less likely to discover price ahead of cash markets. Oellermann, Brorsen and Farris (1989) applied the model of Garbade and Silber to a nonstorable commodity, feeder cattle, and found that no less than 76 percent of new pricing information was registered first in the futures market. Hudson and Purcell (1985) examined lead-lag relationships between live cattle futures and cash prices and concluded that the futures market is an important center for price discovery in the U.S. livestock-meat sector. Conversely, Quan (1992) studied crude oil futures and found that the spot market almost always leads the futures market in registering new information.

The evidence is thus fairly strong that in agricultural commodities with well established futures markets, the futures market plays an important price discovery role.

The functions of price discovery and risk transfer are of the most concern to this study which focuses on the live cattle futures. The storage allocation function is not applicable in the case of this nonstorable commodity.

2.2 Information and Markets

A fundamental problem facing society is that of using information not given to any individual in its entirety (Hayek, 1945). Hayek notes that the pricing system is a very efficient means of condensing and conveying information from many diverse sources to many diverse uses. Simply by observing prices that occur in markets, users and suppliers can quickly determine if a given commodity's value to society has changed without having to incur the enormous cost of surveying all of the individuals who might possess relevant information.

Grossman (1977) developed a model of futures markets as places where "information is exchanged and where people who collect and analyze information about future states of the world can earn a return on their investment in information gathering." He finds that in cases where current spot prices do not accurately reflect unknown future prices of a commodity, there are private as well as social incentives for futures market formation. In his model, some firms are informed (having information about future prices) and some are uninformed. When the informed traders participate in a futures market in an attempt to profit from their information, uninformed traders acquire some of this information simply by observing price movements. When the information thus spread is accurate, more efficient price discovery is the result.

Acquisition of almost any type of information entails some cost. When there are costs associated with information development, rational traders can be expected to seek information only up to the point where the expected marginal benefit from trading on the information equals the marginal cost of obtaining it. In this vein, Grossman and Stiglitz (1980) argue that when information is costly, markets cannot be informationally efficient. This is because fully efficient markets offer no opportunity to earn returns from information gathering and processing. Traders would not incur the costs necessary to obtain the information. It can be inferred, therefore, that if a market is in operation and information is costly, then there is some information not reflected in market prices. Society could benefit from bringing more of this unregistered information into the market by finding ways to lower the trader's cost of acquiring it.

The model of Grossman and Stiglitz was one of noisy rational expectations. Their model asserts that there must be some equilibrium level of noise in markets which allows producers of costly information to recover their costs.[2] If there is no noise, then market actions of the informed traders will convey all of their information to the uninformed traders at no cost and eliminate any opportunity for profit by the informed traders. Sunder (1992) found that the noisy rational expectations model was supported by results

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[2]Noise is all of the other factors that determine price outside of the actions of informed traders.

from experimental asset markets with costly information. This work also indicates that information is passed from informed to uninformed traders by a number of non-price variables such as bids, offers and timing of the bids and/or offers.

Experimental asset markets have yielded further insights into the way markets incorporate information. Lundholm's (1991) work indicates that markets are most efficient when there is aggregate certainty (the union of all trader's information exactly identifies the value of the asset) or when aggregate uncertainty exists but all of the informed traders possess identical signals. Real-world futures markets are likely characterized by aggregate uncertainty (some pieces of the information puzzle are not present in the market) combined with heterogeneity of information signals (traders would form different price expectations even if all received identical news). Thus, based on the experimental evidence, a tendency toward informational inefficiency might be expected in futures markets.

Another interesting result of Lundholm's study was a finding that the amount of time it took the market price to converge to the efficient price was positively related to the number of traders in the market. Apparently, when the number of traders increases, the greater diversity of behavior results in more noise in prices and hinders the movement of information from informed to uninformed traders. Lundholm explains this by noting that the forecast that each new trader brings to the market is composed of both an accurate and a noise component (caused by the high cost of better information which could be used to improve the forecast) . If the noise effect dominates the accurate forecast component, then the information-spreading feature of the market slows and it takes longer to discover the true value of the asset.

2.3 Price Performance in Futures Markets

In earlier sections, it was stated that the pricing system is the tool which our economic system employs to collect, summarize and distribute information. It is important, therefore, to evaluate how well this system is performing its task. Distribution of the information in futures prices is not considered a problem since these prices are highly visible at a low cost to all who are interested in them. Evaluation of futures prices tends to focus on the information collection function. Studies often attempt to determine how much of the relevant information about a commodity is being reflected in futures prices.

Market efficiency is concerned with the entire process by which raw information becomes reflected in prices. This operation can be divided into two subprocesses: (1) Information collection and condensation leading to trader price expectations, and (2) price discovery, the process by which expectations come together to form price. Thus, price discovery and market efficiency are closely linked.

Recognizing that markets would often not be fully information efficient, Fama (1970) detailed three degrees of market efficiency that have become the standard in price performance research. Strong-form efficient markets reflect all of the relevant information (even that information held by only a small number of individuals) about the future supply/demand of a commodity. Semi-strong form efficiency requires that the market only reflect all publicly-available information. Markets are said to be weak-form efficient if current prices embody all of the information provided by past prices.

Strong form efficient markets are unlikely to exist given the work of Grossman and Stiglitz (1980). Research has typically looked for weak and semi-strong forms of efficiency. Garcia *et. al.* (1988) state "Market efficiency probably can never be proven; there probably can he only failure to disprove it." All empirical work thus far seeks to find one or more instances of evidence against a particular form of market efficiency. Failure to find such evidence, however, is not conclusive proof that the market under study does indeed possess the tested degree of efficiency. One can never be sure that there does not exist some undiscovered model or information set that will reject the postulated form of market efficiency. With this in mind, the remainder of this section reviews empirical work involving informational (pricing) efficiency in agricultural futures markets with primary emphasis on the livestock markets.

2.3.1 Weak-Form Analysis—Forecasting Studies

Much of the work concerning the pricing efficiency of futures markets has focused on the ability of futures prices to accurately predict subsequent cash or futures prices. Researchers have sought to disprove weak form market efficiency by looking for evidence that models using only past prices have some predictive power for future prices.

Kofi (1973) was one of the first to test weak form market efficiency in a regression context. Using prices for corn and Maine potatoes, he proposed the following model:

$$CP_h = \alpha + \beta FP_h + e_h \quad (2.1)$$

where CP_h is the harvest-time cash price, FP_h is the price quoted, at some date prior to harvest, for the futures contract with a harvest-time maturity, and e_h is an error term. This model was estimated by OLS for FP_h ranging from one to 11 months from harvest. Kofi used the coefficient of determination (R^2) from these regressions as a measure of market performance; i.e., how well futures prices predicted harvest cash prices. He found futures prices to be a relatively better predictor of harvest cash prices for the continuous inventory commodity (corn) than for the discontinuous inventory commodity (potatoes). In general, R^2 values were larger for futures prices closer to maturity indicating improving market performance as maturity approached. Kofi also discussed the concept of the "balanced" market, a market where futures prices are unbiased predictors of subsequent cash prices. Statistically, this characteristic is checked by estimating the model in (2.1) and testing for $\alpha = 0$ and $\beta = 1$.

Leuthold (1974) estimated essentially the same model as (2.1) for corn and live cattle futures prices except he used futures prices in the maturity month as the dependent variable (this substitution assumes cash and futures prices converge at maturity). He found that R^2 values increased as the contract approached maturity for both commodities suggesting the predictive power of futures prices greatly improves as the forecast horizon is shortened. Using t-tests of the estimated parameters in the model he found that futures prices were unbiased predictors of subsequent prices within four months to maturity for cattle and three months to maturity for corn. Another technique used to evaluate the performance of futures prices involved calculation of the mean squared errors (MSEs) for both the futures and cash price series. MSE is essentially the average squared error between the futures or cash prices j periods prior to delivery and the delivery price. Leuthold found that for both commodities MSEs were positively associated with time to maturity reinforcing the finding that futures become better predictors as the forecast horizon is shortened. For corn, the cash and futures MSEs were comparable in magnitude at each forecast horizon, but for cattle the MSE of the futures series was much larger than the cash MSE. The implication was that current cash prices are better predictors of subsequent cash prices than are futures prices. This means that futures prices are inefficient—there is some information not being incorporated into futures prices that could improve the pricing performance of the market.

The conditions which affect the forecasting performance of livestock futures markets were studied by Martin and Garcia (1981). A model similar to (2.1) was used in this study with cash prices as the dependent variable. The model was modified to include a dummy variable to allow slope parameter shifts for periods when prices were rising or falling. These authors found that the forecasting performance of the live cattle futures prices had not improved since Leuthold's (1974) study. They also found that live cattle prices forecasted better during periods of rising prices while live hog prices forecasted better during price declines. In general, live hog futures prices were found to be better predictors than live cattle prices. Some seasonal effects were also detected in the forecasting accuracy of live cattle futures with these prices providing better forecasts for the summer-maturing contracts, June and August, than for the remaining contracts. By segregating the data into two periods, pre- and post- 1973, the authors were able to determine that livestock futures prices were more reliable forecasts of subsequent cash prices in periods of general economic stability (prior to 1973) than in the more recent, less stable period.

Current futures prices and current spot prices were tested for their ability to provide unbiased forecasts of subsequent live cattle spot prices by Roarke and Shafer (1981) using a model identical to (2.1). Weekly data with lags up to 35 weeks were used. Time to maturity was found to be inversely related to predictive ability. Results showed no real difference between cash and futures prices in predictive ability. However, trends in the data (the authors provide a plot) and autocorrelated residuals call into question the conclusions of this study.

Giles and Goss (1981) used the model in (2.1) to test the pricing efficiency of live cattle and wool futures traded in Australia. Again, R^2 values were taken to signal improved forecasting performance by the futures prices. Similar to previous studies, futures prices for both commodities exhibited improved forecasting ability as maturity approached. Using statistical methods for jointly testing $\alpha = 0$ and $\beta = 1$, the authors showed the live cattle futures to be unbiased predictors of subsequent cash prices within three months of maturity and the wool futures to be unbiased within twelve months of maturity. It is also important to note that this study, unlike previous studies, considered the ramifications of endogenous futures prices in (2.1) and utilized an instrumental variables estimator rather than OLS.

Koppenhaver (1983) argued for the existence of a risk premium in live cattle futures prices. He modeled the difference between the futures price and the subsequent spot price (the forecast error) as a function of a constant, some seasonal dummy variables, recent futures forecast errors, recent spot market price changes, and a variable that purports to measure cash market price risk. The regression results include large positive coefficients on the cash market price risk variable indicating that increased risk in the cash market increases the size of the error between futures and subsequent spot prices. Koppenhaver interprets this finding of a systematic downward bias in live cattle futures prices as indicating the existence of a positive risk premium in the live cattle futures market. Statistical tests associated with this model rejected a null hypothesis of weak-form efficiency in live cattle futures from three to five months prior to delivery.

Weak-form efficiency in the wheat, corn and soybean futures markets was tested with the model in (2.1) by Bigman, Goldfarb and Schechtman (1983). Joint tests of the parameters of these models reject weak-form efficiency for all three commodities at periods longer than six weeks to delivery. The authors postulate that biases in futures prices for distant contracts are the result of costly information. Biases in futures prices reflect the returns available to traders who are willing to collect and process the information necessary to eliminate them. When these information costs are higher than the perceived benefits, the information will go uncollected and the futures prices will remain biased. Naturally, information costs would be expected to increase as the length of the forecast horizon increases, and this may explain why biases are present in prices further from contract maturity and absent nearer to maturity.

The pricing efficiency of live cattle futures was judged to be exemplary by Kolb and Gay (1983). A different methodology, the log-link relative, was developed to evaluate the forecasting accuracy of futures prices for this study. The basic concept for the log link relative is that if futures prices in all time periods are accurate forecasts of the delivery spot price, then the ratio of any two adjacent futures observations should average to unity implying the log of the same ratio should average to zero. Log link relatives used in this study were calculated from daily closing prices. Statistical tests indicated that the log link relatives were not statistically different from zero for 26 of 28 live cattle contracts traded between 1976 and 1980.

Kenyon, Jones and McGuirk (1993) evaluated the ability of the spring price of corn and soybean futures maturing near harvest to predict the harvest price of the same contracts. The model used was essentially the same as (2.1) except that the dependent variable was the harvest-time futures price rather than the harvest-time cash price. Weak-form efficiency could not be rejected by any of the models estimated for this study. When the sample was split, a substantial decline in the predictive ability (measured by R^2) of the spring price became apparent during the years 1974-1991. Prior to this period, futures prices observed in the spring had been a relatively good forecast of fall prices. Recursive variances for the statistical model were calculated and used (in log form) as the dependent variable in a model designed to identify the factors that had influenced the forecast deterioration.[3] Results indicated that declines in yield predictability and larger differences between the spring futures price and the loan rate in the more recent years contributed significantly to the decline in forecasting performance of futures prices for both commodities.

Testing for weak-form efficiency in markets often amounts to testing the proposition that prices generated by a market follow a random walk. Tomek (1994) notes that the random walk model, while it may be appropriate for futures prices, is not an appropriate test of cash commodity prices. He specifically mentions transactions costs as a reason why cash prices may be autocorrelated. Work in the area of noisy rational expectations suggests that prices in a competitive market need not follow a random walk if information is costly to acquire and act upon (Sunder, 1992).

2.3.2 Weak-form Analysis—Non-Forecasting Studies

Non-forecasting studies of futures pricing efficiency have typically focused on the distribution of futures price changes. The general concept is that in efficient markets,

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[3]Recursive variances are obtained by estimating the model with a few observations from the beginning of the data set, recording the variance of that estimation, then adding one observation, re-estimating, recording the variance estimate, and so on until the end of the data is reached. These estimates indicate how the regression variance changes over time.

prices reflect all available information so that new information arrives in a completely random manner. From a weak-form efficiency prospective, if the change in futures prices between periods are not independent of one another, then there exists some information in past prices that is not fully incorporated in the current futures quote and thus the market is weak-form inefficient.

Gordon (1985) examined daily futures price changes for a number of commodities for contracts traded between 1979 and 1984. One important finding of his study was that log price changes in all markets were not normally distributed. Non-parametric tests indicated little evidence of serial dependence or trends in log price changes which would be consistent with weak-form efficient markets. He did, however, find evidence of non-constant variance in many of the price change series which suggests that there may be some information contained in past prices that could improve prices-only forecasting models.

Hudson, Leuthold and Sassaro (1987) used different statistical tests to examine the distribution of futures price log differences for wheat, soybeans and live cattle. While they found considerable leptokurtosis in the data, they conclude that this characteristic is not the result of non-constant variance. The authors postulate that non-normality in the data results from platykurtosis (fewer observations in the tails of the distribution than would be expected) caused by the fact that daily price changes in futures markets are limited by exchange rules. Results from this study showed that non-normality in futures price changes had decreased greatly during the period 1976-1982 as compared with the

1973-1975 period. Because the increased tendency toward normality in price changes indicated a greater probability that prices were following a random walk, the authors suggested that these futures markets had become more efficient over time.

Although most studies that examined futures price changes have concluded that they are not linearly dependent, recent work has shown that there is often a significant amount of non-linear dependence in futures price changes [Yang and Brorsen (1993); Venkateswaran, *et. al.* (1993); Murphy and McGuirk (1994)]. This suggests price changes in most futures markets are not completely random and, therefore, these markets are not weak-form efficient. At the very least, the findings of non-linear dependencies in futures price changes have implications with regard choice of statistical methods used to study these series.

2.3.3 Semi-Strong Form Efficiency Studies

A market is considered semi-strong form efficient if the prices it generates fully reflect all available public information. Several studies have been conducted which have sought to "test" various futures markets for this type of efficiency by looking for evidence that some public information was not fully and immediately registered in prices. That is, as with weak-form efficiency, empirical work seeks not to prove market efficiency but to locate an example to disprove it.

Leuthold and Hartmann (1979) test semi-strong form efficiency in the live hog futures market by comparing forecasts of future cash prices generated by a two-equation supply and demand structural model of the cash live hog market with forecasts offered by futures prices. The supply side of the structural econometric model included such fundamental variables as the hog-corn price ratio and sow farrowings. The structural inverse-demand equation specified the price of slaughter hogs as a function of hog slaughter and disposable income. The root mean squared error (RMSE) of the econometric model forecasts proved to be considerably smaller than the RMSE of forecasts provided by futures prices. The authors concluded that public information did exist which could improve forecasts of future cash prices, but this information was not being fully incorporated into current futures prices. Thus, the live hog futures market was deemed semi-strong form inefficient. The authors suggested that these efficiency shortcomings could be reduced by increasing the number of "well-informed" traders in the market. They go further and propose that commercial firms may be the well-informed traders the market is lacking and suggest lowering costs of market participation to these traders as a means of increasing their market activity.

The empirical work discussed in the previous paragraph was extended to include the live cattle and pork belly futures markets in a second study by Leuthold and Hartmann (1981). A quarterly supply and demand system was specified for live cattle, live hogs and pork bellies and used to forecast subsequent cash prices. RMSE comparisons demonstrated that the econometric model forecast was superior to futures prices in most time periods for hogs but only in a very few time periods for live cattle and pork bellies.

These results led the authors to conclude that livestock futures markets are at least occasionally semi-strong form inefficient.

Just and Rausser (1981) compared the forecasts produced by commercial firms using large econometric models with futures prices for several different commodities. The RMSE criterion was used to rank the forecasting sources with respect to forecasts made between December 1976 and December 1978. Live cattle futures were found to be superior to any of the econometric models within three months of delivery, but for longer forecast horizons the econometric models performed better. Similar results were found for live hog futures: within a one quarter forecast horizon futures prices outperformed the econometric models, but at longer horizons some of the econometric models surpassed futures in forecast accuracy. These results suggest the possibility of semi-strong form inefficiency in livestock futures with the level of efficiency achieved improving closer to delivery.

The existence of a predictable, systematic downward bias in live cattle futures prices was argued by Helmuth (1981) in a controversial study. He claimed to find a trading rule that predicted downturns in live cattle futures prices between 1978 and 1981. Because his rule was based on public information in the form of USDA reported feeding costs, his finding qualifies as evidence against semi-strong efficiency. However, Palme and Graham (1981) examined Helmuth's work and concluded that the evidence did not support his arguments. Among the more important contradictions found by Palme and

Graham was that Helmuth's trading technique was based on data that would not have been available at the time his system needed them to generate trading signals.

Simply because a model has been found that can forecast better than futures prices does not mean that it is profitable to use the model for that purpose. In a real-world context, traders could only be expected to use a model (and thus eliminate inefficiencies) if the expected utility of doing so is greater than the expected utility of inaction. Garcia, *et. al.* (1988) make the point that finding a better forecasting model is only a necessary condition for market inefficiency. They assert that a sufficient condition would require showing that use of the model in actual trading would produce profits when all costs are considered. Actually, this is only correct for risk neutral traders; if a trader were risk averse, then the second moment of the return distribution would also be important in determining whether or not a trader would act. For example, a risk averse trader might not utilize a forecasting model that generated small positive profits on average but with a variance so large that the potential for large losses was substantial.

Garcia *et. al.* formulated a structural econometric model and an ARIMA model of cash cattle prices for forecasting purposes. Forecasts from each model and a composite forecast formed from both models were compared with futures prices using a MSE criterion for forecast accuracy. Results showed that both the structural model and composite forecasts outperformed futures as predictors of subsequent cash prices for all forecast horizons. These forecasts were then used in trading simulations which took into account the direct costs of trading (such as commissions) but did not consider the indirect costs of model building and updating. Four simulation strategies showed small positive profits, but these profits had relatively large variances associated with them. The authors concluded that there appeared to be very little opportunity to profit from the better forecasting models they had discovered and thus these models did not provide strong evidence of inefficiency in the live cattle futures market.

A very similar type of study was conducted with regard to the live hog futures market by Leuthold *et. al.* (1989). As was found with the live cattle market, econometric and composite forecasts dominated futures prices with respect to the forecast MSE of subsequent cash prices. When the superior-forecasting models were used in trading simulations, significant positive profits were observed. The authors did not report the variances of the simulated returns in their paper. Instead, they only listed ranges of the returns. Still, the authors concluded that the positive profits generated by trading on the structural model forecasts were large enough to declare the live hog futures market inefficient.

Often, studies are conducted that test semi-strong efficiency in futures markets by looking for evidence that prices react to previously anticipated information in government reports when they are released. Theoretically, informationally efficient futures markets would react only to unanticipated information contained in government reports. Colling and Irwin (1989) evaluated the reaction of live hog futures prices to unexpected changes in hog inventories reported in the quarterly release of the USDA's *Hogs and Pigs Report*. Expected changes in hog inventories were proxied by forecasts produced from a market survey and published in a widely read trade publication, *Futures World News*. Results indicated that expected inventory changes were incorporated into futures prices prior to the release of the government report and that the market responded to the unanticipated information in these reports in the expected direction. Thus, this work provided no evidence of inefficiency in the live hog futures market.

Runkle (1992) examined the reaction of live hog futures prices to predictable errors in sow farrowing intentions reported in the *Hogs and Pigs Report.* He found empirical evidence that the two-quarter ahead sow farrowing intentions were a biased estimate of actual sow farrowings and tested to see if this predictable component affected movements in live hog futures prices when the report of actual sow farrowings was released. Results indicated that the actual farrowings announcements do contain new information and the futures market reacts to this information but does not respond to the predictable component in the announcement. As with the Colling and Irwin study, this study fails to find inefficiency in the live hog futures market.

2.3.4 Price Formation in Livestock Futures Markets

Slightly different, but very closely related to pricing efficiency, is the concept of price formation in futures markets. Price formation deals with the process of how equilibrium prices come to be. In futures markets, price formation usually involves linkages with the cash market for the commodity. Prices are said to be formed rationally if the agents involved in forming them behave as though they have full knowledge of the underlying price generation process. If agents understand the cash price generation process and behave rationally, then this puts constraints on the way that prices can be formed in the futures market.

Shonkwiler (1988) investigates whether livestock futures prices are rational forecasts using seasonal ARIMA models. The Box-Jenkins methodology was used to fit time series models to cash price data for cattle and hogs. Then, identical models were estimated using futures prices for these commodities and tests for significant differences in the parameter estimates between the two models (cash and futures) were administered. If the parameters differed, then this was taken to be evidence that the futures price is not a rational forecast of subsequent cash prices. Results indicated that futures were rational forecasts up to four months prior to maturity for cattle and two months prior to maturity for hogs, but not at longer forecast horizons.

Koontz, Hudson and Hughes (1992) explain the poor forecasting performance of livestock futures in a rational price formation context. For nonstorable commodities such as cattle and hogs, a supply response to futures prices is possible which could cause them to be poor predictors of subsequent cash prices and also become a self-defeating prophecy. Rational price formation theory maintains that futures prices on distant contracts will stay near average variable cost (AVC) of production because rational producers know that prices which stray far from costs will cause a supply response. Once supply is fixed (after farrowings or placements) futures prices break away from the AVC of production and reflect anticipated future supply/demand conditions. The authors used a seemingly unrelated regressions estimator to regress futures prices on AVC at different lags. They expected AVC to explain a significant portion of futures price prior to supply determination and then expected that relationship to deteriorate as contract maturity approached. Their empirical results generally support rational price formation, although more so for cattle than for hogs. They attribute this to greater uncertainty in the hog production process. These results suggest that producers will find little opportunity to hedge cattle at substantial profit levels prior to the placement decision. More profitable hedging opportunities could be expected closer to contract maturity, but risk is increased by making the production decision prior to, instead of simultaneously with, the hedging decision.

2.4 Large Trader Behavior in Futures Markets

Since the present study involves quantifying the impact of various large trader groups on live cattle futures prices, it is important to review the literature that deals with the behavior of large traders in futures markets.

Leuthold (1983) conducted the first in-depth study of the market participation by different types of large traders in the livestock futures markets. Using monthly commitments of traders from 1969 to 1980 for the live cattle, live hog and feeder cattle futures markets, a descriptive picture of the behavior of large traders was developed. Overall, positions held by large reporting traders were found to comprise a much smaller proportion of open interest in the livestock futures markets than in grain markets. Large reporting traders accounted for between 40 to 50 percent of the open interest in livestock futures during the period of this study.

The commitment data indicated that as the livestock futures markets grew (open interest expanded), both commercial (hedging) and noncommercial (speculative) large trader activity increased. A correlation analysis was conducted to assess the strength of the relationship between commercial large trader futures activity and activity in the physical commodity market. Here, the hypothesis was that as physical commodity inventories grew, greater price risk exposure would cause more commercial hedging activity in the futures market. Positive, but relatively small relationships were found between cash activity and futures positions for large hedgers. There were also positive correlations between large hedger and large speculator market activities suggesting that, as hedging needs increased, large speculators were drawn to the market to take the opposite side of these transactions. Leuthold concludes that hedging has been important for the livestock futures markets and that there is no evidence that they exist primarily for speculative purposes.

A detailed study of the activities of the very largest commercial traders in the livestock futures markets between January 1983 and June 1984 was conducted by the CFTC (1984). These commercial traders included cattle feeders, beef and pork processors, a hog producer and a hog merchandiser. Interviews with representatives of these commercial firms revealed that selective, rather than routine, hedging was the principle form of futures activity engaged in by nine of ten firms. This highlights the importance of price expectations in futures market activities of large commercial traders.

Occasionally, concerns surface involving the potential for price manipulation by large traders in futures markets. Oellermann and Farris (1986) examined the effect of trader concentration on prices and basis relationships from 1977 to 1981 in live cattle futures. Four-trader concentration ratios were calculated from CFTC reporting trader data for three dates: the first and last days of the month prior to delivery, and the tenth day of the delivery month. Regression models were then used to identify relationships with regard to changes in concentration between these dates and the corresponding changes in price. Other regression models examined relationships between large trader concentration and the delivery period basis. No statistical evidence was found to support the hypothesis that large trader concentration influenced either prices or the basis.

The same authors reported on an identical study in feeder cattle futures (Oellermann and Farris, 1988). Four-trader concentration ratios ran much higher in feeder cattle markets during the same time period. For example, the four-trader concentration ratio for long positions on the last trading day of the month prior to delivery averaged 40 percent of open interest in feeder cattle but only 13 percent of open interest in live cattle futures. For short positions, the four-trader concentration ratio averaged 27 percent in feeder cattle and 19 percent in live cattle on that date. Despite the higher concentration in the feeder cattle market, the authors were again unable to detect any significant statistical relationships between large trader concentration and either price or basis.

The Grain Futures Administration (GFA) laid the blame on large speculative traders for a steep break in wheat futures prices in 1925. Using a graphical analysis of large trader net positions, the GFA concluded that the trading behavior of a group of large traders caused the abrupt downturn in futures prices. Petzel (1981) re-examined the GFA data using more appropriate statistical tools. He calculated the cross-correlation coefficients between price changes and changes in the open interest of several groups of traders for a number of positive and negative lags. No significant cross-correlation was detected at any lag (other than zero), indicating there was no long-term price effect from the trading activities of the largest grain speculators. There was significant positive contemporaneous correlation between prices and large trader activity at lag zero. This means that the large traders did "move the market" on the days that they were active in that market. Petzel concludes that the large traders were not manipulating the market. Rather, they were just wrong in their price expectations during the particular time period.

The forecasting skill of different types of traders in futures markets can be measured by their ability to realize profits from their trading activities. Hartzmark (1987) used CFTC large reporting data to calculate net returns to large commercial and noncommercial traders from July 1977 to December 1981 in nine futures markets. Because each trader account in the CFTC data set was identified by a unique account number, Hartzmark was able to arrive at the daily return for each account by "marking to market" the account and subtracting estimated commission costs. Individual account returns were then aggregated according to commercial classification. Over all nine markets, large commercial traders earned significantly larger profits than did their noncommercial counterparts. The live cattle and feeder cattle markets were the only markets of the nine where noncommercial traders realized larger profits than commercial traders.

Hartzmark's results were in opposition to the findings of previous studies. Houthakker (1957) and Rockwell (1983) both found that large speculators earn positive profits from their trading activities. These studies, however, had to rely on month-end data with regard to the net positions of large traders and did not have specific information on individual accounts. Hartzmark suggests that the Houthakker and Rockwell results, based on monthly position data, show that large speculators do well in the long-term, but lose on their day-to-day trading.

In an study of the relationship between price movements and the positions of large reporting traders, Rowsell (1991) used a CFTC large reporting trader data set similar to that of Hartzmark but for live cattle futures between 1983 and 1988.[4] Large trader positions were aggregated according to commercial classification and direction of the position. Correlations between the large trader positions were small. Regression analysis suggested that changes in the large trader positions had only a very small impact on price. A Granger causality analysis seemed to point to a unidirectional flow from price to trader positions. In other words, traders did not cause price. Instead, price movements caused traders to take positions. This relationship was stronger between price and speculative

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[4]The same data set is used in the present study.

positions than between price and hedge positions, prompting the author to conclude that speculative activity is more motivated by price than is hedging activity. Rowsell also concluded that the lack of causality from trader positions to price provided evidence that prices in the live cattle futures market were free from manipulation by large traders.

2.5 Chapter Summary

The literature reviewed in this chapter provides some important conclusions with regard to futures markets and the information that flows through traders into prices. The primary economic functions of futures markets are risk transfer, storage allocation, and price discovery. In livestock futures markets, the price discovery function is especially important and the performance of this mechanism has resource allocation implications. The price system itself is an extremely efficient method for collecting and disseminating information from many sources to many users.

Since information is costly to collect and evaluate, markets can never be completely efficient because traders must be able to expect a positive return to their information collection activities. Uninformed traders in a market are able to access information from the market activities of informed traders without incurring the cost of collecting it. These facts suggest that some amount of noise is necessary in order for a market to exist.

Market efficiency and price discovery are closely linked. Price discovery is a sub-process in the information collection mechanism of a market; therefore, what is good for price discovery is also good for market efficiency. Results from the market efficiency studies reviewed in this chapter are mixed and in some cases seem to be dependent upon the time period or methodology used. Most of the livestock efficiency studies seem to agree, however, that the futures market becomes more efficient as a contract approaches maturity. Inefficiency in distant contracts could well be a function of information costs. Undoubtedly, accurate information on the delivery period value of a commodity becomes more costly at greater distances from delivery. Since traders must weigh the cost of information against expected returns, it should not be surprising that more information goes uncollected as the time to delivery increases.

Reporting traders generate a significant portion of market activity in livestock futures, although not as large a proportion as in some grain markets. The research shows that they do influence prices when they are active in the market, but do not engage in price manipulation. In many futures markets, large commercial traders seem to form the most accurate day-to-day price expectations. In the live cattle futures market, however, it appears that large speculators are better than large commercial traders at predicting daily price movements.

The general conclusions arising from previous futures market work will form a useful foundation upon which the present study will build in exploring the influence of various trader types, and especially large traders, on the price discovery process in live cattle futures.

Chapter 3

THEORETICAL AND EMPIRICAL ISSUES

3.1 Introduction

This chapter begins, in Section 3.2, with the development of a conceptual model of the process by which information becomes incorporated into futures prices. In Section 3.3, the Expected Value-Variance (E-V) model is used to identify the impact of several important variables on a trader's willingness to participate in futures markets. Section 3.4 details the sources of social loss that can arise when agents base economic decisions on inaccurate futures prices. Section 3.5 compares the price discovery process in cash and futures markets. The price discovery implications of profit-maximizing trader behavior is explored in Section 3.6. Section 3.7 describes the theoretical and empirical foundations of quadratic programming methods and Section 3.8 explores the issue of tests for statistical difference of a popular forecast evaluation criterion, mean square error. Section 3.9 provides a summary of the chapter.

3.2 A Conceptual Model of Information Flows Into Futures Markets

Futures markets are institutions that provide a pricing system which helps society solve the problem of efficiently utilizing information not given to any individual in its entirety. To perform this function, futures markets must collect commodity-related information from all of the diverse individuals who possess it. In what follows, an abstract model of the process of information collection and condensation in futures markets is developed.

The information collection process begins with the universe of all information. From this all-encompassing set, traders and potential traders in futures markets each select the subset of information that they consider useful for forecasting future prices of the commodity. Figure 3.1 illustrates this process for six separate traders.[5] A trader's specific information subset may or may not be unique. The diagram in Figure 3.1 shows all six information subsets intersecting, indicating the possibility that certain information is in every trader information set. This common set of information might include such information as the last quoted price or the most recent daily settlement price.

Included in the universe of all information are the price expectations and market activities of other traders. When several traders act solely on the recommendations of the same commodity trading advisor, these traders possess very similar or identical information subsets.

Once all potential traders have identified the information they feel is most important to determining future prices (and cost justified), they must employ some method of condensing their information subset into a price expectation. This is accomplished through the use of a translating mechanism (TM). These translating mechanisms may be complex or simple, objective or subjective, unique or shared. Again, traders who rely solely on the price forecasts provided by the same advisor share the same translating

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[5]Later this will be generalized to represent six groups of traders.

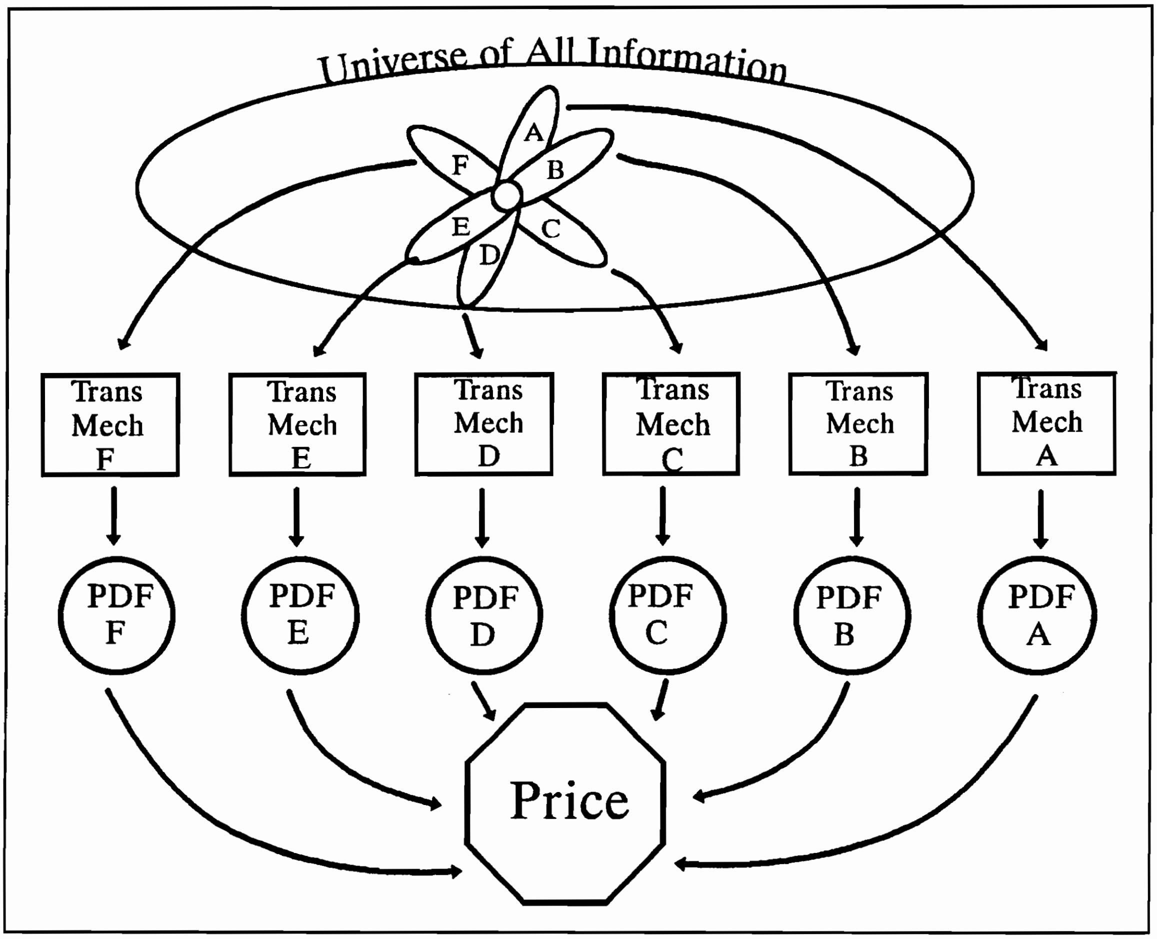

Figure 3.1. Conceptual Model of Information Flows into Futures Markets.

mechanism as well as information subset. Traders may develop their own unique translating mechanisms which may include, to some degree, elements of the TM's of other traders.

Selection of the translating mechanisms, like choice of information subsets, is a subjective process. Once developed, however, the TM may be used in an objective manner to produce price expectations. This the case where formula-type translating mechanisms such as econometric models are used to condense the information subset into a price forecast. Technical trading rules are another example of objective use of a TM. Other translating mechanisms may be much more subjective. This is the case when traders form price expectations based on intuition developed in previous market experiences.

Regardless of the nature of the TM, all produce some price expectation. This price expectation is best represented, not as a single point, but as a function that describes the trader's beliefs as to the likelihood of a wide range of prices. The TM condenses the information subset into a probability density function (PDF) on future prices.

Once a trader has formed a price expectation, he/she then faces the decision of whether or not to act on that price expectation by taking a position in the futures market. The trader's willingness to act on a price expectation may be influenced by a number of variables such as the perceived accuracy of the price expectation, the degree of movement in prices indicated by the expectation, the existence of a cash position, the costs associated with participating in the futures market, and the risk preference of the trader.

As an example of how these trader characteristics can impact willingness to act, consider two potential traders with identical PDFs on future prices. Suppose one potential trader has a large long cash position and the other has no cash position. If the shared price expectation calls for sharply decreasing prices in the future, the trader with the cash position stands to lose much more than the trader with no cash position and has a much stronger motivation to act on the price expectation by taking a position in the futures market.

The price expectation, when combined with the trader's willingness to act, results in trading behavior. Trading behavior is represented in Figure 3.1 by the arrows pointing toward the octagon containing price. In this model, the only thing that influences price is the trading behavior of the market participants. Viewed from the other direction, prices arising from futures markets are solely a function of the trading behavior of market participants. That trading behavior, of course, is a function of information, trader characteristics, and such factors discussed above.

Because willingness to act on a price expectation is important to the formation of prices in a futures market, and therefore to the performance of that market, the next section explores the impacts of various trader characteristics on the willingness to take action in the futures market. The section formally integrates information and trading behavior.

3.3 E-V Analysis of Trader Participation

Whether or not a potential trader actually takes a futures position is dependent upon the expected costs and benefits of doing so. Since this involves an action with uncertain outcomes, the expected utility model is an appropriate representation of the decision making process. The potential trader would be expected to take a futures position if the expected utility of market participation exceeded the expected utility of inaction.

E-V analysis was developed by Markowitz as a portfolio selection tool and extended to include risk-free assets by Tobin. It is founded on the idea that risky prospects can be ordered based on the trade-off between expected value and variance. From these E-V sets, the E-V efficient frontier can be identified as the collection of all choices for which no other choice with the same expected value has a smaller variance. E-V analysis involves using decision maker preferences to select a risky action from among the choices on the E-V frontier.

The E-V approach can be derived from the more general expected utility (EU) maximization framework under some rather restrictive assumptions. Two sufficient assumptions for consistency between E-V choices and expected utility maximization are that the agent's utility function be quadratic (which implies that only the first two moments, the mean and variance, of outcome distributions are important in the decision process) or that the agent's outcome variable expectations are normally distributed. Figure 3.2 illustrates how optimal decisions are made in the E-V framework. Given some E-V efficient set of choices, the agent selects the choice that lies at the tangency between the E-V frontier and his/her highest EU indifference curve. A linear segment with slope identical to the slope of the E-V frontier at the tangency can be extended to the expected value (E[y]) axis. This serves as an approximation to the unknown EU function. The point at which this segment intersects the E[y] axis is called the certainty equivalent (CE). Since they lie on the same indifference curve, the CE would give the decision maker the same expected utility as the optimal choice from the E-V frontier. Freund has shown that

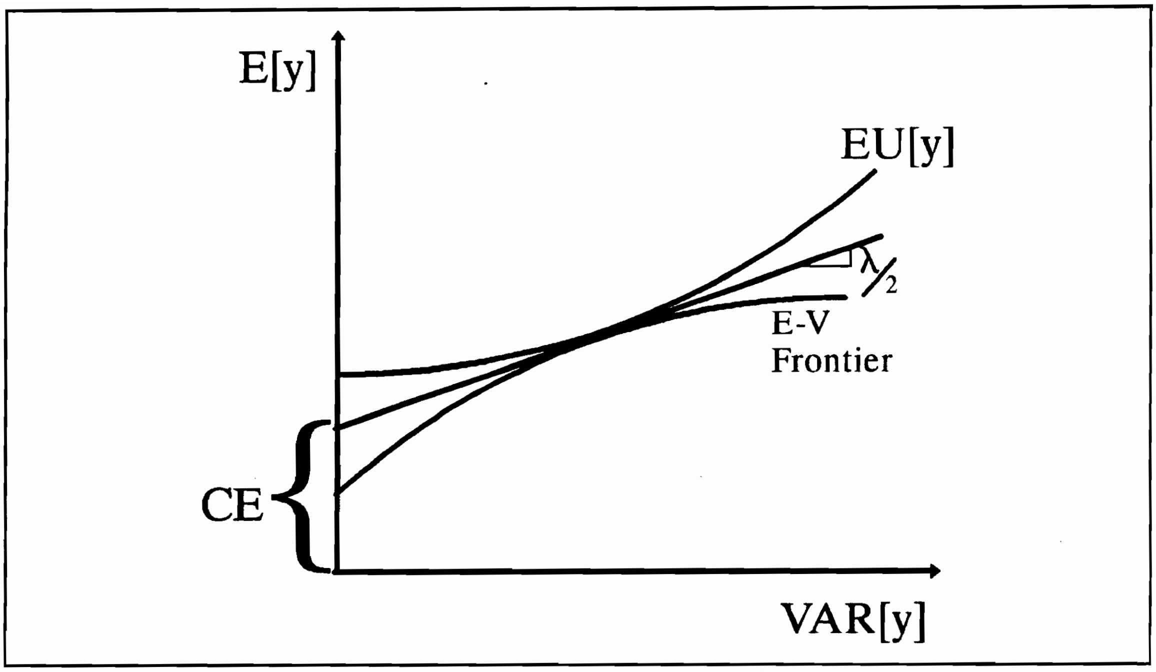

Figure 3.2. Graphical Representation of the E-V Model.

the slope of this segment will be $\lambda/2$ where λ is the agent's risk aversion coefficient.[6] Typically, the E-V analysis proceeds by defining the line segment in terms of the expected value and variance of the risky prospect under study, then maximizing the CE to find the optimal action. Comparative statics can then be used to study how the optimal action changes in response to important parameters in the problem.

The assumptions required to assure that the optimal E-V is also the optimal EU maximizing action have been widely criticized. Quadratic utility implies that the decision maker possesses increasing absolute risk aversion (IARA) and that marginal utility becomes negative at some point. Quadratic utility may, however, serve as an adequate

[6]The risk aversion coefficient is defined as $-U''(y)/U'(y)$ where U is the decision maker's utility function which is expressed solely as a function of income, y (Pratt).

local approximation of the risk averse decision maker's preferences. Also, requiring the outcome variables to be normally distributed restricts the usefulness of the E-V approach in empirical applications.

For empirical work, the usefulness of the E-V model lies in its ability to closely approximate the results of the EU model. As an analytical tool, the relatively uncomplicated structure of the E-V model permits the relationships between variables to be easily studied. E-V models are therefore less important for their ability to measure empirically than for their ability to indicate the direction of movement in important variables as they respond to changes in elements of the decision making process (Robison and Barry).

The effect of variables such as cash position, price level expectation, and accuracy of the price expectation on the willingness to take a futures position can be studied with the aid of the E-V model. The analysis begins with the linear approximation to expected utility depicted graphically in Figure 3.2. Mathematically, this linear combination of risk and returns is expressed as:

$$CE = E[y] - \frac{\lambda}{2}VAR[y]. \tag{3.1}$$

Here, y is the random variable representing the outcome of the risky action and λ is the Pratt risk aversion coefficient.

To utilize the CE concept to determine futures market participation, consider the situation where a potential trader has used his/her information subset and translating mechanism to arrive at a PDF in the current time period (t_0) for the futures price in a later time period (t_1). Assume that the PDF can be characterized by some mean value, f_1, and a random component, ϵ, where $\epsilon \sim N(0, \sigma_\epsilon^2)$. Also, let c_0 represent the current cash price and f_0 the current futures price. To simplify matters, assume that there is only one time period until contract maturity and that the futures price in t_1 converges to the cash price in t_1 so that there is no basis risk. The potential trader's profit function is:

$$\pi = (f_1 + \epsilon - f_0)q_f - C(q_f, I) + (f_1 + \epsilon - c_0)q_c \tag{3.2}$$

A cash position (q_c) may exist and any costs incurred in acquiring or producing the cash position are considered sunk; therefore, what is important to the trader is the change in the value of the cash position between periods. In the absence of production uncertainty and basis risk, futures decisions can be separated from production decisions (Anderson and Danthine). The first term in (3.2) represents revenues from any futures position (q_f) and is arranged so that $q_f > 0$ indicates long futures positions and $q_f < 0$ indicates short futures positions. The second term in (3.2) represents the cost of futures activity and includes not only the direct costs, commissions and interest on margins, but the cost of defining the information subset and selecting the TM.[7] The third term is the change in value of the cash position. Because price in t_1 is uncertain, profit is a random variable.

[7]This cost function would not be of the usual type since the quantity variable, q_f, can take negative values. It would be as a usual cost function in the first quadrant and a mirror image of the usual cost function in the second quadrant. Derivatives of the cost function in the second quadrant should be interpreted as $\partial C/\partial|q_f|$.

The expected value of profit is:

$$E[\pi] = (f_1 - f_0)q_f - C(q_f, I) + (f_1 - c_0)q_c \tag{3.3}$$

and the variance of profit is:

$$VAR[\pi] = (q_f + q_c)^2\sigma_\epsilon^2. \tag{3.4}$$

Therefore the CE of profit is given by:

$$CE = (f_1 - f_0)q_f - C(q_f, I) + (f_1 - c_0)q_c - \frac{\lambda}{2}(q_f + q_c)^2\sigma_\epsilon^2. \tag{3.5}$$

The CE is maximized to find the optimal action. Choice variables in this analysis are the amount of effort exerted in defining the information subset and refining the translating mechanism (I) and q_f. Consistent with the conceptual model, the decision process is a sequential one where the agent first determines the information effort and forms the price expectation. Next, the quantity of futures is selected. Because the information effort is known at the time the futures decision is made, it can be treated as a constant. The decision maker must then choose the futures position, q_f, given the preselected information effort. Since q_f is the only choice variable, this involves setting $\partial CE/\partial q_f = 0$ as follows:[8,9]

$$\frac{\partial CE}{\partial q_f} = (f_1 - f_0) - C_q - \lambda(q_f + q_c)\sigma_\epsilon^2 = 0. \tag{3.6}$$

The second partial derivative of CE with respect to the choice variable, q_f, is:

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[8]In order to use calculus in this analysis it is necessary to assume that the quantity of futures positions is a continuous variable. In reality, futures positions come only in fixed increments. For live cattle, each increment is equivalent to 40,000 lbs.

[9]Partial derivatives of this cost function are symbolized by subscripts immediately following C. For example, C_q is the first partial derivative of C with respect to q_f.

$$\frac{\partial^2 CE}{\partial q_f^2} = -C_{qq} - \lambda\sigma_\epsilon^2 = \delta . \tag{3.7}$$

Since λ is positive for risk averse individuals and σ_ϵ^2 is positive, a sufficient condition for δ to be negative [making (3.7) a maximum] is $C_{qq} \geq 0$. A weaker condition would be $C_{qq} > -\lambda\sigma_\epsilon^2$. The sufficient condition could very well hold with equality since C_{qq} measures the rate of change in non-information marginal cost of taking a futures position. These costs are commissions and interest on margins. For many traders, the additional cost of an additional futures transaction is constant, thus $C_{qq} = 0$. Assuming constant marginal transactions costs, the utility maximizing level of futures activity (q_f^*) is:

$$q_f^* = \frac{f_1 - f_0 - C_q}{\lambda\sigma_\epsilon^2} - q_c . \tag{3.8}$$

The characteristics of the trader's price expectation (mean, variance) in combination with his/her risk attitude determines the optimal price risk exposure ($q_c + q_f^*$). The futures position supplements the cash position to correct for any discrepancies between the fixed cash position and the optimal price risk exposure. If the cash position is larger than the optimal price risk exposure (in absolute value), then the optimal futures position will be in the direction opposite the cash position. This is the same as saying that part of the cash position is hedged to reduce overall price risk exposure.

It would not be unusual to see the cash term outweigh the speculative term in (3.8). That is, the trader may expect higher prices but because of a large long cash position the optimal futures position is short. Also from (3.8), when the variance of the price expectation is very large, the optimal futures position is a full hedge if there is a cash position or zero if there is no cash position. As the trader becomes more uncertain as to the path prices might take, he/she seeks to hedge more of the cash position and engage in less speculative activity.

Next, the formal comparative statics for this model are derived. Some discussion as to how a trader's absolute risk aversion changes with changes in the E-V frontier is required.

Changes in the variables of the trader's profit function will result in shifts of the E-V frontier. For example, cost increases will reduce returns and shift the E-V frontier downward. When the shape or location of the E-V frontier changes, a new tangency with the trader's indifference curves would be expected. The value of λ that characterizes the slope of the indifference curve at the tangency with the E-V frontier may change. How λ changes in response to changes in the E-V frontier determines whether the trader is characterized by increasing, constant or decreasing absolute risk aversion. Decreasing absolute risk aversion (DARA) means that as expected income or wealth increases, the trader becomes less risk averse. Traders with increasing absolute risk aversion (IARA) become more risk averse as expected income increases. Constant absolute risk aversion (CARA) implies that the trade-off between risk and return for the trader is independent of the level of income. Intuition and previous empirical work suggests that most decision makers are characterized by DARA although CARA and IARA cannot be completely ruled out. This analysis focuses on traders with DARA.

Figures 3.3 through 3.6 illustrate different types of absolute risk aversion and the response of the risk aversion coefficient to changes in the E-V frontier. In Figures 3.3 and 3.4, the E-V frontier rotates upward from A to B indicating a decrease in the amount of variance that must be sacrificed at each level of expected income. If the CE maximizing tangent becomes less steep, as illustrated by the movement from C to D in Figure 3.3, then this implies DARA. If the tangent slope must increase to maximize CE after the E-V change (shown as a movement from C to D in Figure 3.4), then IARA is indicated. In general, $\partial\lambda/\partial\theta < 0$ implies DARA and $\partial\lambda/\partial\theta > 0$ implies IARA where θ is a variable that, when increased, shifts the E-V frontier upward. Figures 3.5 and 3.6 present an identical analysis for the case when the E-V frontier shifts downward. In Figure 3.5, the E-V frontier moves from A to B and the CE maximizing tangent becomes less-steeply sloped (moving from C to D) indicating IARA. A more steeply sloped tangent is shown in Figure 3.6 indicating DARA. Thus, when θ is a variable that causes a downward shift in the E-V frontier when it is increased, $\partial\lambda/\partial\theta > 0$ indicates DARA and $\partial\lambda/\partial\theta < 0$ indicates IARA.

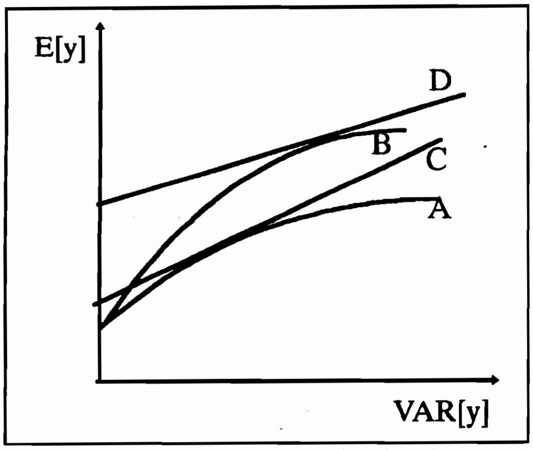

Figure 3.3. Upward Shift in the E-V Frontier and New Tangency for DARA Decision Makers.

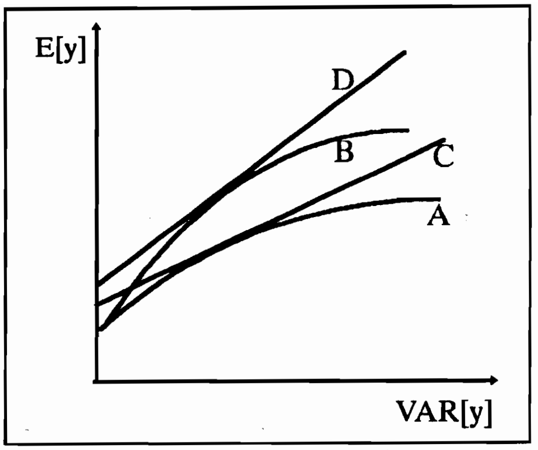

Figure 3.4. Upward Shift in the E-V Frontier and New Tangency for IARA Decision Makers.

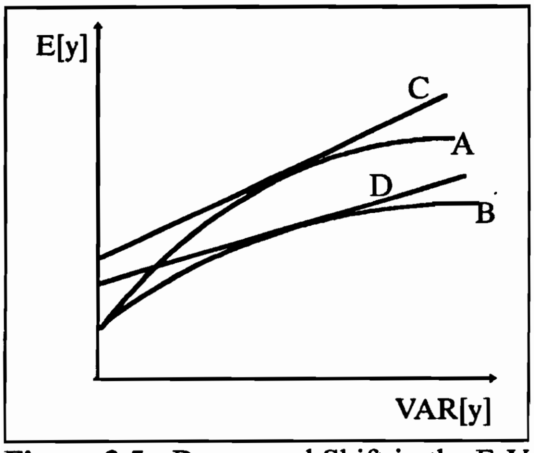

Figure 3.5. Downward Shift in the E-V Frontier and New Tangency for IARA Decision Makers.

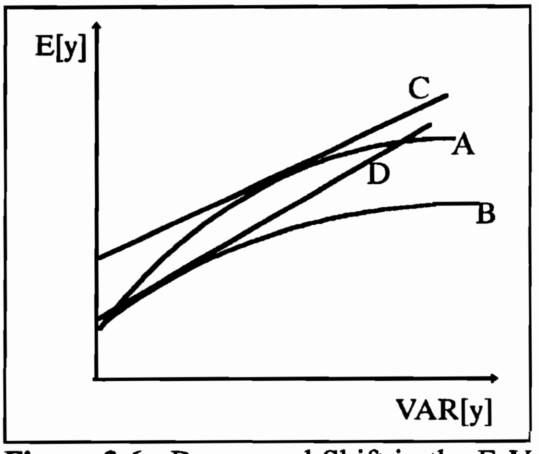

Figure 3.6. Downward Shift in the E-V Frontier and New Tangency for DARA Decision Makers.

The response of futures activity to the characteristics of the PDF of expected prices is now investigated.[10] The total derivative of the first order condition given in (3.6) with respect to futures position and variance of the price expectation is:

$$[-C_{qq} - \lambda\sigma_\epsilon^2]dq_f - [(q_f + q_c)(\lambda + \sigma_\epsilon^2 \frac{\partial\lambda}{\partial\sigma_\epsilon^2})]d\sigma_\epsilon^2 = 0 . \qquad (3.9)$$

Rearranging (3.9) produces:

$$\frac{dq_f}{d\sigma_\epsilon^2} = \frac{(q_f + q_c)(\lambda + \sigma_\epsilon^2 \frac{\partial\lambda}{\partial\sigma_\epsilon^2})}{\delta} . \qquad (3.10)$$

The second expression in the numerator of (3.10) is positive since λ, σ_ϵ^2, and $\partial\lambda/\partial\sigma_\epsilon^2$ are all positive. All risk averse individuals are characterized by $\lambda > 0$. Increases in the variance of the price expectation shift the E-V frontier downward, thus $\partial\lambda/\partial\sigma_\epsilon^2$ is positive for DARA traders. The denominator in (3.10) is negative by the second order conditions given in (3.7). The sign of $dq_f/d\sigma_\epsilon^2$ is therefore determined by the direction of the optimal exposure, $q_f + q_c$.

Table 3.1 summarizes the effect on futures activity of a change in the variance of the price expectation. When the optimal exposure is either positive (long) or negative (short), five different combinations of q_f and q_c are possible. Each of these combinations is examined in Table 3.1 and a trader classification is assigned to each. Beginning with the first two combinations, a trader is considered a hedger (or potential hedger) if he/she has a cash position and no futures position or a cash position and a futures position in the

[10] The term "futures activity" is meant to indicate, not the actual number or size of transactions, but rather the willingness, or desire, to take or hold a position.

Table 3.1. Summary of the Effect on Futures Activity of a Change in the Variance of the Price Expectation.

Optimal Exposure	Sign of $dq_f/d\sigma_\epsilon^2$	Cash and Futures Positions	Trader Type	Impact on Futures Activity When: σ_ϵ^2 Increases	Impact on Futures Activity When: σ_ϵ^2 Decreases
Long ($q_c + q_f > 0$)	Negative				
		$q_c > 0$, $q_f = 0$	Hedger[a]	Increase	Decrease[b]
		$q_f < 0$, $q_c > -q_f$	Hedger	Increase	Decrease
		$q_c = 0$, $q_f > 0$	Speculator	Decrease	Increase
		$q_c < 0$, $q_f > -q_c$	Speculator	Decrease	Increase
		$q_c > 0$, $q_f > 0$	Speculator	Decrease	Increase
Short ($q_c + q_f < 0$)	Positive				
		$q_c < 0$, $q_f = 0$	Hedger[a]	Increase	Decrease[b]
		$q_f > 0$, $q_c < -q_f$	Hedger	Increase	Decrease
		$q_c = 0$, $q_f < 0$	Speculator	Decrease	Increase
		$q_c > 0$, $q_f < -q_c$	Speculator	Decrease	Increase
		$q_c < 0$, $q_f < 0$	Speculator	Decrease	Increase
None ($q_c + q_f = 0$)	Zero				
		$q_c = -q_f$	Hedger (Full)	No Effect	No Effect
		$q_c = 0$, $q_f = 0$	Speculator	No Effect	No Effect

[a]A potential hedger—this trader type can only take futures positions opposite the cash position.

[b]This situation causes the trader to want a position in the same direction as the cash position. Since this is not allowed for this trader type, this is interpreted as a decrease in the desire to take the only allowable futures position.

opposite direction that is smaller in absolute size than the cash position. In the remaining three combinations, a trader is considered a speculator when he/she holds a futures position and no cash position, a futures position larger in absolute size than the cash position, or cash and futures positions in the same direction. There are two possible combinations of q_f and q_c that will produce an optimal exposure of zero and these are listed at the bottom of Table 3.1. The first combination is characteristic of a fully hedged trader where the cash and futures positions are equal in size and opposite. The second combination is that of a speculator who has neither a cash nor futures position.

The last two columns of Table 3.1 give the impact on futures activity of a change in σ_ϵ^2 for each cash-futures combination. These responses are derived by noting the current futures position and then considering the sign on $dq_f/d\sigma_\epsilon^2$. For example, in the first long optimal exposure combination, $dq_f/d\sigma_\epsilon^2 < 0$ implying that a increase in σ_ϵ^2 will cause this trader to seek to reduce q_f. Since $q_f = 0$ initially, this means that the trader will go from no futures position to a short futures position—an increase in futures activity.

Table 3.1 illustrates the difference in trading behavior between hedgers and speculators. As the variance of the price expectation increases, hedgers are more likely to increase their futures activity while speculators can be expected to decrease their futures activity. Also, a change in the uncertainty of the price expectation has no impact on the futures activity of fully-hedged traders or non-participants with no cash position.

To explore how futures market activity is affected by the mean of the price expectation, the total differential of the first order condition in (3.6) is taken with respect to q_f and the spread between the mean expected price and the current futures price, f_1 - f_0:

$$\delta \, dq_f + \left[1 - (q_f + q_c)(\sigma_\epsilon^2 \frac{\partial \lambda}{\partial (f_1 - f_0)})\right] d(f_1 - f_0) = 0 . \qquad (3.11)$$

Rearranging (3.11) produces:

$$\frac{dq_f}{d(f_1 - f_0)} = \frac{(q_f + q_c)\left[\sigma_\epsilon^2 \frac{\partial \lambda}{\partial (f_1 - f_0)}\right] - 1}{\delta} . \qquad (3.12)$$

Increases in the spread between the mean price expectation and the current futures price will increase (decrease) expected profits for traders with long (short) net exposure thus shifting the E-V frontier upward (downward). From the prior discussion, this indicates that $\partial \lambda / \partial (f_1 - f_0)$ is < 0 for DARA traders with positive optimal exposure and $\partial \lambda / \partial (f_1 - f_0)$ is > 0 for DARA traders with negative optimal exposure. Since $\delta < 0$, (3.12) will be positive for all DARA traders.

Table 3.2 summarizes the effect on futures activity of changes in the mean price expectation for each cash-futures combination. With speculators, the impact is as would be expected; when the current futures position is long (short), increases in the mean price expectation increases (decreases) futures activity. For hedgers with long cash positions, increases in the mean price expectation decrease the willingness to act in the futures market because *these traders already have a "bet" that prices will rise in the form of their cash holdings.* An analogous situation occurs for hedgers with short cash positions and decreases in the mean price expectation.

Table 3.2. Summary of the Effect on Futures Activity of a Change in the Mean of the Price Expectation.

Optimal Exposure	Sign of $dq_f/d(f_1-f_0)$	Cash and Futures Positions	Trader Type	Impact on Futures Activity When: (f_1-f_0) Increases	(f_1-f_0) Decreases
Long ($q_c + q_f > 0$)	Positive				
		$q_c > 0$, $q_f = 0$	Hedger[a]	Decrease[b]	Increase
		$q_f < 0$, $q_c > -q_f$	Hedger	Decrease	Increase
		$q_c = 0$, $q_f > 0$	Speculator	Increase	Decrease
		$q_c < 0$, $q_f > -q_c$	Speculator	Increase	Decrease
		$q_c > 0$, $q_f > 0$	Speculator	Increase	Decrease
Short ($q_c + q_f < 0$)	Positive				
		$q_c < 0$, $q_f = 0$	Hedger[a]	Increase	Decrease[b]
		$q_f > 0$, $q_c < -q_f$	Hedger	Increase	Decrease
		$q_c = 0$, $q_f < 0$	Speculator	Decrease	Increase
		$q_c > 0$, $q_f < -q_c$	Speculator	Decrease	Increase
		$q_c < 0$, $q_f < 0$	Speculator	Decrease	Increase
None ($q_c + q_f = 0$)	Positive				
		$q_c = -q_f$	Hedger (Full)	Increase[c]	Decrease[c]
		$q_c = 0$, $q_f = 0$	Speculator	Increase[c]	Decrease[c]

[a]A potential hedger—this trader type can only take futures positions opposite the cash position

[b]This situation causes the trader to want a position in the same direction as the cash position. Since this is not allowed for this trader type, this is interpreted as a decrease in the desire to take the only allowable futures position.

[c]Assuming the current value of f_1 - f_0 is positive.

To study how changes in the cash position affect futures activity, the first order condition is totally differentiated with respect to the cash and futures positions:

$$(-C_{qq} - \lambda\sigma_\epsilon^2)dq_f - \lambda\sigma_\epsilon^2 dq_c = 0 . \tag{3.13}$$

Rearranging (3.13) gives:

$$\frac{dq_f}{dq_c} = \frac{\lambda\sigma_\epsilon^2}{-C_{qq} - \lambda\sigma_\epsilon^2} . \tag{3.14}$$

This expression is negative for all risk averse traders and when $C_{qq} = 0$, $dq_f/dq_c = -1$ implying perfect substitution between cash and futures positions.

Another useful comparative static is the response of futures activity to changes in transaction costs. The total differential of (3.6) with respect to q_f and the marginal cost of futures transactions is

$$\delta dq_f - \left[C_{qq} + (q_f + q_c)\sigma_\epsilon^2 \frac{\partial\lambda}{\partial C_q}\right] dC_q = 0 . \tag{3.15}$$

Rearranging (3.15) produces:

$$\frac{dq_f}{dC_q} = \frac{C_{qq} + (q_f + q_c)\sigma_\epsilon^2 \frac{\partial\lambda}{\partial C_q}}{\delta} . \tag{3.16}$$

Marginal cost increases move the E-V frontier downward, therefore $\partial\lambda/\partial C_q$ is positive for DARA traders. Table 3.3 summarizes the effect of changes in marginal transaction costs on futures activity for all cash-futures combinations. This table indicates that there is a distinct difference in the way the futures activity of hedgers and speculators responds to changes in marginal transaction costs. The reason for this difference lies in the fact

Table 3.3. Summary of the Effect on Futures Activity of a Change in Marginal Transaction Cost.

Optimal Exposure	Sign of dq_f/dC_q	Cash and Futures Positions	Trader Type	Impact on Futures Activity When: C_q Increases	Impact on Futures Activity When: C_q Decreases
Long ($q_c + q_f > 0$)	Negative				
		$q_c > 0, q_f = 0$	Hedger[a]	Increase	Decrease
		$q_f < 0, q_c > -q_f$	Hedger	Increase	Decrease
		$q_c = 0, q_f > 0$	Speculator	Decrease	Increase
		$q_c < 0, q_f > -q_c$	Speculator	Decrease	Increase
		$q_c > 0, q_f > 0$	Speculator	Decrease	Increase
Short ($q_c + q_f < 0$)	Positive[b]				
		$q_c < 0, q_f = 0$	Hedger[a]	Increase	Decrease
		$q_f > 0, q_c < -q_f$	Hedger	Increase	Decrease
		$q_c = 0, q_f < 0$	Speculator	Decrease	Increase
		$q_c > 0, q_f < -q_c$	Speculator	Decrease	Increase
		$q_c < 0, q_f < 0$	Speculator	Decrease	Increase
None ($q_c + q_f = 0$)	Negative[c]				
		$q_c = -q_f$	Hedger (Full)	Decrease	Increase
		$q_c = 0, q_f = 0$	Speculator	Decrease	Increase

[a] A potential hedger—this trader type can only take futures positions opposite the cash position.
[b] if $C_{qq} < (q_f + q_c)\sigma^2_e\, \partial\lambda/\partial C_q$.
[c] if $C_{qq} > 0$

that futures positions are risk-reducing for hedgers but risk-increasing for speculators. When costs increase, the E-V frontier shifts downward and all DARA traders will choose a point on the E-V frontier to the left of the initial cash-futures combination. This implies a reduction in the variance of the cash-futures portfolio. For hedgers, the variance of the overall portfolio can be reduced by increasing the proportion of the cash position that is hedged—an action that implies increased futures activity. For speculators, the variance of the portfolio is reduced by reducing the size of the speculative futures holding—an action that implies less futures activity. For traders that are fully hedged, increases in transactions costs will result in a tendency toward reduced futures activity because no further reduction in the variance of the portfolio is possible.

Up to this point, the analysis has taken the information effort as given. However, the relationship between the optimal information set and the optimal futures position is recursive—the trader is free at any time to chose to use an alternative information set/translating mechanism which will lead to a new optimal futures position. Expanding the information subset or revising the translating mechanism has the potential to improve the price expectation. It is not unreasonable to assume that additional information effort will decrease the variability in the price expectation as well as increase costs. The preceding analysis indicates that this will lead to increased market participation by speculators and decreased market participation by hedgers. Additional information effort could also be expected to lead to an improved estimate of the mean value of subsequent prices. However, an improved estimate of the mean of the price expectation distribution could result in a smaller or larger spread between the current and expected futures price. Thus, the overall effect of increased information effort on futures activity is indeterminant.

Summarizing, the comparative static results from the E-V model show that willingness to act on a given price expectation is:

1. positively (negatively) related to the variance in the price expectation for hedgers (speculators);

2. positively (negatively) related to the size of the expected spread between the current and expected futures price for hedgers with short (long) cash positions. For long (short) speculators willingness to act is positively (negatively) related to the size of the expected spread between the current and expected futures price

3. positively (negatively) related to cash positions for hedgers (speculators);

4. positively (negatively) related to transactions costs for hedgers (speculators); and

5. indeterminant with respect to increased information gathering and translating effort.

3.4 Social Loss from Basing Production Decisions on Futures Prices

Futures markets perform an important social function by gathering information on future supply and demand from many diverse sources and consolidating this information into a single widely observable price. Agricultural producers have been found to use futures prices as a primary source of information (Gardner; Hurt and Garcia; Lance and Helmreich). When producers and users of a commodity rely on futures prices for economic decisions, the accuracy of futures prices as predictors of subsequent cash prices has resource allocation implications. Resource misallocation, and hence social loss, increases when futures prices are poor indicators of cash prices. This section examines two sources of loss that can occur from producers basing production decisions on futures prices. These are: (1) losses due to bias in futures prices, and (2) loss due to unpredictable noise in future supply or demand. Further, it is shown that producer risk aversion has the potential to cause some bias in futures prices. Cattle producers, specifically feedlot operators, are used as examples in illustrating these points.

In order to evaluate the impact of using futures prices to guide production decisions, a framework for determining what is desirable must be established. From a social prospective, the proper measure of well-being is the sum of producer and consumer surplus. Actions or events that reduce social welfare in this respect are deemed to be undesirable.

Cattle finishing is a good example of an agricultural production process where the decision to produce is temporally separated from the realization of product prices. Feeder calves are placed in feedlots, fed a high-energy ration for approximately six months, and emerge as finished cattle ready for slaughter. Feedlot operators must use expectations on future cash cattle prices when making the decision on how many animals to feed in a given time period.

Neoclassical economic theory renders the familiar result that when profit-maximizing producers operate in a competitive market, social welfare is maximized when producers operate at the minimum point on their average total cost (ATC) curve. At this point, all inputs are earning their marginal value product and no economic rents or losses are accruing to producers. In a competitive market, profit maximizing producers will always seek to equate marginal cost with output price. In the cases where output price is uncertain but input costs are known, producers will choose the quantity that equates marginal cost with their expectation of output price. In long- or short- run situations, deviations away from the minimum point on the ATC curve result in social loss.

Figure 3.7 illustrates how cattle placements based on an inaccurate futures price can cause social loss.[11] In this figure, the pareto optimal situation is represented by a price of P_E which would have feeders operating at the minimum of their ATC and result in Q_E produced in the total market. Assume D is a non-stochastic future demand and S is the supply curve of cattle prior to the placement decision. Following the placement decision, the supply curve becomes S′.[12] The post-placement supply curve is much more inelastic than S, but it is not perfectly vertical since feeders may be able to make slight adjustments after placement that will affect the final quantity produced. At placement time, the futures market signals an inaccurate output price of P_{M-6}.[13] This causes individual producers to try and capture profits by producing q′ and fixes the post-

[11]This discussion is an adaptation of the argument put forth by Stein (1981).

[12]In reality, placements are spread over a period of several weeks. To simplify, it is assumed here that placements are determined at one point in time or, that the placements are those that occurred during the placement period while the futures market was signaling an average price of P_{M-6}.

[13]The subscript M-6 indicates six months prior to contract maturity.

placement supply curve at S′. When the cattle are ready for market, the market will clear at a price P_M and a deadweight social loss equal to the shaded triangle (*bcd*) will result.[14] The triangle represents the social welfare loss resulting from the over-allocation of resources to cattle finishing caused by the inaccurate price expectation given by the futures market.

The size of this welfare loss (L) can be measured as:

$$L = \frac{1}{2}(Q_M - Q_E)[(P_{M-6} - P_M) - (P_{M-6} - P_L)]. \quad \textbf{(3.17)}$$

Next, define a line with constant slope b such that:

$$\frac{(P_{M-6} - P_M)}{(Q_M - Q_E)} = b. \quad \textbf{(3.18)}$$

From this we get Q_M-Q_E = (P_{M-6}-P_M)/b. Plugging this into the expression for the welfare loss results in:

$$L = \frac{1}{2b}[(P_{M-6} - P_M)^2 - (P_{M-6} - P_L)(P_{M-6} - P_M)]. \quad \textbf{(3.19)}$$

Recognizing that P_{M-6}-P_M is exactly the forecast error (FE) of the futures price, we have:

$$L = \frac{1}{2b}[FE^2 - (P_{M-6} - P_L)FE]. \quad \textbf{(3.20)}$$

When S′ is perfectly vertical, the distance P_{M-6} - P_L = 0 and the welfare loss is proportional to the squared forecast error. As S′ becomes more elastic, the welfare loss

[14]When Q_M is produced and sold for a price of P_M, producers suffer a welfare loss equal to the triangle *acd*. In this region, the value that producers put on the factors of production (represented by the supply curve, S) is greater than marginal revenue, P_M. Consumers realize gains equal to the triangle *abd* brought about by lower prices. Thus, the deadweight social loss is *bcd*.

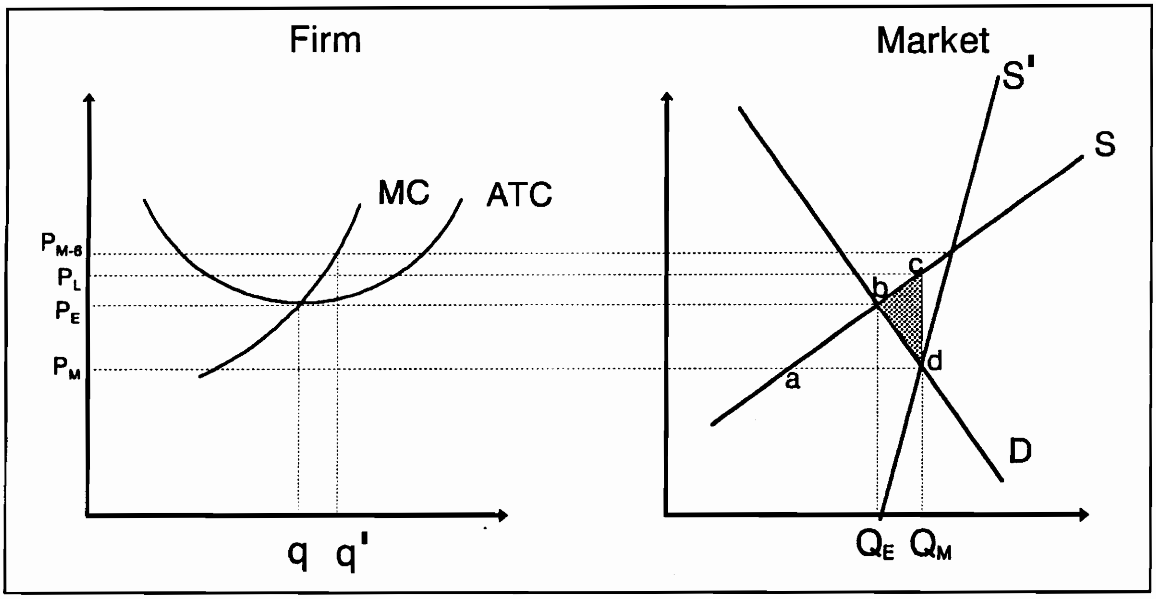

Figure 3.7. Illustration of Welfare Loss Due to Bias in Futures Price at Cattle Placement.

shrinks until it disappears at S′ = S. Here b goes to infinity causing L to become zero. This only occurs where production can be easily altered after the initial production decision has been made. This, of course, is not the case with cattle feeding. Equation 3.20 indicates that the welfare loss in the live cattle market will be slightly less than proportional to the squared forecast error. The more vertical S′ is, the better the squared forecast error is as a measure of welfare loss from poor pricing signals sent by the futures market.

In the previously described situation, future supply and demand curves were assumed to be non-stochastic. Welfare losses in this case are attributable to bias in the distant futures price. Bias occurs when the futures price, for whatever reason, systematically over- or under-predicted subsequent cash price. Sustained trends in futures prices are examples of price bias.

Next consider a situation where both future supply and/or demand possess some amount of noise—unpredictable deviations from their expected values. In Figure 3.8, the price of the live cattle futures contract six months prior to maturity is exactly equal to the equilibrium price indicated by the expected value of the future supply and demand curves. Noise in the demand for live cattle results in the end-of-period demand curve (D′) differing from its expected value (D). Again, there are social losses from the misallocation of resources. These losses are unavoidable if their exists no additional information about future supply/demand that could be brought to the market. If such information exists and can be enticed into the market, then the noise in prices and associated social loss could be reduced. Still, in an *ex post* analysis, the futures price at

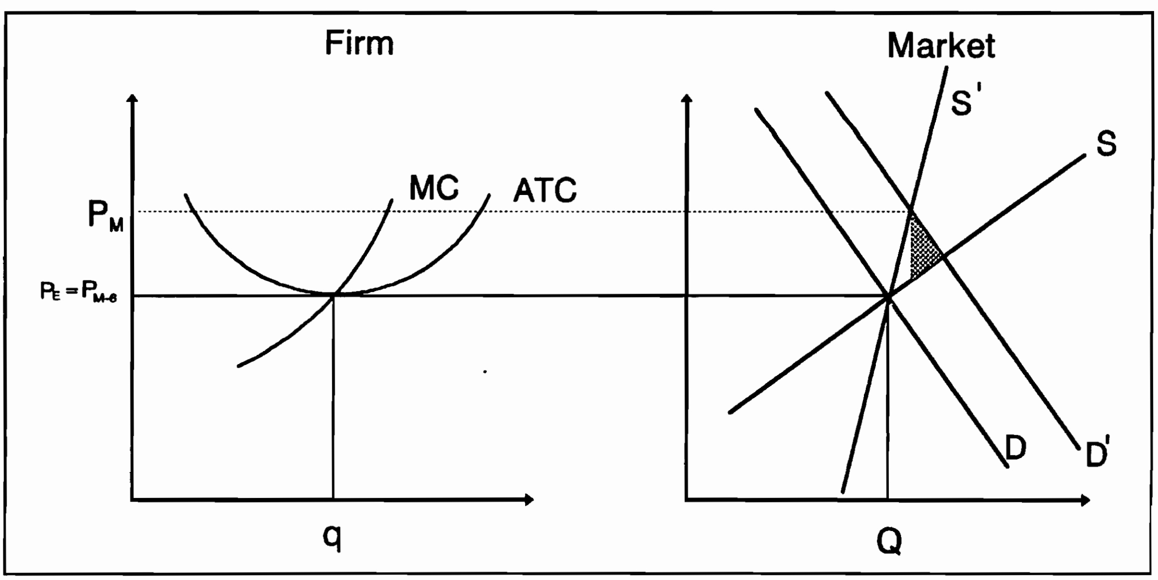

Figure 3.8. Illustration of Welfare Loss Due to Unpredictable Noise in Futures Prices.

placement (P_{M-6}) was a poor forecast of subsequent cash price (P_M). For clarity, only stochastic demand was allowed here, but supply could be stochastic as well.

The total social loss is the sum of the loss attributable to any price bias and the loss associated with noise in futures prices. Note that the forecast error, $P_{M-6} - P_M$ can be written as $P_{M-6} - P_E + P_E - P_M$. The forecast error can be expressed as a function of the bias, or systematic deviation of future price from its expected value ($B = P_{M-6} - P_E$), and the noise, or unpredictable deviation of the maturity (cash) price from its expected value ($U = P_E - P_M$). Further, the social loss triangle can be re-written as:

$$L = \frac{1}{2b}[(B+U)^2 - (P_{M-6} - P_L)(B+U)]. \tag{3.21}$$

Up to this point, the risk attitude of the producer has been ignored. The cost and market curves used in the analysis reflect risk neutral producers. If producers are collectively risk averse, then this risk attitude can explain some of the bias and hence some of the social loss.

Risk is introduced with the aid of the certainty equivalent model. For the cattle producer facing only price risk, the producer's profit function is:

$$\pi = pq - C(q) - B \tag{3.22}$$

where C(q) is the cost function and B represents fixed costs. Expected profit is given by:

$$E[\pi] = E[p]q - C(q) - B \tag{3.23}$$

and the variance of profit is:

$$\sigma^2(\pi) = q^2\sigma_p^2 \quad (3.24)$$

where σ_p^2 is the variance of the stochastic price variable. If the producer is using futures prices exclusively as a forecast of output price, then σ_p^2 is the variance of futures price. The certainty equivalent of profit is defined according to (3.1) with λ representing the Pratt risk aversion coefficient. The certainty equivalent of profit is:

$$\pi_{CE} = E[p]q - C(q) - B - \frac{\lambda}{2}q^2\sigma_p^2. \quad (3.25)$$

Setting the first derivative of π_{CE} with respect to q equal to zero defines the certainty equivalent maximizing condition for the risk averse producer:

$$E[p] = C'(q) + \lambda q\sigma_p^2. \quad (3.26)$$

Since λ is positive for risk averse producers, the impact of price risk is to increase costs to producers. Figure 3.9 illustrates the shift that occurs in firm level cost curves under risk aversion and uncertain output price. There is also a corresponding shift in the market supply curve (S_R).

If the futures price at placement time (P_{M-6}) is exactly tangent to the minimum point on the risk neutral ATC curve, risk averse producers will produce quantity q_R resulting in market quantity Q_R which will clear the market at price P_M. The risk aversion of cattle producers has caused fewer than the pareto optimal number (Q*) of cattle to be placed. Also, the quantity-restricting effect of risk aversion has caused the futures price at placement to be a poor forecast of end-of-period cash price (P_M). From the point of view of the risk averse producer, the placement-time futures price was biased downward.

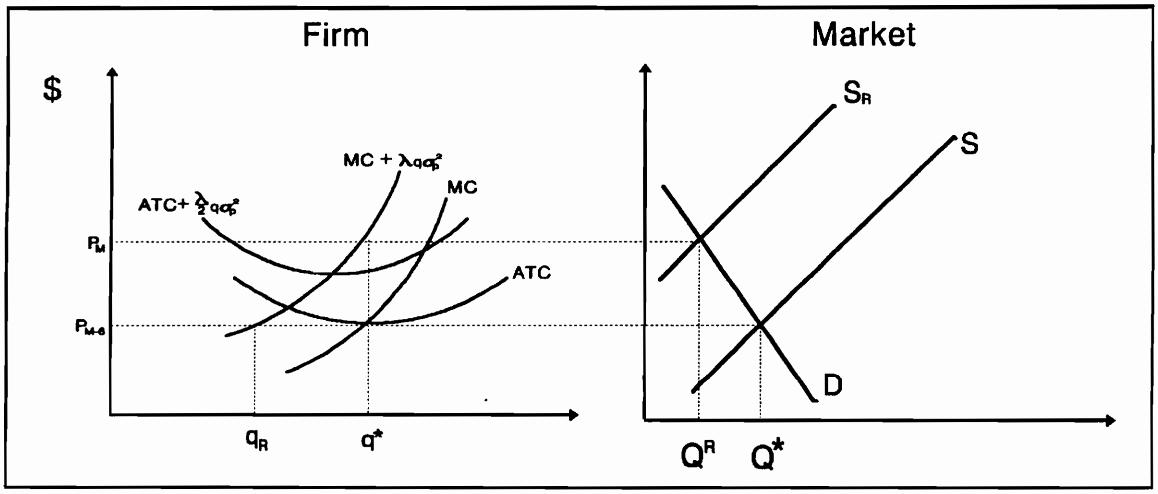

Figure 3.9. Illustration of How Producer Risk Aversion can Introduce Bias into Futures Price.

It is clear that risk aversion itself can introduce a certain amount of biasedness into the futures price. Thus, the previous expression for bias in (3.21) can be divided into the sum of bias stemming from risk aversion (B_R) and bias from other sources (B_O). The social loss function can be re-written as:

$$L = \frac{1}{2b}[(B_R + B_O + U)^2 - (P_{M-6} - P_L)(B_R + B_O + U)] \quad \textbf{(3.27)}$$

Figure 3.9 indicates that as the variance of the futures price decreases, the risk averse cost curves collapse to the risk neutral cost curves and the source of bias from risk, B_R, goes to zero. Reducing the variance of futures prices is also a reduction in the noise, U. Thus, it is apparent that futures price series with smaller variances reduce social loss on two fronts: pure noise and bias due to risk aversion.

In this section it has been shown that when producers rely on futures prices as forecasts of subsequent cash prices, the variance of the futures price series is important in determining the social loss that occurs as a result of resource misallocation. Figure 3.10 presents some potential paths that futures price may take over the life of the contract. Path C is a result of biased prices, path B is an unbiased price path with a large variance, and path A is an unbiased price path with a smaller variance. From the preceding discussion, social loss under path A would likely be smaller than under either B or C. The perfect price path would be one that collapsed to the final settlement value and remained there for the life of the contract. Price risk would be completely eliminated as would be all social loss arising from price risk. Of course, this ideal scenario would never occur because the futures market would disappear as there would be no incentive for traders to participate. However, it is intuitive that socially more desirable futures price paths are those that stay nearer the final settlement value over the life of the contract.

3.5 Price Discovery in Futures Markets

Price discovery is the process by which the market "learns" the true value of a commodity as indicated by supply, demand and the structure of a market. In cash cattle markets, the price discovery process can be a public auction, private negotiation or even a predetermined formula. The price discovery process is repeated for each unit of the commodity, usually a pen of finished animals, and has a distinct beginning and end. The process is considered ended when the buyer and seller reach a market-clearing price and the commodity changes hands. The price discovery process is re-started for each new pen of cattle. Each pen of cattle possesses unique characteristics and thus is technically a

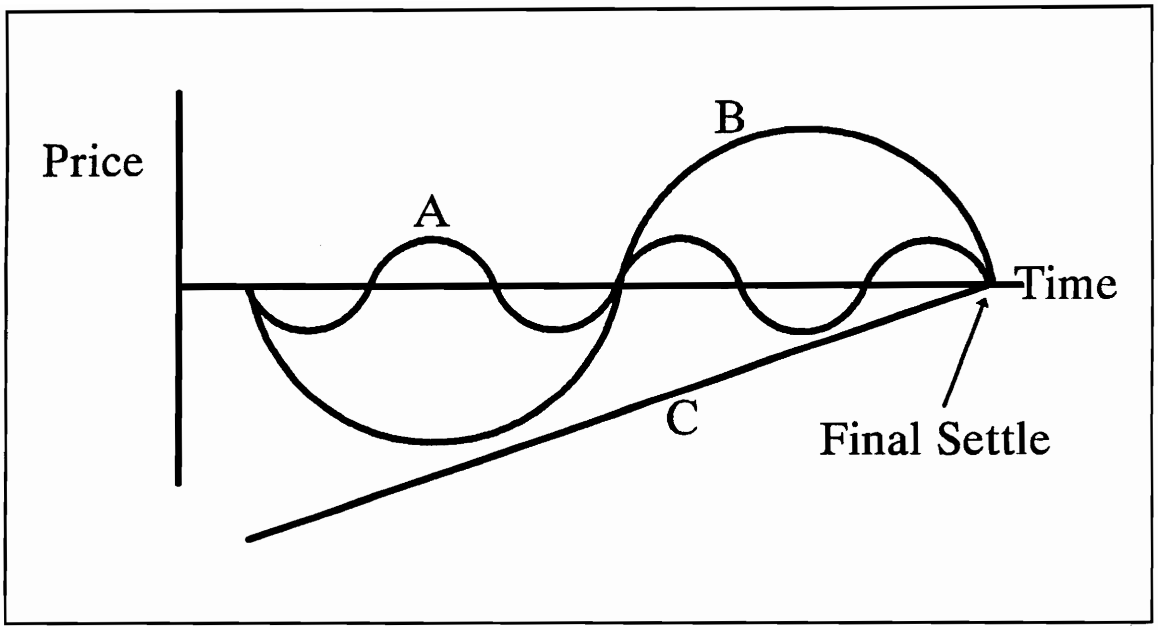

Figure 3.10. Potential Paths for Futures Prices.

different product having its own particular price that must be discovered.

In futures markets, the transacted item is a contract for future delivery of a well-defined commodity. All contracts traded are identical, and thus all have the same economically determined price. Although the price at which each contract is traded is "discovered" in a multiple auction in the pit, because all contracts are identical it is proper to view each trade as part of the larger price discovery process for the commodity defined by the contract. Therefore, the price discovery process in futures markets can be characterized as beginning with the first trade in a particular contract and ending with the final settlement value at maturity. The process is completed when the futures price arrives at (or converges to) the economically determined cash price at maturity.

How well a futures market performs the price discovery function can be measured by how closely the prices generated during the process reflect the true value of the commodity. Price paths with smaller deviations around the final settlement value indicate more efficient price discovery. More efficient price discovery implies reduced social loss from agents basing decisions on futures prices and vice versa. Stated another way, social loss is reduced and the price discovery process improved when futures prices are good forecasts of subsequent cash prices.

A further question worth investigating is what happens when individual producers base production decisions on futures prices without taking a position in the futures market (hedging). The general idea is that when futures are signaling a price higher than that warranted by supply/demand conditions, then producers will over-produce and the resulting flood of product will depress cash prices in the selling time period. The producers will face financial difficulties from having produced large quantities of the commodity that must be sold in the cash market at low prices, perhaps below the cost of production.

This situation is illustrated in Figure 3.7. The futures market signals a price of P_{M-6} at the time the production decision is made, inducing production of Q_M. Cash price at the end of the production period is P_M which is below the individual producer's average total cost of production. If the producer had a short position in the futures market, the decline in futures prices from P_{M-6} to P_M would have produced a profit that could be used to offset losses on the cash position. Note that the size of the deficit between the realized cash price and the producer's ATC is dependent upon the size of the bias in the futures price at M-6. Had that bias been smaller, say P_L instead of P_{M-6}, then market supply S′ would have intersected the long-run supply curve, S, at c and the market-clearing cash price at the end of the production process would have been higher than P_M. Figure 3.11 illustrates this concept with two hypothetical price paths. The first price path is characterized by a large degree of bias in the futures price (A) and generates a large deviation (B) from the pareto optimal price, P_E, at the end of the production period. The second price path has a much smaller initial bias (C), resulting in a smaller discrepancy (D) between the realized cash price and P_E. Thus it is clear that when the futures market is performing the price discovery function well, there is less risk to producers from basing

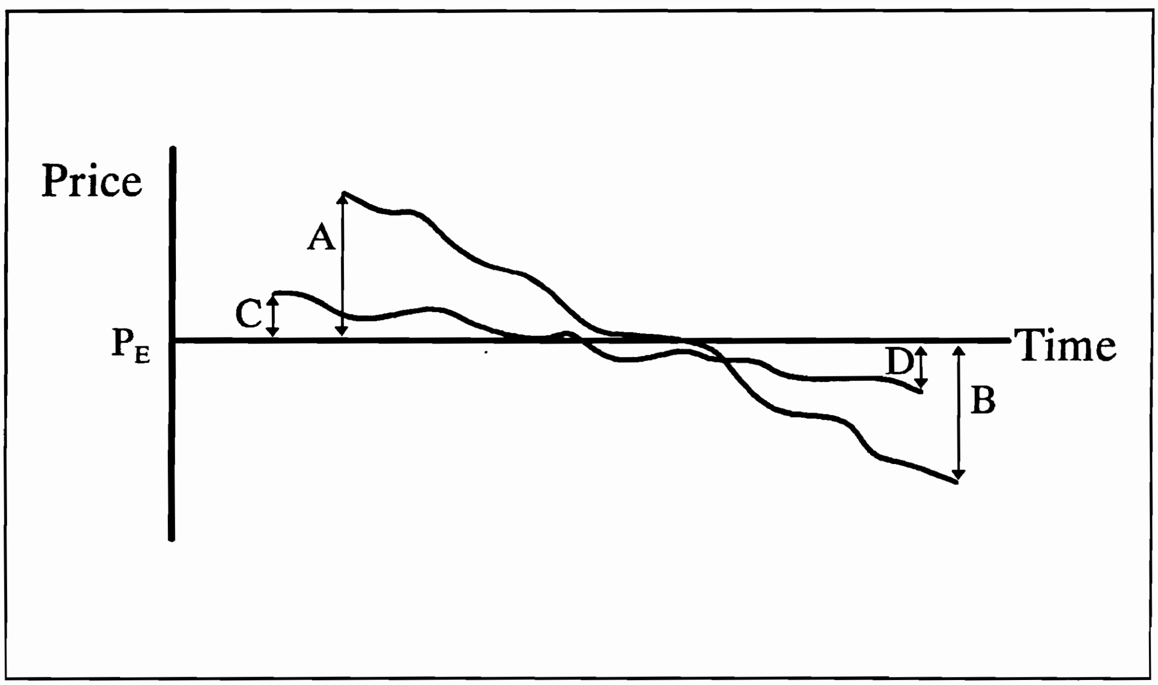

Figure 3.11. Relationship Between Bias in Futures Price and Subsequent Deviation from the Pareto Optimal Price.

production decisions on futures prices. The blanket statement that producers should not use futures prices for production decisions without taking a position in the futures market assumes that the futures market is doing a poor job of price discovery.

3.6 Trader Behavior and Price Discovery

In the two-period scenario used in the preceding E-V analysis, it was in the trader's best interest to forecast the final period futures price as accurately as possible. Since cash and futures prices converge in the final period, forecasting the futures price is the same as forecasting the cash price. More realistically, traders have many opportunities over the life of a contract to revise price expectations and to adjust positions. It is not necessary, therefore, that every price expectation be a forecast of maturity-period cash prices. It is entirely possible that a trader only forms a price expectation for one period forward, waits to observe the realized price in that period, and forms a new price expectation for the next time period. Vukina and Anderson show that if traders do form price expectations for more than one period ahead, these expectations are important in determining the optimal future position in the initial time period, but the optimal positions for periods more than one step ahead are not calculated until that period arrives.

Consider the three-period situation depicted in Figure 3.12 where prices rise from t_0 to t_1 and then fall from t_1 to t_2. At time t_0 the trader forms expectations on prices in t_1 and t_2. Given accurate expectations (i.e., expectations consistent with the realized prices), the profit-maximizing behavior for the trader will be to go long at t_0 and then adjust the

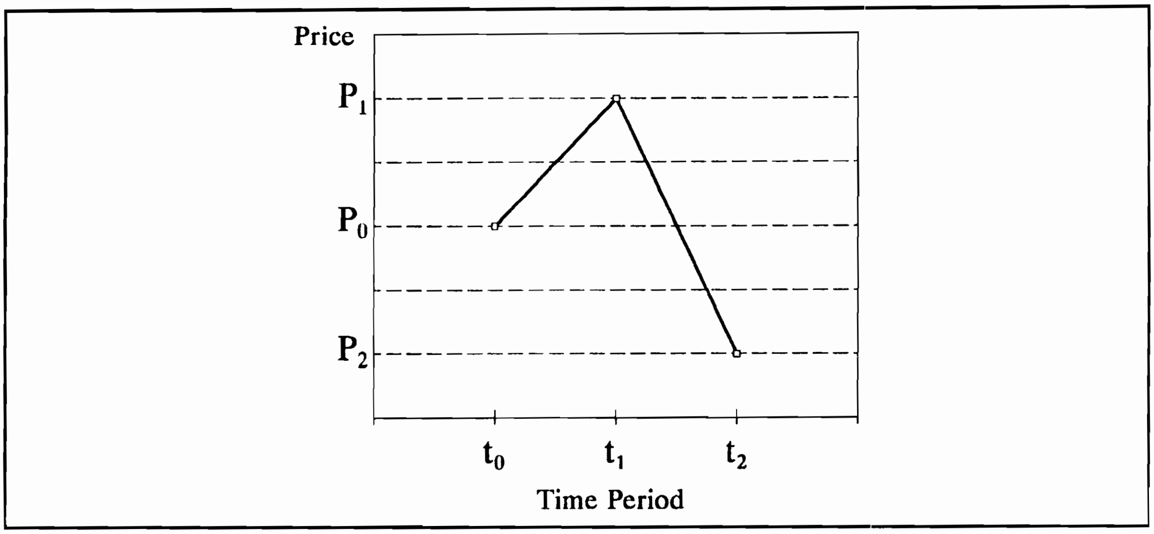

Figure 3.12. Possible Three-Period Price Path.

position so that he/she is net short at t_1. In this way, the trader "captures the peak" in prices. From a social prospective, however, prices in t_0 are "too high" relative to their final settlement price in t_2 and the socially optimal behavior for the trader is to go short at t_0 and increase the short position in t_1. Thus, there is a possible divergence between profit-maximizing trading behavior and the socially optimal trading behavior with respect to price discovery.

This leaves one to question why prices rose in the intermediate time period, t_1. The basic explanation is that, on the whole, all of the other traders in the market had in t_1 price expectations on the true value of the commodity greater than P_0. These expectations were, of course, incorrect. These incorrect expectations reflect the limitations of trader information subsets and/or translating mechanisms.

One way that trader information subsets may be limited is if large numbers of traders hold no private information about commodity supply/demand and rely solely on publicly available information. Since public information is a subset of all information, this is a situation where a large number of traders share the same information subset. If these traders process information similarly, then changes in public information invoke similar changes in expectations and can cause large movements in price. Public information may, at times, produce price expectations out-of-line with the true value of the commodity.

This raises the potential for another type of trading behavior. If large numbers of traders react exclusively to changes in public information, then some traders will find profit from predicting the reaction of other traders to emerging public information. These traders will profit from correct prediction of other trader behavior regardless of whether the other trader behavior is in the best interest of price discovery. This is the case in Figure 3.12. Even though a trader may hold a price expectation that suggests the price in t_0 is "too high", it is still profitable for him/her to take a long position in order to profit from the incorrect expectations of the other traders in the market. This long position is detrimental to price discovery because the trader is, for the moment, ignoring the information that is important to society (the value of the commodity) and focusing instead on predicting and reacting to the behavior of other traders.

Private information that is accurate and translated properly can give those traders possessing it an advantage over other traders who rely solely on public information. This creates a potential for profit and is what motivates firms to develop accurate information on future conditions before it becomes widely available to the public. Two different types of private information may be developed: information about future supply/demand conditions or information about the contents of future public information and the likely reaction of traders to it. The former type of private information is far more beneficial to the price discovery process than the latter which may be detrimental to discovering the true value of the commodity.

Certain types of traders may be more likely to have different goals in private information development. Some traders are in a better position to predict the behavior of other traders in the market. Traders that are very active in the pits (such as locals) have the ability to identify and observe the reaction of different trader types to new public information. One would expect these traders to find more profit in anticipating the trading behavior of others. On the other hand, traders that are further removed from the market and trade less frequently would have more difficulty profiting from prediction of other trader's behavior, and might be more likely to focus on developing private information on future economic conditions.

One solution to the problem of profitable prediction of other traders mistakes is to improve public information. If public information is improved so that it seldom leads traders to incorrect expectations on the value of the commodity, then the actions of those traders who trade based on predictions of others' behavior will be consistent with moving the market toward the true value of the commodity. Another solution would be to lower the cost of developing accurate private supply/demand information so that fewer traders rely solely on public information.

The cost of developing private information is lower for those involved in the commercial trade in a commodity. Cattle feeders operate daily in the markets for live cattle inputs (feeder cattle, feed components) and are able to observe production conditions first-hand. This places cattle feeders in a better position than most to develop accurate private information on future live cattle supply. If cattle feeders use this information to detect when futures prices stray from the likely value of live cattle at the end of the production process, they can profit from taking futures positions. By selling when prices are "too high" and buying when prices are "too low", cattle feeders bring valuable information into the futures market and improve the price discovery process. Cattle demand is derived from consumer demand for meat and this demand is typically very stable over the short-run. Supply is much more variable for this commodity and uncertainty in supply is the primary source of price uncertainty. Thus, the supply-side information held by cattle feeders is especially important to improving price discovery in live cattle futures.

3.7 Quadratic Programming

With this section, the discussion shifts from theoretical issues involving futures markets and price discovery to a description of the empirical tools used in this research.

The simulation models used in this study are all formulated as quadratic programming models.

The general mathematical programming problem involves finding values for the elements of the vector $x = \{x_1, x_2, \ldots, x_n\}$ so as to

$$\max \text{ or } \min f(x)$$

$$\text{subject to } g_i(x) \begin{Bmatrix} \le \\ = \\ \ge \end{Bmatrix} b_i . \qquad \textbf{(3.28)}$$

When both f and all g_i are linear functions of x, the problem is the standard linear programming problem. If either f or any of the g_i are nonlinear in x, then the problem belongs to the general class of nonlinear programming problems. When all of the constraints, g_i, are linear in x and the objective function, f, is a quadratic function in x, then the problem is a special case of nonlinear programming problems, the quadratic programming problem.

The biggest obstacle to solving nonlinear programming problems is arriving at a solution that is a global rather than a local optimum. When there are nonlinearities in the constraints, the feasible region can contain several local optima. Figure 3.13a illustrates a simple two-dimensional feasible region defined by nonlinear constraints for a maximization problem. Even if the objective function is linear, the search algorithm may land at a point in the feasible region such as A and stop without recognizing that the true global maximum for the problem is point B. When all of the constraints are linear, the feasible region is said to be a convex set (Figure 3.13b) meaning that a chord connecting

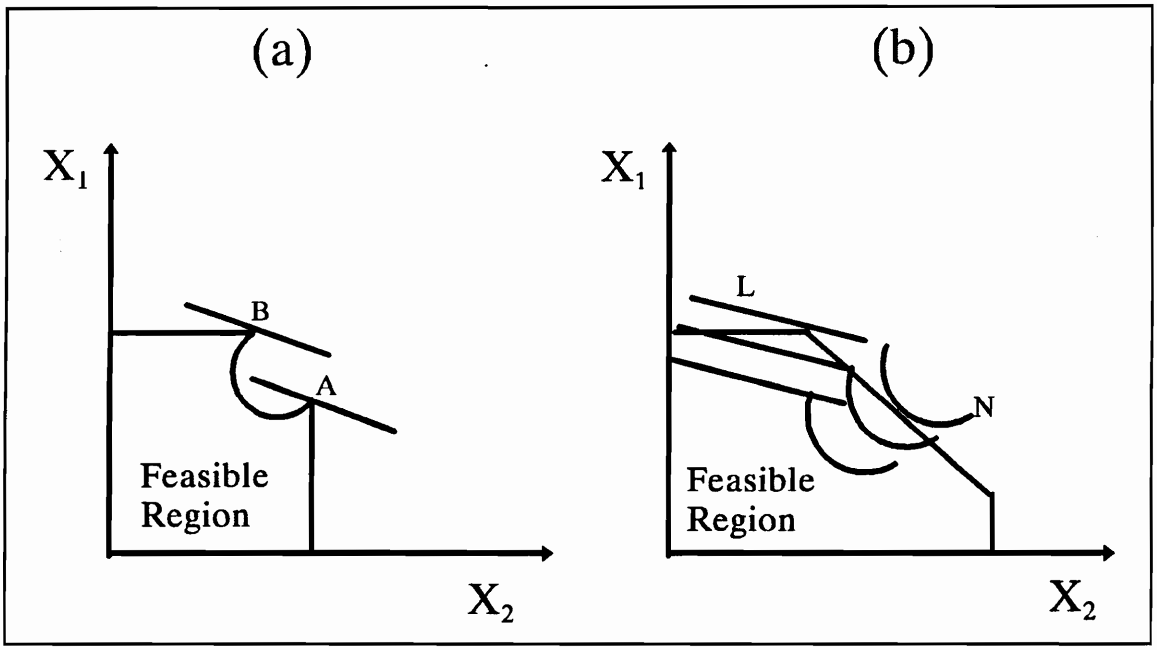

Figure 3.13. (a) Nonlinear Feasible Region with Two Local Optima. (b) Linear Feasible Region With Linear and Nonlinear Objective Functions.

any two points on the boundary of the feasible region will lie entirely inside the feasible region. Figure 3.13b demonstrates the optimal solutions to a maximization problem with linear constraints and a linear objective function (L) or a nonlinear objective function (N). It is important to note that the optimal solution in the case of a linear objective function will always be at a corner-point while for the nonlinear objective function this is not necessarily the case. In fact, the optimal solution for a nonlinear objective function need not even be a boundary point, it could be a point in the interior of the feasible region (Simmons).

Concave or convex objective functions are characterized by absolute extreme points. If the concavity or convexity is strict then the absolute extreme point will be unique otherwise alternative absolute optima may exist (Chaing). Thus, for any maximization (minimization) problem with a nonlinear objective function any feasible extreme point can be considered a global optimum if the objective function is concave (convex) and the constraints form a convex set (Boot).

Van de Panne (1975) gives the general convex quadratic programming problem:

$$\begin{aligned} &\max\ f = p'x - \frac{1}{2}x'Cx \\ &\text{subject to:} \\ &Ax \le b \\ &x \ge 0 \end{aligned} \tag{3.29}$$

where p, x and b are column vectors and C and A are matrices. When C is symmetric and positive semi-definite, the quadratic term in this formulation, $x'Cx$, is convex making f concave.

Necessary conditions for recognizing the optimal solution to a nonlinear programming problem are given by a set of conditions derived independently by Karush in 1939 and Kuhn and Tucker in 1951. Using the notation in (3.28) above, the six Karush-Kuhn-Tucker (KKT) conditions for a maximization with all ≤ constraints are:

$$\begin{aligned} &1.\ \frac{\partial f}{\partial x_j} - \sum_{i=1}^{m} u_i \frac{\partial g_i}{\partial x_j} \le 0 \qquad \text{at } x = x^*; \quad j = 1, 2, ..., n \\ &2.\ x^* \left(\frac{\partial f}{\partial x_j} - \sum_{i=1}^{m} u_i \frac{\partial g_i}{\partial x_j} \right) = 0 \qquad \text{at } x = x^*; \quad j = 1, 2, ..., n \\ &3.\ g_i(x^*) - b_i \le 0 \qquad i = 1, 2, ..., m \\ &4.\ u^*(g_i(x^*) - b_i) = 0 \qquad i = 1, 2, ..., m \\ &5.\ x_j^* \ge 0 \\ &6.\ u_i \ge 0. \end{aligned} \tag{3.30}$$

In these equations, u represents the dual values (or shadow prices) associated with each of the i constraints. If a variable in the vector x takes a non-zero value in the solution, then the expression in the first KKT must hold with equality to satisfy both (1) and (2). Likewise, if a constraint is binding, a non-zero dual value will result, thus (3) must hold with equality to satisfy both (3) and (4). The fifth KKT is the usual non-negativity requirement and the sixth KKT states that all dual values must be positive for any optimal solution to a maximization problem with all ≤ constraints. A corollary (Simmons) expands to the sixth KKT condition to handle constraints other than those of the ≤ variety. This change is:

$$\begin{aligned} u_i &\geq 0 && \text{for } g_i(x) \leq b_i \\ u_i &\leq 0 && \text{for } g_i(x) \geq b_i \\ u_i &\text{ unbounded} && \text{for } g_i(x) = b_i . \end{aligned} \tag{3.31}$$

When an optimization algorithm finds a feasible solution that satisfies all six KKT conditions, the solution is optimal. In fact, a popular algorithm for solving quadratic programming problems, the modified simplex algorithm, incorporates the KKT conditions in the form of linear constraints directly into the problem (Hillier and Lieberman).

In the present application, quadratic programs will be specified to minimize the squared deviations of futures prices around the final settlement value subject to ≤, ≥ and = constraints. The objective function will be:

$$\min \frac{1}{T}\sum_t (\text{price}_t - \text{price}_{\text{final}})^2 \qquad \textbf{(3.32)}$$

In the context of (3.29) these applications will have p = 0 with the solution vector x representing the price deviations and C will be an identity matrix. Since C is positive definite, the objective function is strictly convex[15] and any extreme point satisfying all KKT conditions is guaranteed to be the global minimum.

3.8 Testing for Differences in Mean Square Errors

This study uses models to generate simulated prices under hypothetical trader mixes in the live cattle futures market. These simulated prices are then compared with the observed historical price series to evaluate the impact of changing the trader composition. One important evaluation method involves comparing the mean squared error (MSE) of the simulated and historical series. MSE is commonly used as a measure of the forecast accuracy of predictive models. While smaller MSEs generally indicate better forecasts, often the question arises as to whether the MSEs calculated from two competing models are statistically different from one another. This section looks at the empirical issues surrounding tests for differences in MSE and describes two tests used in this study.

Before examining the potential methods of testing for significant differences in the MSE of the price series produced by competing models, it is useful to look closer at the

[15]The objective function from the maximization in (3.29) is multiplied by -1 for a minimization problem, thus the concave objective function in (3.29) becomes convex in a minimization.

MSE itself. As it is used in this study, the MSE can be expressed as $E[\hat{y} - \delta]^2$ where $\hat{y}$ is the "forecast" of the final settlement price given by a historical or simulated price and δ is a scalar representing the final settlement price. Note that the MSE can be alternatively expressed as follows:

$$\begin{aligned} & E[\hat{y} - E[\hat{y}] + E[\hat{y}] - \delta]^2 \\ & = E[(\hat{y} - E[\hat{y}]) + (E[\hat{y}] - \delta)]^2 \\ & = E[\hat{y} - E(\hat{y})]^2 + [E[\hat{y}] - \delta]^2 + 2E[\hat{y} - E(\hat{y})][E(\hat{y}) - \delta] \end{aligned} \tag{3.33}$$

But the last term of the last equality is zero since

$$E[\hat{y} - E(\hat{y})] = E[\hat{y}] - E[\hat{y}] = 0. \tag{3.34}$$

Thus,

$$\begin{aligned} MSE & = E[\hat{y} - E(\hat{y})]^2 + [E(\hat{y}) - \delta]^2 \\ & = VAR[\hat{y}] + BIAS[\hat{y}]^2. \end{aligned} \tag{3.35}$$

Because the distribution of the MSE statistic is unknown, statistical tests for significant differences in MSE exploit the ability to express the MSE as the sum of the variance of the forecast and the squared bias of the forecast. The difference between MSE of competing forecasts, say a forecast from model A and one from Model B, is given as:

$$MSE_a - MSE_b = (VAR[\hat{y}_a] - VAR[\hat{y}_b]) + (BIAS[\hat{y}_a]^2 - BIAS[\hat{y}_b]^2). \tag{3.36}$$

A sufficient condition to fail to reject a null hypothesis of no difference in MSEs would be a finding of no significant difference in the variances of the competing forecasts *and* no significant difference in the bias associated with each forecast.

It is expected that the historical prices and the simulated prices generated by slightly altering market trader composition will be highly correlated. The usual F-test for differences in variance will be invalid when the competing forecasts are not independent. Granger suggests the following method for working around the problem of dependence between forecasts when there is no bias in either forecast. He suggests using the forecasts errors, e_a and e_b, to form two new series, $Q = e_a + e_b$ and $P = e_a - e_b$. Next, the correlation coefficient for P and Q is calculated and tested for difference from zero. Any finding of a significant correlation indicates statistical difference in the variances of the competing forecasts. By examining the covariance between P and Q, (which constitutes the numerator of the correlation coefficient) this relationship can be seen as:

$$\begin{aligned} COV[P,Q] &= \frac{1}{T-1} \sum_t (e_{at} + e_{bt})(e_{at} - e_{bt}) \\ &= \frac{1}{T-1} \sum_t (e_{at}^2 - e_{bt}^2) \\ &= VAR[\hat{y}_a] - VAR[\hat{y}_b] . \end{aligned} \tag{3.37}$$

Often, however, there is some bias in one or both forecasts. This has led researchers to postulate methods for jointly testing differences in the two components of MSE. Using the two series P and Q described above and allowing for the presence of bias in the forecasts, the MSE difference can be expressed as:

$$MSE(\hat{y}_a) - MSE(\hat{y}_b) = COV[P,Q] + [(\bar{e}_a)^2 - (\bar{e}_b)^2] \tag{3.38}$$

where $\bar{e}_a$ and $\bar{e}_b$ are the means of the error series from models A and B, respectively. Ashley, *et. al.* as well as Brandt and Bessler consider the following linear regression:

$$P_t = \beta_0 + \beta_1(Q_t - \bar{Q}) + u_t . \tag{3.39}$$

where $\bar{Q}$ is the sample mean of the series Q and u_t is a white noise error term. Least squares estimation of (3.39) yields the following parameter estimates:

$$\begin{aligned} \hat{\beta}_1 &= \frac{COV[P,(Q-\bar{Q})]}{VAR[(Q-\bar{Q})]} \\ &= \frac{COV[P,Q]}{VAR[Q-\bar{Q}]} \end{aligned} \tag{3.40}$$

$$\begin{aligned} \hat{\beta}_0 &= \bar{P} - \hat{\beta}_1\bar{Q} \\ &= \bar{e}_a - \bar{e}_b - \hat{\beta}_1(\bar{e}_a + \bar{e}_b) . \end{aligned} \tag{3.41}$$

When $\beta_1 = 0$, the first term on the RHS in (3.38) is zero and β_0 equals the difference between the means of the error series. When both β_0 and β_1 are zero, then both RHS terms in (3.38) must be zero implying there is no difference in the competing MSEs. If either parameter is significantly different from zero, then the MSEs must differ. If (3.38) is set up so that the smaller MSE is subtracted from the larger and the means of both error series are positive, then one can conclude that model B produced a significantly better forecast than model A if the null hypothesis of both parameters equal to zero is rejected in favor of an alternative hypothesis that the two parameters are non-negative and at least one is significantly greater than zero.

This leads to the following procedure for conducting tests for differences in MSE: first, the series possessing the smaller MSE is set up as series B and the forecast errors are calculated for both series. If the mean of either error series is negative, that series is multiplied by -1. The series P and Q are constructed from the error series and the model in (3.39) is estimated by OLS. If either of the estimated parameters in the model are negative and significant, the null hypothesis of $MSE_a = MSE_b$ cannot be rejected. If one parameter estimate is negative but not significantly different from zero, then a one-tailed t test is performed on the other parameter. If it is significantly greater than zero, then the null is rejected. Finally, if both parameter estimates are positive, the usual F-test for $\beta_0 = \beta_1 = 0$ is conducted. If this hypothesis is rejected, then the null hypothesis of equal MSEs is also rejected.

One problem than can arise with this approach is that the regression in (3.39) must be well specified in order that u_t is white noise and the distribution of the parameter estimates is known, thereby validating the aforementioned t and F tests. Both the historical and simulated price series used in this study display a large amount of positive autocorrelation. Thus the error series, as well as the P and Q series, display positive autocorrelation. This can induce autocorrelation in the regression errors, u_t, and invalidate the hypothesis tests.

Another issue arises when more than two forecasts are compared. When $MSE_a > MSE_b > MSE_c$ is observed and tests indicate a statistical difference between MSE_a and MSE_b, it is tempting to assume that MSE_c must also be statistically smaller than MSE_a. This is incorrect, however, because the absolute difference in the MSEs necessary for statistical significance is dependent upon the individual forecast error series. For example, consider two completely unbiased forecasts so that the difference in MSEs can be written as:

$$MSE[\hat{y}_a] - MSE[\hat{y}_b] = COV[P,Q] \tag{3.42}$$

where P and Q are as defined above. Then there is some critical value for the correlation coefficient between P and Q, say r*, that is the minimum value for r where H_0: r = 0 can be rejected in favor of H_a: r > 0. Equation (3.42) can be modified to reflect the situation where the null is barely rejected giving:

$$\frac{MSE[\hat{y}_a] - MSE[\hat{y}_b]}{SD[P] \cdot SD[Q]} = \frac{COV[P,Q]}{SD[P] \cdot SD[Q]} = r* \tag{3.43}$$

where SD[P] and SD[Q] are the standard deviations of the P and Q series, respectively. The absolute difference in MSE required for statistical significance, $MSE[\hat{y}_a]$ - $MSE[\hat{y}_b]$, equals r*(SD[P]•SD[Q]). Since P and Q differ between pairs of forecasts, their standard deviations will also differ, thus the size of the spread between the MSEs necessary for statistical difference also changes. It is possible, therefore, to have a situation where MSE_a is statistically larger than MSE_b and MSE_b is statistically larger than MSE_c, yet no statistical difference exists between MSE_a and MSE_c.

3.9 Chapter Summary

This chapter's discussion of theoretical and empirical issues began with the development of an abstract model to describe how information becomes incorporated into futures prices. Traders select a subset of information and a means of condensing the information into a price expectation. The price expectation, then, in combination with the trader's willingness to act on it, results in trading behavior. The trading behavior of all market participants determines price.

The characteristics which influence a trader's willingness to act on a given price expectation were studied with the aid of the E-V model. Several trader characteristics were found to affect futures activity differently for speculators than for hedgers.

The social loss that can result from basing economic decisions on futures prices originates from two sources: bias in futures prices or noise in future supply and/or demand. Further, it was shown using the E-V model, that producer risk aversion can be responsible for some bias in futures prices.

Price discovery in futures markets was found to be different from price discovery in cash markets. Specifically, it is proper to view the price discovery process in futures markets as lasting the entire life of the contract. Daily settlement prices in futures markets represent intermediate points in the market's quest to discover the true value of the commodity represented by the futures contract. The dispersion of a futures price series around the final settlement value is a measure of how well a market is performing the price discovery function.

The theoretical and empirical underpinnings of the quadratic programming techniques used in this study were presented with an emphasis on the conditions necessary to guarantee globally optimal solutions. Finally, a method for detecting statistically significant differences in the MSEs produced by competing forecasts when the forecasts are not independent was detailed.

Chapter 4

DATA AND MODEL SPECIFICATIONS

4.1 Introduction

This chapter begins with a description of the raw data set that formed the basis for this study. Section 4.3 discusses the criteria that determined which live cattle futures contracts were included in the analysis. The selection and specification of the six trader groups examined in this work is presented in Section 4.4. Section 4.5 details a process designed to generate a measure of the pressure that individual trader groups exert daily on live cattle futures prices. Section 4.6 discusses the mechanics of incorporating interrelationships between the price pressures of different groups in the models used for the analysis. Section 4.7 presents the technical specifications of the mathematical programming models used to simulate alternative trader compositions in the live cattle futures market. A summary of this chapter is given in Section 4.8.

4.2 Data

The unique data set used in this study was provided by the Commodity Futures Trading Commission (CFTC). It consists of 261,172 observations on the individual accounts of traders whose position at the end of a trading session exceeded the minimum limit for mandatory reporting in live cattle futures. This minimum limit was 100 contracts during the time period covered by the data, 1983-1987. These are the data that have formed the basis for the CFTC's *Commitment of Traders Report* that was published monthly until 1994 when more frequent reports were initiated. In the report, the CFTC selected data for one day per month and calculated the total number of positions held by long and short commercial and noncommercial traders.

Each daily position reported in this data set was classified by the CFTC at the time of collection as either commercial or noncommercial. To assume that the commercial designation reflects the positions of hedgers would require a definition of what constitutes a hedge and knowledge of the trader's cash position. Since data on cash positions do not exist and there are considerable differences in opinion as to what constitutes a hedge (Purcell, Locke and Hudson), it is safer to assume only that traders holding futures positions classified as commercial had some cash position in cattle. Noncommercial designations were assigned to the positions of traders who had no cash position in cattle, i.e., speculators.

In addition to the commercial/noncommercial classification, each observation was also coded to reflect the type of trader holding the position. The majority of these were individual customer accounts, but there were also a number of designations for commodity pool operators, commodity trading programs of futures commission merchants, and house positions.

Coded account numbers were used by the CFTC to prevent identification of individual traders. In addition to the coded account number, each observation in the data set included the date of the position, the maturity month and year of the contract, geographic location of the trader (by state), and the number of long and short positions held. Price information was added to this base data set. Daily closing prices on all futures contracts traded between January 1983 and December 1987 were obtained from Technical Tools, a service that collects and sells such information. A computer program was written to check these futures prices for errors (for correct chronological order and to ensure that price changes were within permissible daily limits). The prices were then matched to each observation in the CFTC data set according to date and contract month. The daily change in price was added to the CFTC data set in the same manner.

4.3 Contract Selection

The CFTC data set contained daily data on accounts from January 3, 1983 through November 6, 1987. The first futures contract for which position data exists is thus the February 1983 contract and the last contract for which position data exists is the October 1988 contract (which began trading in August 1987). For a two week period between July 15 and July 29, 1983 the CFTC did not compile the large trader position data due to budget constraints (Rowsell).

Two criteria were important in determining which contract months to include in this analysis. First, all selected contract months must have position data that extended through the last day the contract traded. This was crucial given the discussion in Chapter 3 concerning the use of the final settlement price in evaluating the price discovery performance of the market. Second, it was felt that all of the selected contracts should have the same number of trading sessions available for analysis.

The last contract for which position data existed on the final day of trading was the October 1987 contract. None of the data in the CFTC data set relating to contracts traded after this one could be included in the analysis. Most of the live cattle contracts for which complete position data were available traded for between 250 and 280 trading days. Some of the early contracts, however, had less data. For instance, there were only 34 observations for the February 1983 contract. It was decided that data for at least 200 trading days must be available for a contract to be included in the analysis. The first contract to meet this criterion was the December 1983 contract.

These restrictions left 24 contracts, beginning with the December 1983 contract and ending with the October 1987 contract, available for analysis. Only the last 200 observations on each of these contracts were used. This was done so that the model results could be averaged across all contracts, with each contract rightly receiving equal weight. Also, large (reporting) traders engaged in very little trading early in the life of most contracts rendering those periods relatively uninteresting for the purposes of this study.

The December 1983, February 1984, April 1984 and June 1984 contacts spanned the two week period during which the CFTC did not collect position data, thus an adjustment was required in order to make them available for the analysis. The price data on these contracts needed adjustment because the change in price between the dates of

July 15 and 29 was greater than the day-to-day permissible price change (±$1.50/cwt.). Left untreated, this gap would have caused infeasibility problems in programming models (presented later in this chapter) because the models are constrained to prevent price changes greater than ±$1.50/cwt. To alleviate this problem, the difference between the July 15 price and the July 29 price was added to all prices prior to July 15. Since this price adjustment did not affect the changes between daily prices (other than for the period of missing data) it had no effect on the price pressures calculated for each observation and thus no effect on the analysis.

4.4 Trader Group Specification

Previous studies utilizing this type of data defined groups whose membership changed from day to day. Rowsell (1991) and Yun (1992) make distinctions between traders based on their commercial status and the direction of their position (long or short). Obviously, the trader whose price expectations change frequently could be long one day and short the next, placing him/her in different groups on different days. An objective of this study is to identify those types of traders which, if attracted in greater numbers to the market, will improve the price discovery process. With this in mind, it doesn't make sense to talk about increasing the presence of, say, *long* large speculators because what makes them want to be long (their price expectation) changes daily. It does make sense, however, to talk about increasing the presence of *large* speculators if their price expectations seem to change in a way that consistently benefits the price discovery process.

For this study, it was decided that individual traders (accounts) should remain in the same trader group for the entire period of the analysis. With respect to the data, this meant that each unique account code was assigned membership in a single trader group and all observations associated with that account code and appearing anywhere in the data set were considered a part of the assigned trader group.

All accounts that were only associated with observations identified in the data set as not being those of individual traders were grouped together. This grouping included the accounts of commodity pool operators, commodity trading programs of future commission merchants, and house positions. This group is referred to as the funds/other trader group. As would be expected, all of the observations related to the accounts in this group were classified as noncommercial, or speculative, positions. Next, accounts for which every observation in the data set was classified as commercial were grouped together. Likewise, individual accounts for which every observation was classified as noncommercial were grouped together. These two groups, consisting of pure commercial accounts and pure speculative accounts, are referred to as the commercial and noncommercial groups, respectively.

There were also a number of accounts in the data set that had some commercial and some noncommercial observations. Time series on the positions of these accounts were studied to determine if they were predominantly either commercial or noncommercial traders. A large percentage of these "mixed" accounts showed the first several observations as noncommercial and, then at some point, the observations began being classified as commercial and remained that way for the remainder of the data set. This pattern was taken as indicative of a commercial trader. Since speculative traders faced more restrictive limits on the maximum number of open contracts they may hold, it is likely that new commercial traders have their reported trades classified as noncommercial until their eligibility for commercial classification is determined (i.e., the existence of cash positions is verified). Also, accounts where a large majority of the total number of observations were commercial with just a few instances of noncommercial classification were also taken to be commercial accounts and included in the commercial group. Only three accounts of the mixed type were eventually classified as noncommercial. These possessed mostly noncommercial observations with a few, isolated commercial observations. In essence, it was determined that if an account had some commercial observations associated with it, then that trader must have had positions in the cash commodity at some point in the analysis period and therefore is better described as commercial even if the trader occasionally took speculative positions.

To allow for differences based on the size of the trader (as measured by open contracts held) the commercial and noncommercial groups were split into subgroups. The basis for this subdivision was the average open position (AOP) of the account over the entire period of the study. An account's AOP is the total number of open positions associated with the account divided by the number of observations for that account.

Figures 4.1 and 4.2 plot the histograms for AOP for the commercial and noncommercial groups, respectively. Also included in these figures is the mean AOP for each group.

The mean AOP was used as the dividing point in each group. All accounts possessing an AOP less than the mean were placed in one subgroup and all accounts with AOP larger than the mean in another. For references purposes, these groups are referred to as the medium and large (commercial or noncommercial) groups, respectively. Previously, the term large trader has been used to refer to any trader in the CFTC data set. Now, however, large is taken to mean the very large traders in the CFTC data set and medium refers to the smaller traders within this data set. The large group contains fewer accounts than the medium group although the large group is responsible for more total open positions (over the entire sample period). This gives the large groups greater

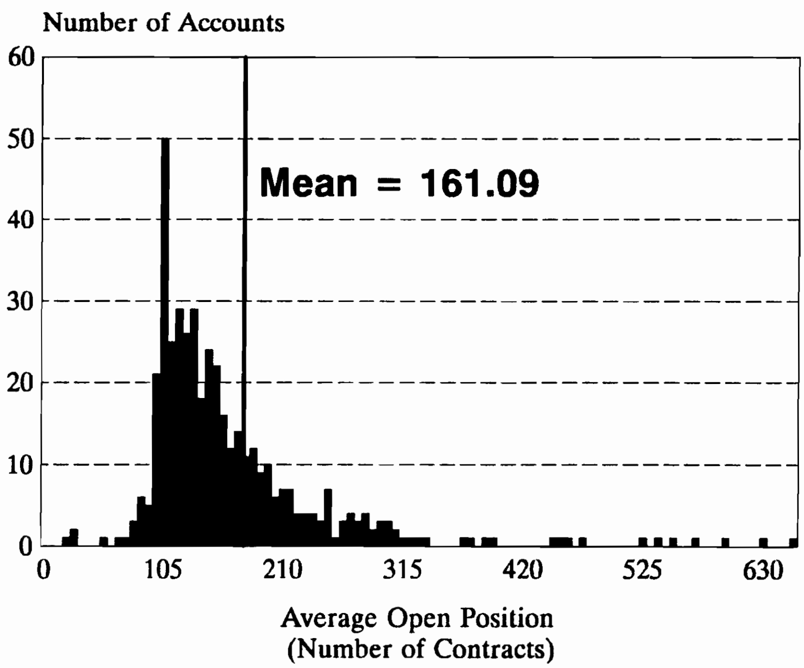

Figure 4.1. Histogram of Average Position Size for the Commercial Accounts.

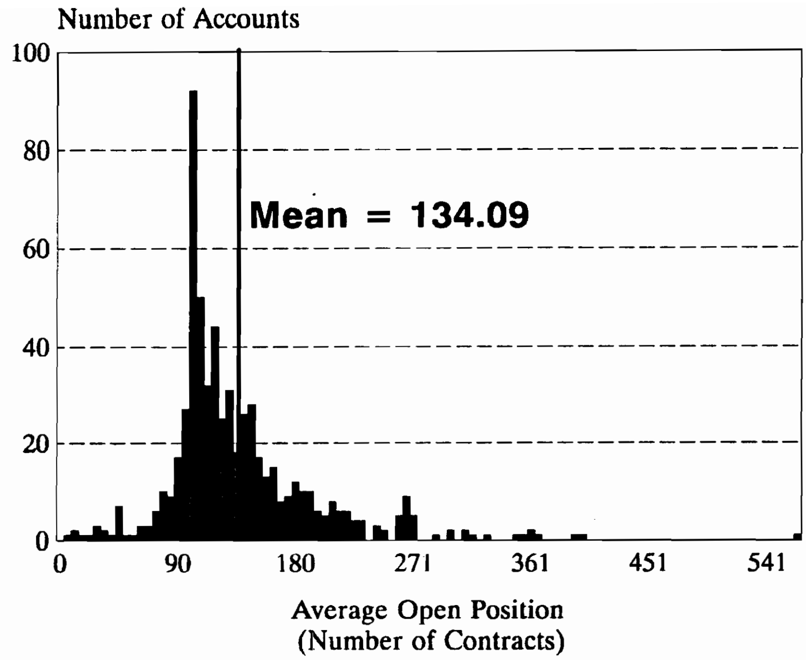

Figure 4.2. Histogram of Average Position Size for the Noncommercial Accounts.

presence in the market (as measured by total number of open contracts).

One other group arises from the data. Small traders (those who hold less than 100 contracts and don't report) hold the positions necessary to balance the net positions of all of the accounts in the CFTC data set. By summing net positions across the five trader groups identified from the CFTC data and reversing the sign, the net positions of the small trader group can be calculated. Thus, all of the traders in live cattle futures over the period of the analysis can be classified into one of six groups: large commercials, medium commercials, large noncommercials, medium noncommercials, funds/other traders, and small traders.

Table 4.1 lists the number of accounts that fall into the first five trader groups as calculated from the CFTC data. The actual number of small traders is unknown, but it is unnecessary for the analysis. The net position of the small traders is what is important and it can be calculated.

After all accounts in the CFTC data set had been assigned to a group and all of the observations associated with each account coded to reflect this assignment, data aggregation was undertaken. The position data (number of contracts long and short) was summed over all accounts in a particular group for each trading day in a specific contract. Then, the number of short positions was subtracted from the number of long positions to arrive at a net position for the group in the specific contract on each trading day. Negative net positions indicate that the group was net short. The daily net position holds some general information concerning the price expectations of each group. Groups that are net long on a particular day must, on the whole, be expecting higher prices in the future. The sum of the net positions across all groups for a trading day must equal zero

Table 4.1 Number of Accounts in Each of the Five Trader Groups Constructed from the CFTC Data Set.

Trader Group	Number of Accounts
Large Commercial	149
Medium Commercial	228
Large Noncommercial	285
Medium Noncommercial	386
Other Traders	137
Total:	1,185

because every long position is matched to a short position. The daily net position of the small trader group was calculated as the net position required to cause all six trader group net positions to equal zero.

4.5 Development of Price Pressure Measures

The ultimate data measure required for the models presented later in this chapter is a statistic to register or record the amount of pressure exerted on price by each of the trader groups. The discussion so far has focused on the analysis of the raw CFTC position data to produce daily net positions for six specific trader groups. Changes in these net positions, together with observed changes in price, hold information about changes in the collective price expectation of each group. This section details how the net position data and price data are combined to form price pressure measures.

To help illustrate the development, the price pressure calculations for one observation from the data set are presented. Daily net positions of each trader group can be symbolized as NP_{it} where the i subscript represents the trader group and t is a time period subscript. Table 4.2 gives the net positions of each of the trader groups in the December 1984 live cattle contract for two days in late October, 1984.[16] From the initial raw data given in Table 4.2, the changes in net positions (ΔNP_{it}) are calculated and are also presented in Table 4.2. Here, negative numbers indicate that a particular trader group

[16]Abbreviations for each of the trader groups are defined in the table. These abbreviations are used extensively in the remainder of this dissertation without further reference.

Table 4.2. Net Positions, Change in Net Positions, Settlement Prices, and Change in Price For Two Observations on the December 1984 Live Cattle Contract.

	First Observation	Second Observation
Date:	10/29/84	10/30/84
	----- Net Position ----- (Number of Contracts)	
Trader Group:		
Large Comm (LC)	-682	-634
Med. Comm. (MC)	377	368
Large Noncomm. (LN)	886	1266
Med. Noncomm. (MN)	266	451
Funds/Other (OTH)	-1713	-1723
Small Traders (ST)	866	272
	----- Change in Net Position ----- (Number of Contracts)	
Trader Group:		
Large Comm (LC)		48
Med. Comm. (MC)		-9
Large Noncomm. (LN)		380
Med. Noncomm. (MN)		185
Funds/Other (OTH)		-10
Small Traders (ST)		-594
Settlement Price ($/cwt):	63.92	64.22
Price Change ($/cwt.):		0.30

has become "more short" or "less long" during the trading day and positive numbers indicate the converse.

Next, the net position changes are used to calculate fractions which represent the percentage of new net positions for that day attributable to each of the trader groups. For reference purposes, these fractions are called initial fractions (I_{it}) and are calculated as:

$$I_{it} = \frac{\Delta NP_{it}}{\sum_i |\Delta NP_{it}|}. \tag{4.1}$$

The number of new net positions is simply the sum of the absolute values of the changes in net positions across all trader groups. The new net positions are "new" in the sense that they are new to a particular group–they are positions that did not exist for that group at the end of the previous trading session. New net positions may arise from a shuffling of existing open positions between groups (e.g., offsetting an existing position) or they may result from the opening of new positions. Thus, the new net positions referred to here are not synonymous with new open interest; they are simply devices to measure the net activity in the market for a particular trading session.

Using these initial fractions, the daily price change is divided among the six trader groups to produce an initial measure of price pressure, IP_{it}, where $IP_{it}=I_{it}\cdot|\Delta P_t|$. Table 4.3 presents these calculations for the example observation. Since the initial fractions necessarily sum to zero, the initial price pressure measure also sums to zero. The absolute

Table 4.3. Calculation of Initial, Supplemental and Total Price Pressure Measures for the December 1984 Live Cattle Contract on 10/30/84.[a]

Total New Net Positions: 1226 contracts

Mover New Net Positions: 613 contracts

$|\Delta P|$: 0.30 \$/cwt.

	Initial Pressure[b] $IP = I \bullet \|\Delta P\|$	Supplemental Pressure $SP = S \bullet \|\Delta P\|$	Total Pressure $TP = IP + SP$
Trader Group:			
LC	$.0117 = {}^{48}/_{1226} \bullet 0.30$	$.0235 = {}^{48}/_{613} \bullet 0.30$	.0352 = .0117+.0235
MC	$.0022 = {}^{9}/_{1226} \bullet 0.30$	$.0044 = {}^{9}/_{613} \bullet 0.30$	.0066 = .0022+.0044
LN	$.0929 = {}^{380}/_{1226} \bullet 0.30$	$.1860 = {}^{380}/_{613} \bullet 0.30$	.2789 = .0929+.1860
MN	$.0452 = {}^{185}/_{1226} \bullet 0.30$	$.0905 = {}^{185}/_{613} \bullet 0.30$	.1357 = .0452+.0905
OTH	$-.0025 = {}^{-10}/_{1226} \bullet 0.30$	0 (NMG)	-.0025 = -.0025+0
ST	$-.1453 = {}^{-594}/_{1226} \bullet 0.30$	0 (NMG)	-.1453 = -.1453+0
Totals:[c]	0.00	0.30	0.30

[a]Symbols as follow: ΔP=Price Change, IP=Initial Pressure, I=Initial Fraction, SP=Supplemental Pressure, S=Supplemental Fraction, TP=Total Pressure, NMG=Not a Mover Group.
[b]Units for pressure measures are \$/cwt.
[c]May not add due to rounding.

value of the daily price change is used in these calculations because the direction of the price pressure is communicated by the sign on the initial fraction.

At this point it is useful to examine some of the example results. Table 4.3 indicates that there is always some positive and some negative pressure on price at this stage. Moreover, the total positive initial pressure on price is exactly equal to the total negative pressure for a given observation. The price pressure measures themselves are in the same units as the futures price, dollars per hundredweight in this example.

These initial price pressure measures are now set aside to be used in subsequent calculations. Very seldom is there no change in the futures price from day to day. Thus, one or more trader groups must have exerted some additional pressure on price which resulted in the observed price movement. On days when the price moves down (up), it must be the case that those trader groups who were net sellers (buyers) exerted the additional price pressure. The next step in the procedure involves dividing the price change among only those groups that had net position changes corresponding to the direction of the price change. These groups are referred to as mover groups. For example, if the direction of the price change is up, the mover groups for that observation are those possessing positive (more long/less short) net position changes. This step in the calculations acknowledges the fact that since the observed price change was in a particular direction, the groups whose net positions changed in a way consistent with that change must have exerted, in sum, more pressure on price than did the groups whose net positions moved contrary to the direction of price. Allocating the price change to mover groups for a observation begins with the calculation of supplemental fractions. These fractions are derived in the same fashion as the initial fractions, except that only the mover groups are part of the calculation. The supplemental fractions (S_{it}) can be represented by:

$$S_{it} = \frac{\Delta NP_{it}}{\sum_i |\Delta NP_{it}|} \quad \forall\, i \in \text{mover groups} \tag{4.2}$$

Table 4.3 provides examples of the supplemental fraction calculation. The denominator in this fraction is the total number of new net positions attributable to the mover group(s). Because this number is half of the total new net positions, the supplemental fractions will be double the initial fractions.

The supplemental fractions are then used to divide the price change among the mover groups to form the supplemental price pressure measure, SP_{it}. This relationship is similar to the initial fraction calculation in that $SP_{it} = S_{it} \cdot |\Delta P_t|$. This calculation is carried through for the examples in Table 4.3. Again, the absolute value of the price change is used because the sign on the supplemental price pressure is conveyed by the supplemental fraction. Finally, the initial and supplemental price pressure measures are summed to arrive at a total measure of price pressure for each of the trader groups, TP_{it} (Table 4.3).

By construction, the total price pressures summed across all of the trader groups gives the exact daily price change. This is necessary in order that the change in price can be described solely as a function of the market activity of the six trader types. There will always be some positive (buying) and some negative (selling) pressure on price at each observation. The price pressure modeling process was applied first to the observations in the data set for the December 1984 live cattle contract. Figures 4.2-4.3 plot the total price pressure measures for the large commercial and large noncommercial trader groups over the life of this particular contract.

These plots share several distinguishing characteristics. The most striking feature of these time series is the high degree of negative autocorrelation they display.[17] Positive changes in price pressure are consistently followed by negative changes and vice versa. This suggests that trader groups exert substantial price pressure in either direction on one day then exert little pressure the following day. The lack of positive autocorrelation indicates that multi-day periods of sustained price pressure are rare. These characteristics would seem to suggest some degree of efficiency in the market. Whenever a group's price expectation changes, it is able to transmit this to the market within one trading period.

It is important to identify the assumptions embodied in this price pressure modeling process. First, it must be recognized that since the data are daily, no intraday

[17]Autocorrelation functions calculated from these data also indicated a large amount of negative autocorrelation.

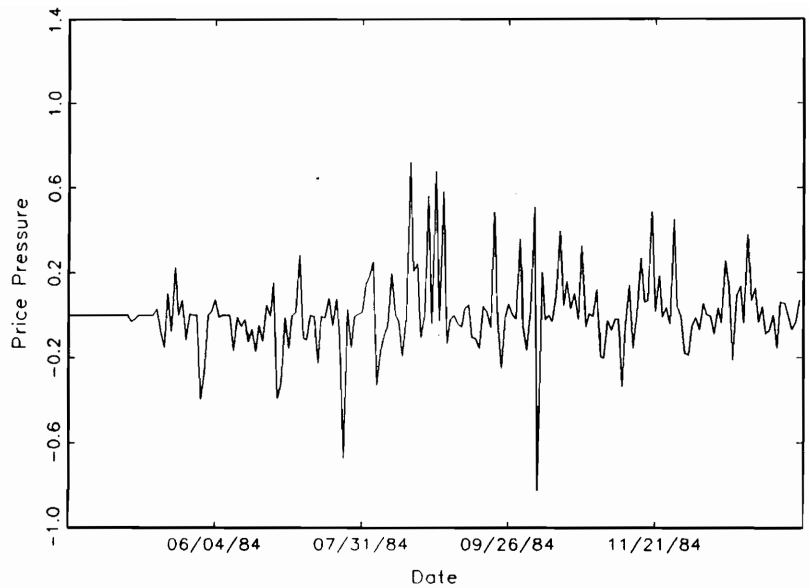

Figure 4.3. Commercial Price Pressure for the December 1984 Live Cattle Contract.

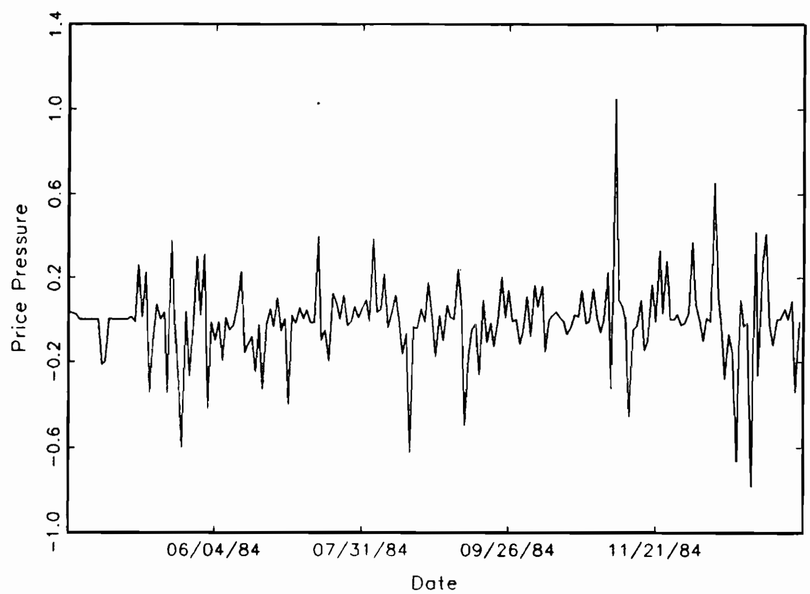

Figure 4.4. Noncommercial Price Pressure for the December 1984 Live Cattle Contract.

price pressure can be detected. In reality, price pressure changes with every contract that is bought or sold, but the price pressure reported here is the *net* price pressure resulting from aggregation of all intraday price pressure. For example, one group might engage in a large number of trades during a particular day and cause large changes in price. If the intraday price changes caused by this group are equally divided between positive and negative, then the group will show little or no price pressure on the daily level. Acknowledging that intraday trading activity is not completely captured by the price index measures, it is certainly better to have daily data than data sampled at a lower frequency.

Implicit in the way this measure is calculated is the assumption that every futures trade by a particular trader group in a given trading session has equal impact on price pressure. In reality, it is likely that individual traders engage in trades at different price levels, at different times within the day, and with different temporal characteristics. Thus the pressure exerted by trades originating from different individuals should and probably does vary. However, since the model calls for aggregation over all traders in a group, generalizing to give all trades by that group some equal, or average, weight does not affect the analysis. Differing contributions by individual traders would only be important if the analysis focused on individual traders rather than groups of traders. Later in this chapter, several models are presented that increase or decrease the market presence (through price pressure) of one or more groups. These models all assume that the trades added or removed have equal weight.

In addition, the price pressure modeling process does not allow for different degrees of pressure per unit from trades of different groups when both groups possess net position changes in the same direction. For example, in the calculation of initial pressure, if both the large and medium commercial group show positive changes in net position, then each unit ΔNP of the groups receives identical weight in the pressure calculation. What this means is that when two or more groups are observed to "push" price in the same direction, it is impossible to tell if one or more of the groups are pushing "harder" per ΔNP than the remaining groups. All trades of both groups get the same per unit weight and the degree of pressure exerted by each group is conveyed by the size of each group's net position change.

On those infrequent occasions when there is no change in price from the previous day's close ($\Delta P = 0$), all of the $TP_{it} = 0$. This occurs even though there may be as many as six nonzero ΔNP_{it}'s. Theoretically, $\Delta P = 0$ could result from summing nonzero TP_{it}'s as long as the positive TP_{it}'s were equal in value to the negative TP_{it}'s. There are an infinite number of values the six TP_{it} could take and still sum to zero. The constraint assumed by this process is that all $TP_{it} = 0$. Although this price pressure modeling process may not be ideal in all respects (such as when $\Delta P = 0$), it does provide a rule than can be applied consistently to each observation to arrive at an objective price pressure measurement.

4.6 Modeling Intergroup Responses

Traders in futures markets interact in a dynamic environment and it is possible that the actions of one trader group will have an effect on, or evoke a response from, one or more of the other trader groups. Since the simulation models used in this study will utilize changes in the price pressure of one or more groups, it is important to identify responses to changes in price pressure between groups.

If each trader group responds to some degree to the actions of all remaining trader groups, then price pressure can be expressed as:

$$TP_i = \alpha_i + \sum_j f_j(TP_j) \tag{4.3}$$

where TP_i is the total price pressure exhibited by the interest group, α_i is that portion of price pressure that originates from the interest group's own action (aside from its response to other group's actions) and TP_j is the price pressure of all remaining groups. The complete change in TP_i is given by the total differential:

$$\Delta TP_i = \frac{\partial TP_i}{\partial \alpha_i} \Delta \alpha_i + \sum_j \frac{\partial TP_i}{\partial TP_j} \Delta TP_j \, . \tag{4.4}$$

In order to expand this notation into matrix form, let the trader group symbols (LC=large commercial, MC=medium commercial, LN=large noncommercial, MN=medium noncommercial, OTH=funds/others, ST=small traders) substitute for the appropriate TP_i or TP_j. Recognizing that $\partial TP_i/\partial \alpha_i = 1$, this system of total derivatives can be represented by:

$$\begin{bmatrix} 1 & -\frac{\partial LC}{\partial MC} & -\frac{\partial LC}{\partial LN} & -\frac{\partial LC}{\partial MN} & -\frac{\partial LC}{\partial OTH} & -\frac{\partial LC}{\partial ST} \\ -\frac{\partial MC}{\partial LC} & 1 & -\frac{\partial MC}{\partial LN} & -\frac{\partial MC}{\partial MN} & -\frac{\partial MC}{\partial OTH} & -\frac{\partial MC}{\partial ST} \\ -\frac{\partial LN}{\partial LC} & -\frac{\partial LN}{\partial MC} & 1 & -\frac{\partial LN}{\partial MN} & -\frac{\partial LN}{\partial OTH} & -\frac{\partial LN}{\partial ST} \\ -\frac{\partial MN}{\partial LC} & -\frac{\partial MN}{\partial MC} & -\frac{\partial MN}{\partial LN} & 1 & -\frac{\partial MN}{\partial OTH} & -\frac{\partial MN}{\partial ST} \\ -\frac{\partial OTH}{\partial LC} & -\frac{\partial OTH}{\partial MC} & -\frac{\partial OTH}{\partial LN} & -\frac{\partial OTH}{\partial MN} & 1 & -\frac{\partial OTH}{\partial ST} \\ -\frac{\partial ST}{\partial LC} & -\frac{\partial ST}{\partial MC} & -\frac{\partial ST}{\partial LN} & -\frac{\partial ST}{\partial MN} & -\frac{\partial ST}{\partial OTH} & 1 \end{bmatrix} \begin{bmatrix} \Delta LC \\ \Delta MC \\ \Delta LN \\ \Delta MN \\ \Delta OTH \\ \Delta ST \end{bmatrix} = \begin{bmatrix} \Delta\alpha_{LC} \\ \Delta\alpha_{MC} \\ \Delta\alpha_{LN} \\ \Delta\alpha_{MN} \\ \Delta\alpha_{OTH} \\ \Delta\alpha_{ST} \end{bmatrix} \qquad \textbf{(4.5)}$$

or, Bx = d where B is the matrix of partial derivatives with ones on the diagonal, x is the vector of total price pressure changes and d is the vector of exogenous price pressure changes. The total price pressure changes can be solved for as a function of the exogenous changes according to $x = B^{-1} d$. Let b_{ij} represent the individual elements of the B^{-1} matrix. The marginal influence on one group's price pressure of an exogenous change in any other group's price pressure, $\partial\Delta TP_i/\partial\Delta\alpha_j$, is b_{ij}. When i = j, the b_{ii} element indicates the total change in TP_i (including all of the response effects of other trader groups) for a one unit change in α_i. This value will be greater than one if $\Sigma_j(\partial TP_i/\partial TP_j)(\partial TP_j/\partial TP_i) > 0$ and it will be less than one when $\Sigma_j(\partial TP_i/\partial TP_j)(\partial TP_j/\partial TP_i) < 0$.

Prior to discussing the efforts to estimate the partial derivatives required to model the intergroup responses, it is helpful to examine how these parameters will be incorporated into the model. The partial derivatives in (4.5) are used to find the B^{-1} matrix and it is the elements of this matrix that are used in the modeling process. For ease of exposition, let the numerical subscripts 1 to 6 represent the trader groups according to: 1 = large commercial, 2 = medium commercial 3 = large noncommercial, 4 = medium noncommercial, 5 = funds/others, and 6 = small traders. The B^{-1} matrix can then be represented by:

$$B^{-1} = \begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} & b_{16} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} & b_{26} \\ b_{31} & b_{32} & b_{33} & b_{34} & b_{35} & b_{36} \\ b_{41} & b_{42} & b_{43} & b_{44} & b_{45} & b_{46} \\ b_{51} & b_{52} & b_{53} & b_{54} & b_{55} & b_{56} \\ b_{61} & b_{62} & b_{63} & b_{64} & b_{65} & b_{66} \end{bmatrix} \tag{4.6}$$

Recall that the daily change in price is equal to the sum of all six price pressure measures. To illustrate, consider an exogenous 10 percent change in large commercial price pressure. In a model without intergroup response effects, then new (or simulated) daily change in price (ΔP^*) would be calculated as:

$$\Delta P^* = 1.10TP_{LC} + TP_{MC} + TP_{LN} + TP_{MN} + TP_{OTH} + TP_{ST}. \tag{4.7}$$

When intergroup responses are allowed, the new daily change in price is calculated as follows:

$$\Delta P^{*} = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} TP_{LC} \\ TP_{MC} \\ TP_{LN} \\ TP_{MN} \\ TP_{OTH} \\ TP_{ST} \end{bmatrix} + \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} & b_{16} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} & b_{26} \\ b_{31} & b_{32} & b_{33} & b_{34} & b_{35} & b_{36} \\ b_{41} & b_{42} & b_{43} & b_{44} & b_{45} & b_{46} \\ b_{51} & b_{52} & b_{53} & b_{54} & b_{55} & b_{56} \\ b_{61} & b_{62} & b_{63} & b_{64} & b_{65} & b_{66} \end{bmatrix} \begin{bmatrix} 0.1TP_{LC} \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \qquad \textbf{(4.8)}$$

The total effect of the exogenous change in TP_{LC} will be $(b_{11} + b_{21} + b_{31} + b_{41} + b_{51} + b_{61})$ $0.10\ TP_{LC}$. The difference between this and the no intergroup response model is the factor representing the sum down the first column of the inverse matrix, B^{-1}. Let $k_j = \Sigma_i b_{ij}$. If $k_{LC} = 1$, then the two models in this example are identical. If the sum is greater than one, this indicates that, with all intergroup responses accounted for, the exogenous change in large commercial price pressure will have a $100(k_{LC} - 1)$ percent greater influence on the new price than in a model where intergroup responses are ignored. If $k_j < 1$, this means that the jth trader group's exogenous price pressure changes will have a $100(1 - k_j)$ percent smaller influence on the new price than in a no response model. In effect, the k_j are *price* *pressure multipliers*—they indicate the percentage of an exogenous increase in a group's price pressure that is passed on to the price change, all intergroup responses having been taken into account.

The previous exposition on the nature of the column sums will be useful in validating the partial derivative estimates. The size of the price pressure multipliers gives some indication of the magnitude of the intergroup responses. *A priori*, intergroup responses are expected to be small to moderate because the correlations between price pressures would be expected to be small. Trader groups would not be expected to take a major portion of their trading strategy from the observed actions of other groups. Negative values for any price pressure multipliers should be viewed with suspicion. Negative multipliers imply that an exogenous increase in the group's price pressure actually causes price to move in a direction opposite the original price pressure. This results when the intergroup response effects completely overwhelm and negate the exogenous change in price pressure. Values for the multipliers greater than two should also be examined carefully. A value of $k_j > 2$ means that the intergroup response effects have more than doubled the original exogenous change in the jth group's price pressure.

4.7 Programming Model Specifications

The primary objective of this modeling effort is to simulate price paths that reflect a live cattle futures market with a different mix of traders from the mix that was historically observed. These simulated price paths, along with the trader mix that produced them, can then be evaluated for their effect on the price discovery process. The general idea is to postulate a model where prices behave in a manner consistent with the actual live cattle futures market (e.g., limit moves are enforced, closing price for day t + 1 is equal to the closing price on day t plus the price change on t + 1). Changes are then allowed in the price pressure of one or more trader groups (which mimics changes in their market presence) so that simulated daily price changes (and thus simulated daily prices) are developed. These simulated prices, when viewed as a time series, are a simulated price path.

All of the simulation models are quadratic programming models designed to minimize an objective function that defines the MSE of the price series. MSE is simply the mean squared deviation of each observation in the price series from the final settlement price ($MSE = \Sigma_t [Price_t - Price_{final}]^2/N$). There are a number of advantages to specifying the simulation model in this manner. From the discussion in Section 3.4, by minimizing, or even simply reducing, the MSE of a price series the price discovery process is improved. Examining how the trader mix was changed in order to accomplish a MSE reduction provides information on the relative value of each trader group to the price discovery process. A programming model has the advantage that it generates dual values (shadow prices) which reflect the marginal value of each trader group to minimizing MSE, and hence to the price discovery process. Also, by formulating the model as one that optimizes a specific objective function, the model chooses the optimal trader mix and thus is able to avoid arbitrary exogenous specification of changes in trader mix.

Ten different models were specified for this study. Although the models are all variations of the same general concept, each one provides different information on the contribution of the six trader groups to the price discovery process in live cattle futures. Each model is applied to the price pressure data on each of the 24 futures contracts. Some of the models are specified so that a change in trader mix holds for the entire period that the contract is traded (200 trading days) and some models permit the contract life to be divided in to 10 subperiods (of 20 trading days each) with a different trader mix allowed in each subperiod. The subperiod models are designed to investigate how trader group influence on price evolves as the contract approaches maturity. Table 4.4 provides details on the characteristics of each model and the purpose for which each was designed. Table 4.5 presents description of the symbols used in the mathematical representation of the models which follow.

The 10 models employed in the study, with each model accompanied by the appropriate constraints, are provided below. The subsequent pages then provide more detailed explanations of the models and how they are constructed.

Table 4.4. Distinguishing Characteristics and Purposes for the Ten Model Specifications.

Model Number	Sub-periods	Distinguishing Characteristic	Purpose
1	No	All price pressures held at historical levels	Generate shadow prices to indicate relative influence of each group over life of contract.
2	Yes	All price pressures held at historical levels	Generate shadow prices to indicate relative influence of each group in each subperiod.
3	No	All price pressures allowed to vary simultaneously	Determine optimal trader mix over life of contract.
4	Yes	All price pressures allowed to vary simultaneously	Determine optimal trader mix by subperiod.
5 - 10	Yes	Only one trader group's price pressure is allowed to vary from historical in each model (Model 5 = LC Model 6 = MC Model 7 = LN Model 8 = MN Model 9 = OTH Model 10 = ST)	Determine optimal market presence of a particular group in each subperiod, *ceteris paribus*.

Table 4.5. Symbol Definitions for the Mathematical Representation of the Models.

Symbol:	Description:
Known Parameters:	
$PRICE_0$	Historical beginning price for a futures contract; the price 201 trading days before the contract expired.
ENDPR	Historical final settlement price for a futures contract.
PP	Historical price pressure calculated according to Section 4.5
k	Price pressure multiplier that captures intergroup response effects for a particular futures contract.
N	Number of trading days in a contract, N=200.
Variables:	
MSE	Mean Squared Error
PRICE	Simulated Daily Price
PPCT	Percentage of historical price pressure for non-subperiod models.
PCT	Percentage of historical price pressure for sub-period models.
Subscripts:	
t	trading day; t = 1 to 200.
g	trader group; g = 1 to 6;
p	sub-period; p = 1 to 10;
j	single trader group allowed to vary in Models 5-10.

MODEL 1

$$\text{Min} \quad MSE = \frac{1}{N}\sum_t (PRICE_t - PRICE_{200})^2 \qquad (4.9)$$

subject to:

$$PRICE_t = PRICE_0 + \sum_g \left(\sum_{t=1}^{t} PP_{tg} + (PPCT_g - 1) k_g \sum_{t=1}^{t} PP_{tg}\right) \qquad [200] \quad (4.10)$$

$$PRICE_{200} = ENDPR \qquad (4.11)$$

$$PRICE_t - PRICE_{t-1} \geq -1.50 \qquad [199] \quad (4.12)$$

$$PRICE_t - PRICE_{t-1} \leq 1.50 \qquad [199] \quad (4.13)$$

$$PPCT_g = 1 \qquad [6] \quad (4.14)$$

$$MSE,\ PRICE_t \geq 0 \qquad (4.15)$$

MODEL 2

$$\text{Min} \quad MSE = \frac{1}{N}\sum_t (PRICE_t - PRICE_{200})^2 \qquad (4.17)$$

subject to:

$$PRICE_{t=1\text{ to }20} = PRICE_0 + \sum_g (\sum_{t=1}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=1}^{t} PP_{tg}) \qquad [20] \quad (4.18)$$

$$PRICE_{t=21\text{ to }40} = PRICE_{20} + \sum_g (\sum_{t=21}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=21}^{t} PP_{tg}) \qquad [20] \quad (4.19)$$

$$PRICE_{t=41\text{ to }60} = PRICE_{40} + \sum_g (\sum_{t=41}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=41}^{t} PP_{tg}) \qquad [20] \quad (4.20)$$

$$PRICE_{t=61\text{ to }80} = PRICE_{60} + \sum_g (\sum_{t=61}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=61}^{t} PP_{tg}) \qquad [20] \quad (4.21)$$

$$PRICE_{t=81\text{ to }100} = PRICE_{80} + \sum_g (\sum_{t=81}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=81}^{t} PP_{tg}) \qquad [20] \quad (4.22)$$

$$PRICE_{t=101\text{ to }120} = PRICE_{100} + \sum_g (\sum_{t=101}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=101}^{t} PP_{tg}) \qquad [20] \quad (4.23)$$

$$PRICE_{t=121\text{ to }140} = PRICE_{120} + \sum_g (\sum_{t=121}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=121}^{t} PP_{tg}) \qquad [20] \quad (4.24)$$

$$PRICE_{t=141\text{ to }160} = PRICE_{140} + \sum_g (\sum_{t=141}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=141}^{t} PP_{tg}) \qquad [20] \quad (4.25)$$

$$PRICE_{t=161\text{ to }180} = PRICE_{160} + \sum_g (\sum_{t=161}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=161}^{t} PP_{tg}) \qquad [20] \quad (4.26)$$

$$PRICE_{t=181\text{ to }200} = PRICE_{180} + \sum_g (\sum_{t=181}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=181}^{t} PP_{tg}) \qquad [20] \quad (4.27)$$

$$PRICE_{200} = ENDPR \qquad (4.28)$$

$$PRICE_t - PRICE_{t-1} \geq -1.50 \qquad [199] \quad (4.29)$$

$$PRICE_t - PRICE_{t-1} \leq 1.50 \qquad [199] \quad (4.30)$$

$$PCT_{pg} = 1 \qquad [6] \quad (4.31)$$

$$MSE,\ PRICE_t \geq 0 \qquad (4.32)$$

MODEL 3

$$\text{Min} \quad MSE = \frac{1}{N}\sum_{t}(PRICE_t - PRICE_{200})^2 \tag{4.33}$$

subject to:

$$PRICE_t = PRICE_0 + \sum_{g}\left(\sum_{t=1}^{t} PP_{tg} + (PPCT_{pg} - 1)k_g \sum_{t=1}^{t} PP_{tg}\right) \qquad [200] \tag{4.34}$$

$$PRICE_{200} = ENDPR \tag{4.35}$$

$$PRICE_t - PRICE_{t-1} \geq -1.50 \qquad [199] \tag{4.36}$$

$$PRICE_t - PRICE_{t-1} \leq 1.50 \qquad [199] \tag{4.37}$$

$$PPCT_g \geq 0.80 \qquad [6] \tag{4.38}$$

$$PPCT_g \leq 1.20 \qquad [6] \tag{4.39}$$

$$MSE,\ PRICE_t \geq 0 \tag{4.40}$$

MODEL 4

$$\text{Min} \quad MSE = \frac{1}{N}\sum_t (PRICE_t - PRICE_{200})^2 \qquad (4.41)$$

subject to:

$$PRICE_{t=1 \text{ to } 20} = PRICE_0 + \sum_g \left(\sum_{t=1}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=1}^{t} PP_{tg}\right) \qquad [20] \qquad (4.42)$$

$$PRICE_{t=21 \text{ to } 40} = PRICE_{20} + \sum_g \left(\sum_{t=21}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=21}^{t} PP_{tg}\right) \qquad [20] \qquad (4.43)$$

$$PRICE_{t=41 \text{ to } 60} = PRICE_{40} + \sum_g \left(\sum_{t=41}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=41}^{t} PP_{tg}\right) \qquad [20] \qquad (4.44)$$

$$PRICE_{t=61 \text{ to } 80} = PRICE_{60} + \sum_g \left(\sum_{t=61}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=61}^{t} PP_{tg}\right) \qquad [20] \qquad (4.45)$$

$$PRICE_{t=81 \text{ to } 100} = PRICE_{80} + \sum_g \left(\sum_{t=81}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=81}^{t} PP_{tg}\right) \qquad [20] \qquad (4.46)$$

$$PRICE_{t=101 \text{ to } 120} = PRICE_{100} + \sum_g \left(\sum_{t=101}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=101}^{t} PP_{tg}\right) \qquad [20] \qquad (4.47)$$

$$PRICE_{t=121 \text{ to } 140} = PRICE_{120} + \sum_g \left(\sum_{t=121}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=121}^{t} PP_{tg}\right) \qquad [20] \qquad (4.48)$$

$$PRICE_{t=141 \text{ to } 160} = PRICE_{140} + \sum_g \left(\sum_{t=141}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=141}^{t} PP_{tg}\right) \qquad [20] \qquad (4.49)$$

$$PRICE_{t=161 \text{ to } 180} = PRICE_{160} + \sum_g \left(\sum_{t=161}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=161}^{t} PP_{tg}\right) \qquad [20] \qquad (4.50)$$

$$PRICE_{t=181 \text{ to } 200} = PRICE_{180} + \sum_g \left(\sum_{t=181}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=181}^{t} PP_{tg}\right) \qquad [20] \qquad (4.51)$$

$$PRICE_{200} = ENDPR \qquad (4.52)$$

$$PRICE_t - PRICE_{t-1} \geq -1.50 \qquad [199] \qquad (4.53)$$

$$PRICE_t - PRICE_{t-1} \leq 1.50 \qquad [199] \qquad (4.54)$$

$$PCT_{pg} \geq 0.80 \qquad [60] \qquad (4.55)$$

$$PCT_{pg} \leq 1.20 \qquad [60] \qquad (4.56)$$

$$MSE,\ PRICE_t \geq 0 \qquad (4.57)$$

$$\text{Min} \quad MSE = \frac{1}{N}\sum_t (PRICE_t - PRICE_{200})^2 \tag{4.58}$$

subject to:

$$PRICE_{t=1 \text{ to } 20} = PRICE_0 + \sum_g (\sum_{t=1}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=1}^{t} PP_{tg}) \quad [20] \tag{4.59}$$

$$PRICE_{t=21 \text{ to } 40} = PRICE_{20} + \sum_g (\sum_{t=21}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=21}^{t} PP_{tg}) \quad [20] \tag{4.60}$$

$$PRICE_{t=41 \text{ to } 60} = PRICE_{40} + \sum_g (\sum_{t=41}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=41}^{t} PP_{tg}) \quad [20] \tag{4.61}$$

$$PRICE_{t=61 \text{ to } 80} = PRICE_{60} + \sum_g (\sum_{t=61}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=61}^{t} PP_{tg}) \quad [20] \tag{4.62}$$

$$PRICE_{t=81 \text{ to } 100} = PRICE_{80} + \sum_g (\sum_{t=81}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=81}^{t} PP_{tg}) \quad [20] \tag{4.63}$$

$$PRICE_{t=101 \text{ to } 120} = PRICE_{100} + \sum_g (\sum_{t=101}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=101}^{t} PP_{tg}) \quad [20] \tag{4.64}$$

$$PRICE_{t=121 \text{ to } 140} = PRICE_{120} + \sum_g (\sum_{t=121}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=121}^{t} PP_{tg}) \quad [20] \tag{4.65}$$

$$PRICE_{t=141 \text{ to } 160} = PRICE_{140} + \sum_g (\sum_{t=141}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=141}^{t} PP_{tg}) \quad [20] \tag{4.66}$$

$$PRICE_{t=161 \text{ to } 180} = PRICE_{160} + \sum_g (\sum_{t=161}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=161}^{t} PP_{tg}) \quad [20] \tag{4.67}$$

$$PRICE_{t=181 \text{ to } 200} = PRICE_{180} + \sum_g (\sum_{t=181}^{t} PP_{tg} + (PCT_{pg} - 1)k_g \sum_{t=181}^{t} PP_{tg}) \quad [20] \tag{4.68}$$

$$PRICE_{200} = ENDPR \tag{4.69}$$

$$PRICE_t - PRICE_{t-1} \geq -1.50 \quad [199] \tag{4.70}$$

$$PRICE_t - PRICE_{t-1} \leq 1.50 \quad [199] \tag{4.71}$$

$$PCT_{pg, g \neq j} = 1 \quad [50] \tag{4.72}$$

$$PCT_{pj} \geq 0.80 \quad [10] \tag{4.73}$$

$$PCT_{pj} \leq 1.20 \quad [10] \tag{4.74}$$

$$MSE,\ PRICE_t \geq 0 \tag{4.75}$$

4.7.1 Model 1

The objective function of this model, and of all the models, defines MSE as the sum of squared deviations of the 200 daily prices from the final or true value divided by the number of observations. This is simply a measure of dispersion of actual or simulated futures prices around the "true" price. Because smaller values of MSE are more desirable from a price discovery prospective, this objective function is minimized.

The first constraint, (4.10), defines how prices are calculated in the model. Since t runs from 1 to 200, there are actually 200 individual constraints that take the form of (4.10). For any model constraint where the mathematical representation stands for more than a single constraint, the number of constraints implied by the equation is given in square brackets immediately following the equation. In simple terms, this constraint indicates that the price in any time period is the beginning price plus all of the price changes that have occurred up to that point in time.

To understand the price constraint, it is useful to look first at the form this constraint takes when there are no intergroup response effects in the model. In this situation, the constraint is:

$$PRICE_t = PRICE_0 + \sum_g (PPCT_g \cdot \sum_{t=1}^{t} PP_{tg}) \qquad \textbf{(4.76)}$$

In this model the choice variables are $PPCT_g$. These represent the change in market presence (as measured by price pressure) of group g as a percentage of the original price pressure for group g. When $PPCT_g$ = 1, group g's market presence is equal to the historical level observed in each time period. If all the $PPCT_g = 1$, then this equation says that price in t equals price in t - 1 plus the sum of the historical price pressures in period t. By design, the sum of the historical price pressures exactly equals the historical price change in that time period so that when all $PPCT_g = 1$, the simulated price generated by the model is identical to the historical price. When one or more of the $PPCT_g \neq 1$, then the simulated price change (and thus the simulated price) will differ from the historical pattern.

Intergroup response effects are calculated according to the equations given in (4.5). As noted in the previous section, the total effect of a change in one group's price pressure on the price change in period t can be compactly represented by the column sums corresponding to the price pressure multiplier parameters, k_g.[18] When $k_g = 1$, the total effect of an exogenous change in the price pressure of group g is 100 percent of the exogenous change. For $k_g < 1$, the total effect of an exogenous change in price pressure is less than 100 percent and for $k_g > 1$, the total effect is more than 100 percent. The constraint in (4.10) adds these intergroup response effects to the constraint given by (4.76).

The constraint given in (4.11) simply requires the final simulated price to equal the final historical price. This is important to the realism of the model. Any simulated price series should be expected to converge at maturity to the same price the historical

[18]The subscript g is substituted in place of the j used previously to provide notation consistent with the trader group subscripts used in the model specifications.

series shows. After all, their is only one true value for the commodity represented by the futures contract. It should also be noted that through (4.10), any simulated price series will have the same beginning value as the historical price series. In essence, the model is constrained to begin and end in the same place that the historical series did. The path that it chooses to follow between these two points need not be the same as the historical price path.

The model must also avoid generating simulated price changes that could not occur in reality. The constraints represented by (4.12) and (4.13) enforce limits on price movements. During the period for which these data were collected, live cattle futures prices were restricted by exchange regulations from moving more than ±1.50 $/cwt. in any given trading period. Since these constraints deal with price changes, (4.12) and (4.13) each imply 199 actual model constraints.

The distinguishing constraint of this model is given by (4.14) where all of the $PPCT_g$ variables are restricted to unity. This implies that the simulated price series arising from Model 1 will be identical to the historical price series. While this will not generate an optimal trader mix, these six constraints will have associated with them shadow prices which will provide important information. These shadow prices will indicate how the MSE will respond to a one unit increase in the RHS of any of these constraints. That is, the shadow price associated with a particular constraint will convey the marginal value of increasing a particular group's market presence *from its historical level.* This information measures a particular group's influence and potential influence on price discovery. The final constraint in this model, (4.15), is the usual non-negativity requirement.

4.7.2 Model 2

This model is identical to Model 1 except that it is a subperiod model. Instead of the choice variables being indexed over trader group only, they are indexed over trader group and subperiod (p). To distinguish these choice variables from the ones in non-subperiod models, they are designated PCT rather than PPCT. Each subperiod consists of 20 trading sessions with subperiod 1 being the first 20 daily trading sessions and subperiod 10 being the last 20 trading sessions.

In order to accommodate the inclusion of subperiods, the price definition constraint of Model 1 (4.10) was replaced with 10 separate constraints [(4.18) through (4.27)], one for each subperiod. Each of these constraints does exactly the same thing as (4.10), but only for a specific period of 20 time periods. All of the remaining constraints are as in Model 1.

Whereas Model 1 had six choice variables, Model 2 has 60. In Model 1, the change in market presence for any particular group (indicated by $PPCT_g$) held for the entire life of the contract. Model 2 is considerably more flexible with each group being allowed a different market presence in each subperiod. The primary reason for specifying subperiod models is to study how trader groups influence price discovery at different points in the life of the contract. For Model 2, this means that the shadow prices arising from the 60 constraints implied by (4.31) will be examined to determine how each group's marginal contribution to MSE changed as time passed and the maturity date approached.

4.7.3 Model 3

Model 3 is a non-subperiod model very similar to Model 1. It's distinguishing feature is that trader group market presence is no longer constrained to its historical value. This is the first model in which an optimal trader mix is generated and the first for which the simulated prices arising out of the model differ from the historical prices.

Although the decision variables in this model are allowed to vary, some bounds must still be imposed upon them. Without bounds, a trader group could be removed from the market entirely ($PPCT_g = 0$) or its market presence increased to infinity. Neither situation is reflective of what might be expected from a real-world market response to a policy change. Further, removing a very large portion of any trader group or increasing the presence of a group to a very large degree would likely entail liquidity effects not accounted for by the present model. Because the models used in this study ignore any liquidity effects of changes in market presence by the various trader groups, the models are probably most accurate for relatively small alterations in price pressure.

For these reasons, it was decided that the market presence of any trader group should not be allowed to change by more than ±20 percent. These restrictions are imposed by (4.38) and (4.39). In addition to the optimal trader mix provided by the solution to this model, these constraints will provide shadow prices for any trader group whose optimal market presence is 80 (or 120) percent of its historical value. These shadow prices indicate the marginal value of additional decreases (increases) in that group's price pressure. For $0.8 < PPCT_g < 1.20$, the shadow prices will be zero.

4.7.4 Model 4

Model 4 is the sub-period version of Model 3. This is the most flexible of all the models. Not only are the decision variables allowed to vary from unity, they can take different values in each subperiod. Because of its high degree of flexibility, this model is expected *a priori* to be the one that produces the simulated price path with the smallest MSE.

The model will render 60 optimal levels of market presence, one for each trader group in each time period. In addition, the 120 constraints implied by (4.55) and (4.56) will provide shadow prices for any PCT_{pg} for which these constraints are binding at the optimal solution. For trader groups that were beneficial to the price discovery process in a particular subperiod, $PCT_{pg} > 1$ would be expected.

4.7.5 Models 5-10

Models 5-10 are subperiod models designed to evaluate the effect on prices of a change in only one trader group's market presence while holding the remaining five group's price pressure at their historical levels. The constraints in (4.72), (4.73) and (4.74) impose these restrictions. These models allow the study of optimal market presence for individual trader groups without distortion from simultaneous changes in market presence by other groups.

These models could also be used to study the effect on prices of a specific change in market presence by a particular trader group. For example, if a policy maker determined that a policy might be expected to increase the market participation of a specific trader group by τ percent, then the appropriate model (from Models 5-10) could be altered so that (4.73) and (4.74) are replaced with:

$$\frac{\sum_{p} PCT_{pk}}{10} = 1 + \frac{\tau}{100} \qquad \textbf{(4.77)}$$

This equation restricts the average price pressure of the group of interest over all 10 subperiods to τ percent more than the historical average for that group.[19] Then the model could be solved to generate a simulated price path and a MSE value associated with that price path. If this MSE was smaller than that from Model 1 or Model 2 (historical MSE), then the policy, had it been in effect, would have improved price discovery.[20] Such use of these models is recognized, but not exercised in the present study. To do so would

[19]The average over all subperiods is used here rather than a flat τ percent increase in every subperiod to prevent infeasibility problems. The only feasible solution that will give the same beginning and ending prices as the historical series when five of six trader group price pressures are fixed at historical levels in all subperiods is for the group of interest price pressure to also be fixed at its historical level in all subperiods.

[20]This is the maximum improvement in price discovery that could be expected (i.e., the best case result). To find the worst case result the direction of the optimization could be reversed and the objective function maximized subject to the same constraints.

require a specific policy scenario and an estimate of which types of traders would alter their market participation and by how much.

Finally, all of the models in this chapter have been presented with intergroup response effects included. A second set of models, identical except omitting the intergroup responses, were also constructed and solved so that the importance of including the intergroup responses could be evaluated.

4.8 Chapter Summary

The base data set used in this study was provided by the CFTC and contains daily observations on the positions of reporting traders in live cattle futures from January 1983 to November 1987. From this data set, six general groups of traders were identified: large and medium commercial traders, large and medium noncommercial traders, funds/other traders and small (nonreporting) traders. The CFTC position data were used in conjunction with price data to construct an index to measure the daily net price pressure of each trader group. By construction, these price pressure measures exactly define the daily change in price. Because of this characteristic, the time series of prices for any futures contract can be specified in terms of some beginning value and the sequential price pressures of all six trader groups.

Quadratic programming models were constructed with MSE as the objective function and constraints designed to enforce market rules. By allowing the quadratic programming algorithm to alter the market presence of each trader group enroute to minimizing the objective function, new (simulated) prices can be generated. In addition to the simulated prices, the programming models yield shadow prices which indicate the relative value of each trader group to the price discovery process. Ten different variants of the programming model were specified. In some models, the optimal market presence of any group holds for the entire life of a futures contract. The solutions to these models will indicate the average contribution of each trader group to price discovery over the entire contract. In other models, the market presence is allowed to vary in 10 different subperiods over the life of the contract. Solutions to these models will allow identification of the relative contribution of each trader group to price discovery in each subperiod and indicate how group influence on price discovery changes as contract maturity approaches.

Chapter 5

RESULTS

5.1 Introduction

This chapter begins with a discussion of the statistical characteristics of the price pressure measures calculated from the historical trader position data. Section 5.3 presents the results of the analysis to estimate the partial derivatives upon which the intergroup responses depend. Empirical results of the programming model optimizations are presented in Section 5.4. MSEs from the programming model simulations are presented in Section 5.5. Section 5.6 compares the results from models that include intergroup responses to those that omit them in order to gauge the impact and importance of incorporating interrelationships between trader groups in the simulation models. Finally, Section 5.7 gives a brief summary of the large set of results presented in this chapter.

5.2 Price Pressure Descriptive Statistics

The price pressure measures, once calculated from the raw CFTC data, become the basic data unit for the remainder of the analysis. By construction, the price pressure measures are consistent with the conceptual model presented in Section 3.2 in that, taken together, they define and determine the daily change in the live cattle futures price. Because these measures play a major role in the remainder of the analysis, it is important to closely examine the characteristics of the price pressure series.

Table 5.1 gives the descriptive statistics for the six historical price pressure series. All 4,800 observations (24 futures contracts x 200 observations per contract) are included in these calculations. The small trader group possesses the largest positive mean price pressure and the large commercial group has the most negative mean. All of the mean values fall very close to zero, indicating that all of the groups, with the exception of the small traders, seem to exhibit equal amounts of positive and negative pressure over time. The small trader group appears to be more prone to positive pressure.

The small trader group also exhibits the most variation in price pressure as indicated by the standard deviation. The medium noncommercial group's price pressure varies the least with the standard deviation being only about one third of the value associated with the small trader group. In general, the variances of the two medium groups are much smaller than the variance of the remaining four trader groups. These patterns are borne out by the maximum and minimum values presented in the table. The

Table 5.1. Descriptive Statistics for the Price Pressure Measures by Trader Group for All 24 Futures Contracts.

Trader Group	Mean	Std. Dev.	Min.	Max.	Skewness	Kurtosis	N
LC	-0.008	0.295	-2.220	1.906	-0.559	12.167	4800
MC	0.001	0.170	-1.940	1.935	-0.654	27.182	4800
LN	-0.003	0.319	-2.250	2.250	-0.171	13.094	4800
MN	0.000	0.120	-1.364	1.296	-0.356	29.882	4800
OTH	-0.001	0.275	-2.250	2.220	-0.302	18.315	4800
ST	0.018	0.385	-2.243	2.250	0.091	10.448	4800

largest possible price pressure value is 2.25 while the smallest is -2.25. These values occur on days where only two groups exhibit nonzero ΔNP and a limit move also occurs. On these days, if the price change is positive (negative) the mover group exerts an initial pressure of .75 (-.75) and a supplemental pressure of 1.50 (-1.50). The large noncommercial group attains both the maximum and minimum values of price pressure. The small trader group attains only the maximum value while the funds/other group attains only the minimum. Ranges in price pressure for the two medium trader groups are much smaller than the ranges for the remaining four groups.

The skewness and kurtosis coefficients calculated from the sample data are also reported in Table 5.1. These are important in detecting departures from normality in the distribution of the price pressure data. Variables whose distribution is normal are characterized by skewness equal to zero and kurtosis equal to three. All trader groups other than the small trader group show price pressure distributions slightly skewed in the negative direction. All of the sample kurtosis coefficients are very large compared to what would be expected from normally-distributed data. Using the Bera-Jarque test, which jointly tests for skewness different from zero and/or kurtosis different from three, the null hypothesis of normality was rejected at the 0.01 level for all of the price pressure samples.

To check for the possibility of contemporaneous linear dependencies among the price pressures of different trader groups, the correlation matrix of these six variables was calculated and is presented in Table 5.2. As was suggested in chapter 4, the correlation coefficients appear small in magnitude. But because of the large degrees of freedom (4,798), a number of these are statistically different from zero.[21] Small trader price pressure is negatively correlated with the price pressure of all five other trader groups. This is not unexpected since the small trader group is the group that takes positions that balance all of the large trader positions. There appears to be no linear relationship between the price pressure of the two large trader groups, but there is a significant positive linear relationship between the pressure series of the two medium groups. This correlation matrix provides evidence that price pressure measures for many pairs of trader groups are indeed related.

Another important descriptive statistic is one that measures the average overall pressure of each trader group. The mean of the price pressures does not adequately capture this characteristic because the negative and positive values tend to cancel one another. A better statistic which accounts for, and gives equal weight to, both positive and negative price pressure, is the mean of the absolute value of price pressure. These statistics were calculated for each contract month and are presented in Table 5.3. The overall market presence of each group (as measured by the amount of price pressure exerted) is conveyed by these data. The table indicates that market presence and influence varies from contract to contract for all trader groups but the relative size of the

[21]These statistical tests assume the pairs of variables are distributed bivariate normal. Later in this chapter it is shown that these joint distributions are symmetric but leptokurtic. This departure from normality is expected to cause the selected size of the test ($\alpha = .05$) to slightly overstate the true size of the test.

Table 5.2. Correlation Matrix for the Price Pressure Measures of the Six Trader Groups Over All 24 Futures Contracts.[a]

	MC	LN	MN	OTH	ST
LC	-0.014	-0.026	0.002	-0.054*	-0.268*
MC		0.061*	0.178*	0.005	-0.089*
LN			0.098*	0.008	-0.212*
MN				0.048*	-0.033*
OTH					-0.182*

[a] asterisks indicate correlation coefficients significantly different from zero, α=.05.

statistic between groups changes very little. During the period studied, the small trader group had the largest overall market presence. Following the small traders, the large commercial and large noncommercial groups exhibited similar market presence. Next comes the funds/other group followed by the medium commercial group. The medium noncommercial group had the smallest degree of influence on price.

Average market presence, measured here by the mean absolute value of price pressure, is influenced by three factors: 1) the number of open positions the group is responsible for, 2) the degree of agreement between individual traders within a group with respect to changes in position direction, and 3) the frequency with which a trader group is a mover group. *Ceteris paribus*, groups with a greater number of open positions will have a larger average market presence. If a group's members trade in such a way that the number of contract purchases during a trading session are nearly equal to the number of

Table 5.3. Means of the Absolute Value of Price Pressure by Trader Group for Each Futures Contract.

	---------- Trader Group ----------					
Contract	LC	MC	LN	MN	OTH	ST
Dec 83	0.138	0.054	0.161	0.041	0.091	0.246
Feb 84	0.198	0.068	0.182	0.034	0.101	0.214
Apr 84	0.171	0.082	0.150	0.073	0.087	0.215
Jun 84	0.129	0.076	0.138	0.043	0.104	0.191
Aug 84	0.095	0.047	0.111	0.056	0.085	0.175
Oct 84	0.125	0.032	0.122	0.026	0.103	0.162
Dec 84	0.106	0.046	0.117	0.025	0.093	0.166
Feb 85	0.122	0.039	0.166	0.016	0.070	0.141
Apr 85	0.118	0.048	0.158	0.032	0.083	0.182
Jun 85	0.141	0.064	0.141	0.038	0.139	0.194
Aug 85	0.172	0.089	0.134	0.050	0.113	0.236
Oct 85	0.169	0.113	0.155	0.040	0.135	0.223
Dec 85	0.207	0.093	0.198	0.049	0.148	0.265
Feb 86	0.236	0.089	0.230	0.043	0.165	0.302
Apr 86	0.258	0.087	0.247	0.073	0.126	0.342
Jun 86	0.235	0.118	0.223	0.025	0.183	0.330
Aug 86	0.213	0.101	0.259	0.039	0.210	0.328
Oct 86	0.180	0.076	0.259	0.039	0.194	0.349
Dec 86	0.210	0.086	0.206	0.048	0.158	0.283
Feb 87	0.142	0.044	0.205	0.033	0.159	0.254
Apr 87	0.151	0.068	0.183	0.047	0.132	0.209
Jun 87	0.140	0.061	0.169	0.045	0.146	0.202
Aug 87	0.128	0.042	0.146	0.049	0.136	0.215
Oct 87	0.156	0.076	0.169	0.078	0.139	0.191
Overall Average:	0.164	0.071	0.176	0.043	0.129	0.234

contract sales (i.e., there is little agreement on direction of price movement), then the group's net position changes little regardless of the absolute number of open contracts it holds. Small changes in net position translate into little price pressure and if the group consistently behaves in this manner, its average market presence will be small. The third factor that affects average market presence deals with the conviction with which group members transmit their price expectations to the markets via trading activities. If two groups have equal changes in net position during any trading session, but one group is a mover group while the other is not, then the mover group must have had more "desire" per contract change in net position to complete trades. This desire could manifest itself in the form of aggressive order placement during the trading session in terms of the level of price specified in sell or buy orders.

It is hard to determine precisely the relative importance of these three factors in explaining the differences in average market presence listed in Table 5.3. One clue is given by the fact that the large commercial and large noncommercial groups are responsible for more total open positions than the medium commercial and medium noncommercial groups and the average market presence of the large groups is greater than that of the medium groups. This suggests that the first factor, number of open positions, dominates the second and third for these trader group definitions and data.

Price response to changes in the trader group mix is dependent upon trader group market presence. Prices will be influenced more by a one percent change in the price pressure of a group with a large market presence than the same percentage change in the price pressure of a group with lesser market presence. Therefore, it will be important to remember the differences in market presence indicated by Table 5.3 when interpreting the results of the simulation models.

Further information on the statistical characteristics of the price pressure measures can be gained from examining their estimated density functions. Figure 5.1 plots the estimated bivariate density between the large commercial price pressure and the large noncommercial price pressure over all 24 futures contracts. For comparison purposes, a standard normal distribution is plotted in Figure 5.2 with z-axis scaling identical to that of Figure 5.1. The non-normality of the price pressure data is readily apparent. The LC, LN joint distribution estimate appears relatively symmetric but excessively peaked, confirming the large sample kurtosis coefficients reported in Table 5.1. Figure 5.3 is the bivariate density between LC and LN estimated from data relating to a single futures contract only (December, 1984). Leptokurtosis is also apparent in this estimated density but is less severe than in Figure 5.1. When compared with a similarly scaled bivariate standard normal distribution possessing identical covariance (Figure 5.4), the non-normality of the density in Figure 5.3 is clear. Because most of the usual statistical tests and tests of parameter significance in econometric models assume normally distributed data, the non-normality of the price pressure data will affect the interpretation of these tests.

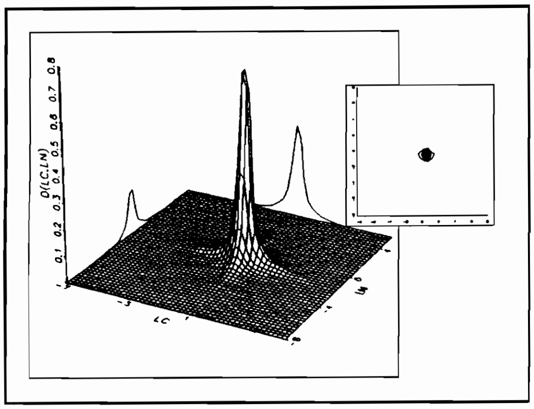

Figure 5.1. Estimated Bivariate Density Function Between LC and LN Price Pressure Over All 24 Futures Contracts.

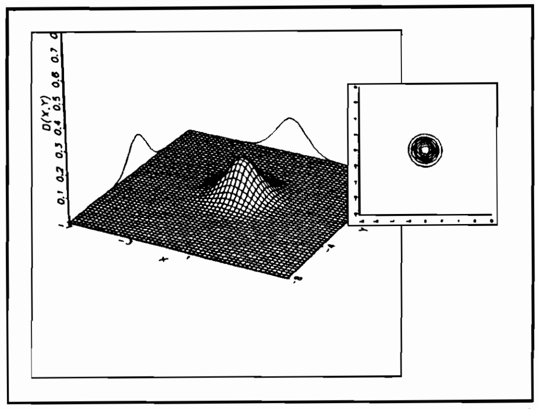

Figure 5.2. Reference Bivariate Normal Corresponding to the Estimated Density Function Plotted in Figure 5.1.

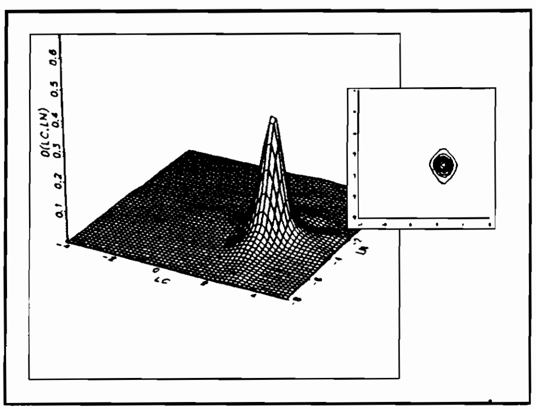

Figure 5.3. Estimated Bivariate Density Function Between LC and LN Price Pressure for the December 1984 Live Cattle Contract.

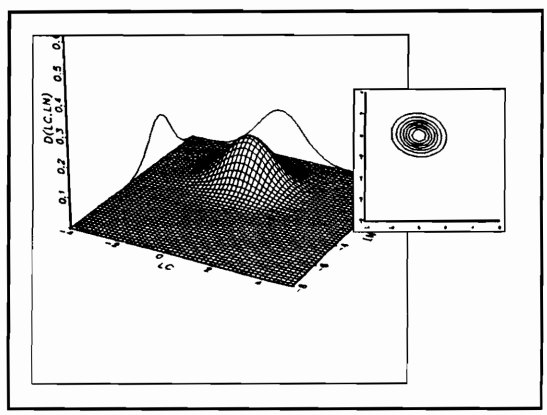

Figure 5.4. Reference Bivariate Normal Distribution Corresponding to the Estimated Density Function in Figure 5.3.

5.3 Estimation of Intergroup Responses

From a modeling perspective, an obvious way of estimating the partial derivatives in the B matrix (first presented in equation 4.5) is to specify a model where each trader group's price pressure measure is a function of all the remaining group's price pressure. A set of simple regression models could be specified as:

$$TP_i = \alpha_i + \sum_j \beta_j TP_j + \varepsilon_i \qquad \textbf{(5.1)}$$

where j is all trader groups other than i and ϵ_i is a random disturbance. In this model, $\beta_j = \partial TP_i / \partial TP_j$ and thus the estimated parameter, $\hat{\beta}_j$, is taken as an estimate of the partial derivative of interest.

Estimation of the model in (5.1) by ordinary least squares (OLS) assumes that the TP_j are exogenous and fixed. From the way the price pressure measures are calculated, it is obvious that all of the price pressures are determined simultaneously within a time period. This fact would seem to indicate that the proper estimator for any econometric model that specifies one price pressure as a function of all the others would be a simultaneous system estimator such as three stage least squares (TSLS). However, single equation methods provide estimates that can be compared with the TSLS results for model validation.

Table 5.4 presents the results of OLS estimation of the model in (5.1) equation by equation using the data from all 24 futures contracts. The price pressure multipliers (column sums of the B^{-1} matrix discussed in Chapter 4) corresponding to these parameter estimates were calculated and are given at the bottom of this table. The standard errors of the parameter estimates are also listed in this table, although the statistical significance of these estimates cannot be formally tested due to the non-normality of the price pressure data. These parameter estimates are very similar to the correlation coefficients (Table 5.2) in sign and in relative magnitude. The price pressure multipliers range from 0.525 for the small trader group to 1.590 for the medium noncommercial group. These are in line with *a priori* expectations of the intergroup responses discussed in Section 4.6.

To estimate (5.1) with the simultaneous system estimator, it is necessary to include exogenous variables in the specification to allow for identification of the equations and for use as instruments in the second stage of the estimation. There are no obvious choices

Table 5.4. Parameter Estimates, Standard Errors and Price Pressure Multipliers from OLS Estimations Using Data From All 24 Contracts.[a]

	---------- Trader Group ---------- (Independent Variable)					
Dependent Variable:	LC	MC	LN	MN	OTH	ST
LC		-0.07	-0.08	0.03	-0.12	-0.24
		(0.02)	(0.01)	(0.03)	(0.02)	(0.01)
MC	-0.02		0.01	0.25	-0.01	-0.04
	(0.01)		(0.01)	(0.02)	(0.01)	(0.01)
LN	-0.10	0.04		0.23	-0.05	-0.20
	(0.02)	(0.03)		(0.04)	(0.02)	(0.01)
MN	0.01	0.12	0.03		0.02	0.00
	(0.01)	(0.01)	(0.01)		(0.01)	(0.00)
OTH	-0.11	-0.04	-0.04	0.11		-0.16
	(0.01)	(0.02)	(0.01)	(0.03)		(0.01)
ST	-0.37	-0.18	-0.26	0.04	-0.27	
	(0.02)	(0.03)	(0.02)	(0.04)	(0.02)	
Multiplier:	0.622	1.065	0.851	1.590	0.758	0.525

[a]Standard Errors in ().

for these exogenous variables. Economic theory provides no guide as to what additional variables should be used in this model. It was determined that lagged values of the endogenous variables (which are considered pre-determined) would be the most appropriate instruments to use.[22] Thus the structural model corresponding to (5.1) for the TSLS estimator is:

$$TP_{it} = \alpha_i + \sum_{\substack{j=1 \\ j \neq i}}^{6} \beta_j TP_{jt} + \sum_{p=1}^{6} \delta_p TP_{i,t-p} + \varepsilon_{it} \tag{5.2}$$

Here, i goes from 1 to 6 and represents each of the trader groups; thus, there are six equations in the system. All groups not equal to i are in the set j. Each group's price pressure is specified as a function of all the remaining groups' price pressure and six lags of its own price pressure. The TSLS results are presented in Table 5.5 (autoregressive parameters are omitted). These estimates are larger in magnitude than the OLS estimates and the signs are inconsistent in many cases with the OLS estimates. The exceedingly large values of these parameter estimates resulted in wildly varying multipliers that are much different from the values calculated for the other estimator. The multipliers for this model range from -0.983 for the large commercial group to 12.394 for the medium commercial group. These statistics lie outside of the range that could be considered reasonable given prior expectations of small to moderate intergroup responses.

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[22]Although some might object to this approach of adding variables primarily for identification purposes, there were few acceptable alternatives. As it turned out, the TSLS estimates were unreasonable and thus not used.

Table 5.5. Parameter Estimates, Standard Errors and Price Pressure Multipliers from TSLS Estimations Using Data From All 24 Contracts.[a]

	---------- Trader Group ---------- (Independent Variable)					
Dependent Variable:	LC	MC	LN	MN	OTH	ST
LC		0.46	-0.71	1.81	-0.33	-0.28
		(0.29)	(0.16)	(0.43)	(0.14)	(0.11)
MC	0.23		0.51	-0.89	0.32	0.25
	(0.08)		(0.08)	(0.23)	(0.07)	(0.06)
LN	-0.44	1.17		1.36	-0.19	-0.03
	(0.14)	(0.24)		(0.40)	(0.14)	(0.12)
MN	0.14	-0.30	0.26		0.22	0.16
	(0.05)	(0.11)	(0.06)		(0.05)	(0.04)
OTH	-0.09	0.89	-0.27	0.82		-0.57
	(0.12)	(0.26)	(0.16)	(0.36)		(0.07)
ST	-0.44	0.71	-0.24	1.34	-0.91	
	(0.17)	(0.34)	(0.21)	(0.47)	(0.13)	
Multiplier:	-0.983	12.394	8.275	6.303	0.910	4.584

[a]Standard Errors in ().

The poor performance of the TSLS estimator in producing reasonable intergroup response parameter estimates may be due to the exogenous variables chosen as instruments or it may be because there is very little simultaneity among the price pressure measures. Regardless of the cause, the TSLS estimates are clearly unacceptable for use in a simulation model designed to reproduce reality.

For these reasons, it was decided that the most accurate parameter estimates were those arising from the OLS application. The only real drawback to using OLS in this situation is that it ignores the obvious simultaneity in the system specification. The inability to get realistic parameter estimates from the simultaneous system estimator forced the use of a non-simultaneous estimator.

Having decided on the estimator and specification to use in arriving at the partial derivatives in (4.5), the next consideration was sample size. Should the intergroup response effects be estimated over the entire data set, with the same response parameter estimates used for every futures contract, or should the response parameters be estimated separately for each contract? Examination of the data suggested that the parameter estimates for (5.1) differed from contract to contract. This finding suggested that the basic model assumption of parameter instability was invalid for the regression involving the entire data set. Given that the parameter estimates, and more importantly, the multipliers calculated from them, differ between contracts, it makes sense that the simulation would be a more accurate reflection of reality if different parameters were allowed for each futures contract.

The equations represented by (5.1) were estimated and the price pressure multipliers were calculated for each group of 200 observations representing the data for a specific futures contract (Table 5.6). These multipliers exhibit a fairly high degree of variability from contract to contract. The multipliers associated with the MC and MN group are the most variable and these are the only trader groups with an average multiplier greater than one. Positive autocorrelation appears to be present in all of the multiplier series suggesting that intergroup responses are similar for contracts that trade

Table 5.6. Price Pressure Multipliers by Contract Month Calculated from the OLS Parameter Estimates.

	---------- Trader Group ----------					
Contract	LC	MC	LN	MN	OTH	ST
December 1983	0.342	1.239	0.781	1.556	0.746	0.760
February 1984	0.751	1.465	0.906	1.919	0.590	0.443
April 1984	0.653	1.376	0.983	1.641	0.443	0.527
June 1984	0.551	1.202	0.791	1.205	0.601	0.632
August 1984	0.433	0.945	0.607	1.119	0.824	0.754
October 1984	0.808	0.987	0.806	2.457	0.945	0.295
December 1984	0.304	1.510	1.069	2.262	0.678	0.530
February 1985	0.531	0.550	1.008	1.257	1.114	0.337
April 1985	0.636	0.965	1.065	2.167	0.870	0.378
June 1985	-0.012	1.708	1.002	1.624	0.892	0.654
August 1985	0.517	1.178	0.912	2.100	0.883	0.603
October 1985	0.614	1.223	1.211	1.593	0.832	0.525
December 1985	0.386	1.375	0.965	2.564	0.833	0.662
February 1986	0.894	1.251	0.915	1.875	0.759	0.344
April 1986	0.795	1.411	0.974	1.399	0.661	0.435
June 1986	0.734	0.580	0.864	0.515	0.726	0.515
August 1986	0.815	0.737	0.629	1.144	0.817	0.584
October 1986	0.457	0.872	0.751	1.564	0.761	0.626
December 1986	0.831	0.813	0.793	1.467	0.774	0.623
February 1987	0.475	0.729	0.640	1.896	0.833	0.624
April 1987	0.725	0.937	0.910	1.947	0.798	0.379
June 1987	0.811	0.862	1.076	1.666	0.673	0.350
August 1987	0.510	0.432	0.945	1.658	0.831	0.627
October 1987	0.507	2.235	1.031	2.373	0.985	0.127
Average:	0.586	1.108	0.901	1.707	0.786	0.514
Std. Dev.	0.212	0.409	0.153	0.482	0.140	0.157
Minimum:	-0.012	0.432	0.607	0.515	0.443	0.127
Maximum:	0.894	2.235	1.211	2.564	1.114	0.760

simultaneously.[23] The largest multiplier is associated with the MN group in the December1985 contract (2.564) while the smallest is the only negative multiplier (-0.012) and belongs to the LC group in the June 1985 contract.

5.4 Programming Model Results

The General Algebraic Modeling System (GAMS) was used to code all of the models used in this study. Each of the 10 models was solved using the price pressure data from each of the 24 contracts resulting in a total of 240 model solutions. Only the solution results with direct implications to the price discovery aspects of this study are presented. For most models, the results are averaged over all contracts to allow the large picture to emerge. In some situations, where the volume of price discovery-related results is large, the results are listed in an appendix table or displayed graphically in appendix figures.

5.4.1 Model 1 Results

The six decision variables in Model 1 are the variables used to alter market presence, $PPCT_g$. All other model variable values depend on the value taken by these six variables. However, the values of the six decision variables were fixed at unity by the constraints represented by (4.14). This means that the simulated prices defined by (4.10)

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[23]Normally, six or seven live cattle contracts are traded in any given trading session.

will be exactly equal to the historical prices as defined by the sum of the price pressure parameters, PP_{tg}.

The algorithm used in the optimization iterates only a few times until it arrives at the only feasible solution for this problem (all $PPCT_g = 1$). It should be noted that due to rounding in the price pressure measures, the limit move constraints and the ending price constraints had to be relaxed very slightly to render the model feasible. These adjustments were small. In the case of the limit move constraints, the RHS was set to ±1.501 and in the case of the ending price constraint, the equality was replaced by ≤ or ≥, whichever was consistent with the direction of the rounding errors for the price pressures calculated for a particular futures contract. Neither of these model alterations caused the simulated prices generated by the model to differ from those historically observed.

This model was solved for all 24 futures contracts individually. The most interesting results of this model are the shadow prices generated by the six constraints represented by Equation 4.14 [$PPCT_g = 1$]. These shadow prices represent the change in the objective function that results from a one unit increase in the RHS of these constraints. Basically, these shadow prices represent the impact on MSE of doubling the presence of the trader group corresponding to the constraint. Because all of the constraints are linear, the solution is invariant to linear transformations of the constraints. Therefore, to find the impact on MSE of a one percent increase in the market presence of any trader group, the appropriate shadow price can be divided by 100. It is the relative, rather than absolute, size of these shadow prices that is important.

Table 5.7 lists the shadow prices by trader group for each futures contract included in the study. Within a particular futures contract, the largest negative shadow price identifies the trader group doing the most to keep prices near the final settlement price and the trader group associated with the largest positive shadow price is doing the most to cause prices to differ from the final settlement price. In those contract months where there are no negative shadow prices, marginally increasing the presence of *any* trader group would increase MSE. In these situations, the smallest positive shadow price indicates the group that would do the least harm to the objective function for an equivalent marginal percentage increase in market presence.

Table 5.7 reveals that the property of being most beneficial to price discovery (largest negative shadow price or smallest positive shadow price) belonged to the large noncommercial group in seven contracts (29%), the small trader group in seven contracts (29%), the large commercials in six contract months (25%), funds/other traders in two contracts (8%), and the medium commercial and medium noncommercial groups in one contract each (4%). These shadow prices are important because they signal the marginal contribution of each trader group to minimizing MSE *as measured at the historically observed prices and levels of market participation.* Thus, these results provide an ex-post measure of the relative value of these groups to the price discovery process in the live cattle futures market.

Table 5.7. Shadow Prices for Each Trader Group for Each Contract from Model 1 With Intergroup Response Effects Included.

	---------- Trader Group ----------					
Contract	LC	MC	LN	MN	OTHER	ST
December 1983	6.62	5.67	19.07	19.66	3.78	-13.21
February 1984	34.11	-10.09	51.96	-1.78	-6.20	-21.00
April 1984	23.83	-8.51	9.19	-3.96	-0.45	-18.31
June 1984	0.58	1.84	1.69	-0.12	-0.34	0.89
August 1984	-0.69	0.92	-0.87	-0.15	-1.50	6.17
October 1984	-4.29	-0.15	-2.58	1.79	-0.50	2.77
December 1984	1.07	2.29	8.00	-3.92	2.33	-6.86
February 1985	-4.20	0.68	5.51	0.82	0.45	1.20
April 1985	4.79	0.49	-36.54	5.13	5.31	10.61
June 1985	0.39	-4.44	20.36	-6.84	0.79	0.55
August 1985	-18.42	-9.40	17.87	-2.46	-3.55	22.15
October 1985	4.92	5.41	5.95	0.65	7.09	1.04
December 1985	1.44	5.97	2.63	4.84	10.89	2.52
February 1986	-22.27	-2.51	0.47	5.01	4.93	3.87
April 1986	-5.35	9.03	-11.98	0.96	4.39	-2.54
June 1986	-8.73	-2.40	1.75	-0.31	-2.12	19.39
August 1986	26.67	-6.31	-8.43	-2.71	43.36	-13.61
October 1986	-3.80	-8.07	-24.54	-4.21	44.43	18.97
December 1986	25.18	-2.63	-4.78	1.98	3.74	-3.74
February 1987	17.64	-7.01	3.39	12.60	42.88	-74.34
April 1987	26.89	17.04	-64.63	8.05	14.55	-15.48
June 1987	54.39	-10.43	48.99	-1.64	10.31	-37.97
August 1987	17.66	-1.68	-22.89	-4.16	-9.24	-8.55
October 1987	9.57	-16.18	-34.77	-33.19	22.04	-5.99

Had all of the futures contracts been included in one "supermodel" where the objective function was specified as the sum of all the MSEs of the individual contracts, then the shadow price for each trader group in the large model would simply equal the sum of the shadow prices from minimizing MSE in each contract individually. Dividing the "supermodel" shadow prices by the number of contracts would give the average shadow price over all contracts and have no effect on the relative size of the shadow prices. Therefore, it is appropriate to use the shadow prices averaged across contracts as an indicator of the marginal value of each trader group over the entire four year study period.

In accordance with the mean shadow prices given in Table 5.8, the six trader groups can be ranked according to their marginal value in improving price discovery in live cattle futures from 1983 to 1987. A ranking in order of most beneficial to most detrimental would give:

1. Small Traders
2. Medium Commercial
3. Large Noncommercial
4. Medium Noncommercial
5. Large Commercial
6. Funds/Other Traders.

It is important to know whether the values listed in Table 5.8 are significantly different from one another. Viewing these results as sample means from a population with an unknown distribution, the Central Limit Theorem can be invoked in testing for significant differences in the sample means. This theorem guarantees that the asymptotic

Table 5.8. Average Shadow Prices Across All 24 Futures Contracts for Model 1 With Intergroup Response Effects Included.

	---------- Trader Group ----------					
	LC	MC	LN	MN	OTH	ST
Avg. Shadow Value	7.833	-1.687	-0.632	-0.165	8.225	-5.478
Sig. Test[a]	3	2	1	2	4	2

[a]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the row.

distribution of the differences in sample means is normal regardless of the population distribution as long as the population distribution has a finite mean and variance and the samples are independent (Judge, *et. al.*). Based on the samples in hand, the shadow prices indeed possess a finite mean and variance and there is no reason to suspect the independence assumption is invalid. Two different tests of means are used (Stevenson). If the sample variances are not significantly different (usual F-test, α=.05) then the test statistic is:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{N(S_1 + S_2)^2}{2(N-1)}} \cdot \sqrt{\frac{1}{2N}}} \tag{5.3}$$

where:

$\bar{x}$ = sample mean,
S^2 = sample variance,
S= sample standard deviation,
N = number of observations.

If the test reveals unequal variances, then the appropriate test statistic is:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{N(S_1 + S_2)^2}{2(N-1)}} \cdot \sqrt{\frac{1}{2N}}} \tag{5.4}$$

In the first case, Z is distributed standard normal and in the second case, t is distributed Student's t with N-1 degrees of freedom (N = 24).

The sample means are evaluated in pairwise comparisons. Because of the large number of comparisons, the results of the significance tests are presented in a compact manner in the bottom line of Table 5.8. This row gives the number of times the null hypothesis (equality of means) was rejected using the above test (α = .05) to compare the mean in the line directly above with the five remaining means. A value of five in this row would mean that the particular mean was found to be significantly different from all other means. Any value less than five indicates the null hypothesis was not rejected in some of the comparisons. Although it is not explicit, it should not be difficult to determine which pairs rejected the null. For instance, the small trader mean was significantly different from two other means on the row. A rational inference would be that those two means were the two furthest from the small trader mean, namely the large commercial mean and the funds/other trader mean. This method of reporting the results of statistical tests for differences was devised to reduce the volume of test results (not as important with this model as it is with the subperiod models where the number of tests is much greater) yet still providing a method for adequately judging the results of individual comparisons.

The significant difference tests only have meaning when the 24 values in each column of Table 5.7 are viewed as samples from a larger population, such as all live cattle futures contracts. Then, inferences of significant differences in marginal contribution to the price discovery process hold only for those pairs of means where the null hypothesis was rejected. When the population is defined as all live cattle futures contracts with maturities between December 1983 and October 1987, *then the result is exact* and the ranking given above holds without question. It is interesting to consider using the study period as a representative sample of all live cattle futures contracts ever traded, but it is likely to be a poor approximation. Both 1985 and 1986 showed price volatility, for arguably different reasons, that exceeded the normal. In 1985, cattle were held in feedlots to excessive weights and the price decline reached $10.00/cwt. In 1986, the "dairy herd buyout" program of the USDA had a major, one-time influence on the beef market.

Some general observations can be made from examining the data in Table 5.7. First, the magnitude of the shadow prices for the two medium groups is generally much smaller than those of the remaining four groups. The two medium groups apparently have relatively less market presence when compared with the four other groups (Table 5.3). This restricts the two medium group's potential for having either a large positive or a large negative influence on MSE. Another characteristic of the results in Table 5.7 is that there are very few near-zero shadow prices. Near-zero shadow prices indicate that the corresponding trader group had a near-optimal market presence, historically. Thus, gains in price discovery appear to be possible from changes in the market presence of all of the trader groups.

As an example of trends in contribution to price discovery, it can be seen that beginning with the December 1986 contract through the October 1987 contract, the large commercial group consistently behaved in a manner which tended to move price away from its true value. By comparison, during the same period, the small trader group worked to reduce price dispersion around its final value.

5.4.2 Model 2 Results

Model 2 was identical to Model 1 except that the inclusion of subperiods raised the number of decision variables (PCT_{pg}) to 60—one for each trader group in each of 10 subperiods. All of these decision variables were constrained to unity by the constraints represented initially by Equation 4.31 [$PCT_{pg} = 1$]. Again, the algorithm iterated only a small number of times until it arrived at the only feasible solution for this problem (all $PCT_{pg} = 1$ and all of the $PRICE_t$ variables equal to the historical prices).

The purpose of specifying the subperiod model was to gain an understanding of how time to maturity affected trader group contribution to the price discovery process. Each subperiod consists of 20 trading sessions and corresponds to approximately one month in chronological time. A full listing of all the shadow prices for all of the decision variables in each futures contract is given in Appendix Table A.1. Since the optimal solutions to Model 1 and Model 2 were identical, summing Model 2 shadow prices over the subperiods gives a value identical to the corresponding shadow value in Model 1. Essentially, the Model 2 results are the Model 1 results, but with more detail.

The large number of shadow prices generated by Model 2 (1,440) suggests the use of summary statistics to facilitate interpretation of the results. Table 5.9 lists the mean shadow prices for each trader group by subperiod. A period-by-period listing of the most helpful and most harmful trader groups with respect to price discovery is as follows, where 1 = the first 20 day period and 10 = the 20 day period ending in contract maturity:

Subperiod	Most Helpful	Most Harmful
1	LN	LC
2	ST	OTH
3	ST	LN
4	ST	OTH
5	ST	LC
6	ST	OTH
7	ST	LC
8	LN	ST
9	LN	OTH
10	LC	LN

The small trader group appears to behave in a manner that tends to reduce MSE of the price series up until three calendar months prior to maturity. Large noncommercial interests do the most to restrict price dispersion from that point up until the last twenty trading days. In the last 20 trading sessions, it is the large commercial interests that do the most to bring price toward its true value. This result would be expected. It is the

Table 5.9. Average Shadow Prices Across All 24 Futures Contracts for Model 2 With Intergroup Response Effects Included.

	---------- Trader Group ----------					
Subperiod	LC	MC	LN	MN	OTH	ST
1	3.158	-1.617	-3.495	-0.034	1.000	1.294
2	2.054	-1.062	0.335	-0.406	2.894	-1.756
3	-0.633	0.826	1.849	-0.141	0.700	-1.939
4	0.473	0.521	0.717	0.124	1.216	-0.237
5	1.526	-0.418	0.490	0.266	0.862	-1.142
6	0.397	0.527	-0.402	0.568	2.395	-0.795
7	1.104	-0.152	0.257	-0.242	-0.739	-1.067
8	-0.163	-0.274	-0.382	-0.309	-0.264	0.212
9	-0.009	-0.021	-0.064	-0.034	0.158	-0.037
10	-0.074	-0.017	0.063	0.043	0.003	-0.011
Subperiod			Row-wise Significance Tests[a]			
1	2	4	0	3	2	1
2	1	2	0	1	3	1
3	1	1	3	1	0	2
4	0	0	0	0	0	0
5	2	1	0	0	0	1
6	0	1	1	1	2	3
7	4	1	1	1	1	2
8	1	1	0	1	0	3
9	0	0	0	0	0	0
10	2	1	1	2	0	0
Subperiod			Column-wise Significance Tests[b]			
1	3	7	0	0	4	2
2	4	5	0	0	4	0
3	2	5	4	0	0	4
4	0	2	0	0	3	0
5	4	1	0	0	0	0
6	0	2	1	2	4	2
7	3	1	0	2	6	4
8	4	2	1	4	4	3
9	4	2	1	2	4	2
10	4	3	1	4	5	3

[a]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same row.
[b]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same column.

actions of hedgers who can deliver cattle under the futures contract that move the futures toward the cash market in the last trading days. Since the cash market usually does not vary a great deal in a 20-day period with supplies largely non-responsive to price, moving the futures toward a relatively stable cash market should tend to reduce the MSE of the futures price.

The four larger trader groups (LC, LN, OTH, ST) all take turns at being the group most harmful to prices with the funds/other group having the largest number of observations in that category (4). In the last 20 daily trading sessions, it is the behavior of the large noncommercial traders that tends to be most harmful to discovery of the true value of the commodity. These traders are closing out speculative positions during the delivery period of the futures. The absence of either medium trader group from this list is due to their smaller overall market presence.

One apparent pattern in Table 5.9 is that the magnitude of the shadow prices seems to be reduced for all groups as maturity approaches. This is consistent with the observation that as maturity approaches, prices tend to fluctuate nearer the final value. Because there is less overall deviation from the final value in the last few subperiods, there is less opportunity for any group to influence price dispersion as compared with earlier subperiods.

The lower section of Table 5.9 gives the results of pairwise tests for differences in the means listed in the top of the table. These tests are administered in the same manner as those for Model 1 and the results are reported in the same fashion. The row-wise significance tests indicate the number of rejections of the null hypothesis (equal means) between the corresponding mean in the upper portion of the table and the remaining five means on that row. Similarly, the column-wise significance tests indicate the number of rejections between the corresponding mean in the upper portion of the table and the remaining nine means in that column. The remarks made in Section 5.4.1 concerning the significance tests and viewing the results as a sample from a larger population are relevant here as well.

5.4.3 Model 3 Results

This model is a non-subperiod model identical to Model 1 except that the six decision variables ($PPCT_g$) are no longer constrained to unity. Instead, the decision variables, which represent the degree of market presence of each trader group, are constrained by the expressions in (4.38) and (4.39) to lie between 0.8 and 1.20. The solution to this model provides an optimal trader mix for each futures contract. This solution also provides values for the simulated price variables ($PRICE_t$) which differ from the historical prices and represent the price path that would be expected had the optimal trader mix been present in this market.

Table 5.10 lists the optimal values of the decision variables for each trader group in each contract month. If a group's trading behavior was working to increase MSE, then the model will reduce that group's market presence and its new market presence (as indicated by the value of the decision variable, $PPCT_g$) will be less than its historical

Table 5.10. Optimal Percentage Changes in Group Price Pressure and Shadow Prices by Contract for Model 3 With Intergroup Response Effects Included.[a]

	---------- Trader Group ----------					
Contract	LC	MC	LN	MN	OTH	ST
Dec. 83	0.80	0.80	0.80	0.80	0.80	0.86
	(4.51)	(6.14)	(11.89)	(12.94)	(4.48)	(0.00)
Feb. 84	0.80	0.80	0.80	1.17	0.91	0.87
	(20.49)	(4.87)	(24.81)	(0.00)	(0.00)	(0.00)
Apr. 84	0.80	1.04	0.80	0.98	1.20	0.96
	(16.16)	(0.00)	(8.56)	(0.00)	(-0.41)	(0.00)
Jun. 84	0.93	0.80	0.96	1.20	1.09	0.80
	(0.00)	(0.35)	(0.00)	(-0.07)	(0.00)	(1.41)
Aug. 84	1.20	0.80	0.80	0.91	0.80	0.82
	(-0.00)	(0.22)	(0.45)	(0.00)	(1.03)	(0.00)
Oct. 84	1.20	1.20	0.80	0.80	1.06	0.80
	(0.00)	(-0.22)	(0.78)	(0.99)	(0.00)	(0.47)
Dec. 84	0.80	1.05	0.80	0.80	0.86	1.20
	(1.71)	(0.00)	(2.71)	(5.34)	(0.00)	(-0.21)
Feb. 85	1.13	0.80	0.80	0.80	0.80	1.14
	(0.00)	(0.17)	(0.61)	(0.01)	(0.18)	(0.00)
Apr. 85	0.80	0.96	1.08	0.80	0.80	0.80
	(4.08)	(0.00)	(0.00)	(3.18)	(2.60)	(6.21)
Jun. 85	0.80	1.10	0.80	1.20	0.93	0.83
	(0.35)	(0.00)	(21.09)	(-6.94)	(0.00)	(0.00)
Aug. 85	0.99	1.03	0.80	1.03	0.88	0.80
	(0.00)	(0.00)	(15.40)	(0.00)	(0.00)	(7.92)
Oct. 85	0.80	0.90	1.07	0.88	0.80	0.80
	(6.61)	(0.00)	(0.00)	(0.00)	(2.27)	(3.01)
Dec. 85	0.80	0.80	0.97	0.83	0.80	0.80
	(1.44)	(1.91)	(0.00)	(0.00)	(16.32)	(0.30)
Feb. 86	1.03	0.89	0.80	0.80	0.80	0.90
	(0.00)	(0.00)	(2.51)	(4.53)	(4.67)	(0.00)
Apr. 86	0.94	0.80	0.98	0.80	0.92	0.82
	(0.00)	(2.48)	(0.00)	(3.19)	(0.00)	(0.00)
Jun. 86	0.95	0.80	0.80	1.20	0.94	0.80
	(0.00)	(2.60)	(4.03)	(-0.19)	(0.00)	(6.73)

Table 5.10 continued	LC	MC	LN	MN	OTH	ST
Aug. 86	0.85 (0.00)	0.92 (0.00)	0.97 (0.00)	1.03 (0.00)	0.80 (23.80)	0.80 (10.90)
Oct. 86	0.94 (0.00)	0.82 (0.00)	0.99 (0.00)	0.80 (5.74)	0.80 (24.14)	0.80 (13.10)
Dec. 86	0.80 (15.68)	1.00 (0.00)	1.00 (0.00)	0.83 (0.00)	1.03 (0.00)	0.80 (2.55)
Feb. 87	0.80 (13.13)	0.80 (6.85)	0.95 (0.00)	1.13 (0.00)	0.80 (11.48)	0.97 (0.00)
Apr. 87	0.80 (29.82)	0.80 (18.88)	0.95 (0.00)	0.80 (3.73)	0.80 (5.14)	1.20 (-3.68)
Jun. 87	0.80 (32.37)	0.80 (5.15)	0.80 (35.75)	1.05 (0.00)	0.80 (7.33)	0.96 (0.00)
Aug. 87	0.80 (9.23)	1.20 (-1.39)	1.12 (0.00)	1.04 (0.00)	0.80 (0.50)	0.96 (0.00)
Oct. 87	0.80 (5.93)	0.80 (4.31)	1.03 (0.00)	1.08 (0.00)	0.80 (17.89)	1.20 (-1.66)

[a]Shadow prices in ().

value. On the other hand, the optimal solution will include market presence larger than the historical for those groups whose trading behavior worked to reduce MSE. Many of the optimal values reported in Table 5.10 are equal to either the upper nor lower bounds placed on them. In these situations, the binding constraints, either (4.38) or (4.39), yield shadow prices which have the same interpretation as those in the previous models. In those instances where the optimal value falls between 0.80 and 1.20, the shadow price of an increase in the RHS of one of these constraints is zero, since the constraint is not binding. Shadow prices corresponding to the binding constraint (or zero if neither the upper or lower bound is binding) are reported in parentheses below the optimal values of the decision variables in Table 5.10.

The mean optimal values and mean shadow prices for Model 3 are given in Table 5.11. All of the average optimal values are less than one indicating that, on average, reduction in the market presence of all groups improves the price discovery process. This says that price could have moved from its beginning value to its final value with less involvement by all of the groups along a price path characterized by smaller dispersion around the final price. The implication of this is that all of the groups, to some extent, are involved in creating unnecessary "blips" in the price path during the life of the futures contract.

A ranking of the trader groups from least to most harmful to price dispersion as indicated by the optimal values for Model 3 is:

1. MN
2. ST, MC
3. LN
4. LC
5. OTH.

Again, the relatively smaller historical market presence of the two medium trader groups is largely responsible for their lesser influence on price dispersion.

The mean shadow prices listed in Table 5.11 are all positive indicating that the lower bound on $PPCT_g$ was often binding. These shadow prices are less informative than those of Models 1 and 2 because they indicate the marginal value of an increase in market presence from the values these decision variables take in the optimal solution of Model 3. Since this trader mix is a postulated one and did not actually occur, the shadow prices

Table 5.11. Average Optimal Values and Average Shadow Prices Across All 24 Futures Contracts for Model 3 With Intergroup Response Effects Included.

	Trader Group					
	LC	MC	LN	MN	OTH	ST
Avg. Optimal Value	0.890	0.905	0.903	0.949	0.876	0.905
Sig. Test[a]	1	0	0	2	1	0
Avg. Shadow Price	6.730	2.180	5.358	1.352	5.060	1.960
Sig. Test[a]	3	3	3	3	3	3

[a]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the row.

do not provide information on the historical value of any group to price discovery. Instead, they indicate only the marginal value of a group should the optimal trader mix be imposed or present. Row-wise statistical tests, conducted in the same manner as for the previous models, are also listed in Table 5.11.

Simulated prices rendered by the optimal Model 3 solutions are compared with the historical prices for each live cattle futures contract (last 200 trading days) in Appendix A, Figures A.1 through A.24. In some contracts, the simulated prices differ notably from the historical prices indicating considerable gains in price discovery from simultaneously altering the market presence of all six trader groups. In other contracts, there is a smaller difference between the simulated and historical price series. Although there are exceptions, there is a general tendency for the optimal mix of traders to discover less extreme prices when the price path is one that shows mostly negative deviations from the final price.

5.4.4 Model 4 Results

Model 4 is the subperiod version of Model 3. This model has 60 choice variables, each of which is bounded by the same lower and upper limits as the decision variables in Model 3. Again, the purpose of reformulating the model to include subperiods is to allow analysis of changes in optimal market participation as the contract approaches maturity.

A full listing of the optimal values and shadow prices for Model 4 is given in Appendix Table A.2. Table 5.12 presents a summary of this information giving the average optimal values across all 24 futures contracts for each trader group along with the row-wise and column-wise tests for differences in these means. Likewise, Table 5.13 gives the average shadow prices from Model 4 for each trader group in each subperiod.

From Table 5.12 it can be seen that in every subperiod except subperiod nine, one or more of the trader groups has an average optimal value greater than one. These groups, on average, must have engaged in market behavior during that subperiod that did more to improve price discovery in the market than to harm it. Two patterns immediately observable in this table are the relatively large optimal values associated with the small trader group through the seventh subperiod and the relatively small optimal values belong-

Table 5.12. Average Optimal Values Across All 24 Futures Contracts for Model 4 With Intergroup Response Effects Included.

	---------- Trader Group ----------					
Subperiod	LC	MC	LN	MN	OTH	ST
1	0.985	1.033	0.961	0.967	0.900	0.977
2	0.917	1.060	1.024	0.891	0.933	0.997
3	1.018	0.959	0.891	0.933	0.973	1.023
4	0.976	1.039	0.970	0.967	0.941	1.023
5	0.950	1.016	0.974	0.953	0.996	1.008
6	1.030	0.925	0.946	0.950	0.955	1.003
7	0.975	1.006	0.984	0.947	0.931	1.034
8	1.000	0.990	0.885	0.930	0.880	0.984
9	0.913	0.900	0.958	0.946	0.926	0.955
10	0.942	0.997	0.956	1.001	1.000	0.958
Subperiod			Row-wise Significance Tests[a]			
1	1	2	0	2	4	1
2	3	3	3	3	2	2
3	2	0	3	2	1	2
4	0	1	0	0	2	1
5	0	0	0	0	0	0
6	3	2	1	1	0	1
7	0	0	0	1	1	2
8	2	2	3	0	3	2
9	0	0	0	0	0	0
10	0	0	0	0	0	0
Subperiod			Column-wise Significance Tests[b]			
1	0	2	2	1	3	0
2	3	3	3	3	0	0
3	2	2	5	0	2	0
4	0	3	2	1	0	0
5	1	2	2	0	2	0
6	4	5	1	0	1	0
7	0	2	2	0	0	2
8	2	1	7	0	4	0
9	3	7	1	0	0	1
10	1	1	1	1	2	1

[a]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same row.
[b]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same column.

Table 5.13. Average Shadow Prices Across All 24 Futures Contracts for Model 4 With Intergroup Response Effects Included.

	Trader Group					
Subperiod	LC	MC	LN	MN	OTH	ST
1	1.766	-0.921	-0.303	-0.028	0.576	0.247
2	0.967	0.062	0.712	0.223	0.666	0.134
3	-0.167	0.081	0.805	-0.348	0.132	-0.095
4	0.246	0.029	0.330	0.127	0.524	-0.046
5	0.237	0.029	0.237	0.147	0.039	0.068
6	-0.076	0.052	0.192	0.055	-0.043	0.223
7	0.129	0.274	0.307	0.036	0.500	-0.042
8	0.286	0.286	0.986	0.499	0.478	0.082
9	1.017	0.797	0.242	0.517	0.427	0.117
10	0.803	0.679	0.168	-0.134	0.506	1.657
Subperiod	Row-wise Significance Tests[a]					
1	2	3	0	3	2	0
2	0	0	0	0	0	0
3	1	1	4	1	1	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	3	1	1	0	0	1
7	1	1	1	1	3	3
8	0	0	1	0	0	1
9	2	2	2	0	0	2
10	1	1	1	3	0	2
Subperiod	Column-wise Significance Tests[b]					
1	2	9	0	3	2	0
2	2	2	0	3	1	1
3	2	2	4	4	0	1
4	1	3	0	0	1	1
5	2	4	1	1	2	1
6	7	4	1	2	5	1
7	5	4	0	2	2	1
8	2	2	0	5	1	1
9	6	8	1	5	0	1
10	3	4	1	3	0	8

[a]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same row.
[b]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same column.

ing to the funds/other trader group in nearly every subperiod. These results are consistent with the findings of the previous models.

This model is the most flexible of all the models. By allowing the decision variables to take different values in every subperiod for each group, this model generates many more feasible points than the previous models. Consequently, MSE at the optimal solution for this model should be smaller than for any other model in the study.

The results generated by this model would probably be impossible to achieve in reality. It is doubtful that any policy change could exogenously induce the wide variety of alterations in trader mix called for by the optimal solution to this model every 20 trading sessions. Rather, this model is useful in that it illustrates the maximum potential price discovery gains if policy makers could be given absolute control over trader mix in the live cattle futures market. If this maximum potential gain is small, then it can be concluded that attempts to improve price discovery through alterations in trader mix are of limited value. If the potential gain is relatively large, however, this suggests that significant gains in price discovery can be achieved from policy-induced alterations in the trader mix.

One way to assess the potential gains to price discovery is to compare the MSE at the optimal trader mix generated by Model 4 and the MSE of the historical price series. This is done later in the chapter. Another, less formal, yet still enlightening, way is to compare the price path of the simulated price series produced under the optimal trader mix of Model 4 to the historical price path. Appendix Figures A.25 to A.48 present these comparisons for each futures contract in the study. From these figures, it is apparent that the Model 4 simulated prices differ substantially from the historical prices in all contracts. Both positive and negative departures from the final price are greatly reduced, suggesting reduced MSE and a more effective price discovery process.

5.4.5 Results from Models 5-10

Models 5-10 are subperiod models somewhat more restricted than Model 3 or Model 4. In these models, the market presence of only one trader group (per model) is allowed to vary while all other groups are held at their historical market presence. In this way, the changes in optimal market presence of the group of interest can be evaluated in isolation from the other groups.

A trader group's historical trading behavior was either helpful or harmful in reducing the MSE of a price series, and this fact does not change between models. If a trader group was found to be harmful to MSE in one model (and thus its market presence reduced by the optimizing algorithm) the same general result will occur in all other models. What differs between models is the degree of interaction between groups in reaching the constrained minimum of the objective function. In Models 5-10, the optimal values of the decision variables follow the same general pattern of their counterparts in Model 4, but may assume somewhat different values because of the additional restrictions placed on these models by (4.72).

A full listing of the results of Models 5-10 is given in Appendix Table A.3. Table 5.14 provides the average optimal values and Table 5.15 gives the corresponding average shadow prices across all 24 futures contracts for these models. In this table, the first column represents the optimal values in each subperiod of the variable $PCT_{p,LC}$ because, in Model 5, the large commercial group was the only group allowed to have market presence different from its historical level. Model 6 allowed only $PCT_{p,MC}$ to vary and thus these are the values reported in the second column of this table. The same pattern is followed through to the last column which lists the results of Model 10, the model where only the small trader group was allowed to vary.

The results are similar to those of Model 4, for reasons cited above, but a general trend toward larger optimal market presence can be seen in the individual group models (Models 5-10). Average optimal values greater than one are associated with the small trader group in seven of 10 subperiods. The majority of average optimal values are less than one for the other five trader groups. Optimal values from these five models exhibit no particular patterns as maturity approaches.

5.6 MSE Comparisons

The MSEs of models 3-10 were evaluated in pairwise comparisons with the MSE of model 1 (which is identical to the MSE of model 2) for each futures contract using the regression approach of Ashley, *et. al.* described in Section 3.8.

Table 5.14. Average Optimal Values Across All 24 Futures Contracts for Models 5-10 With Intergroup Response Effects Included.

	---------- Trader Group ----------					
Subperiod	LC	MC	LN	MN	OTH	ST
1	0.984	1.066	0.967	0.967	0.928	0.995
2	0.942	1.066	1.027	0.884	0.918	1.013
3	1.040	0.936	0.917	1.000	0.967	1.026
4	0.991	0.993	1.005	0.917	0.979	1.024
5	0.969	0.996	0.981	0.975	1.009	0.969
6	0.967	0.992	0.952	0.956	1.002	1.023
7	0.983	0.930	0.983	0.999	0.992	1.082
8	1.032	1.027	0.933	0.989	0.931	1.012
9	0.970	0.919	0.958	0.962	0.956	1.042
10	0.986	0.995	0.991	1.039	0.994	0.955
Subperiod			Row-wise Significance Tests[a]			
1	1	4	1	1	1	0
2	2	3	3	3	3	2
3	2	2	3	1	0	2
4	1	1	1	4	0	1
5	0	0	0	0	0	0
6	0	0	1	0	0	1
7	1	2	1	2	1	5
8	2	2	3	1	4	2
9	1	1	1	1	1	5
10	0	0	0	1	0	1
Subperiod			Column-wise Significance Tests[b]			
1	0	7	0	2	2	1
2	2	7	3	8	4	1
3	4	3	4	2	0	0
4	0	3	2	4	0	0
5	1	3	0	1	3	2
6	1	4	1	2	3	1
7	0	4	1	2	2	5
8	1	3	2	2	4	1
9	1	7	0	2	0	2
10	0	3	1	5	2	3

[a]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same row.
[b]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same column.

Table 5.15. Average Shadow Prices Across All 24 Futures Contracts for Models 5-10 With Intergroup Response Effects Included.

	---------- Trader Group ----------					
Subperiod	LC	MC	LN	MN	OTH	ST
1	1.744	-1.189	0.058	-0.074	0.798	-0.343
2	0.392	-0.240	0.496	0.407	1.183	0.037
3	0.010	0.540	0.577	-0.560	0.171	-0.193
4	0.482	-0.087	0.019	-0.034	0.564	-0.286
5	0.089	0.263	0.072	0.289	-0.038	-0.410
6	0.118	0.011	-0.129	0.278	-0.381	0.272
7	0.169	0.438	0.751	0.035	0.408	-0.136
8	0.205	-0.149	2.336	0.201	0.623	-0.089
9	1.055	0.525	0.428	0.087	0.608	-0.236
10	1.027	0.419	0.741	-0.147	0.229	0.820
Subperiod			Row-wise Significance Tests[a]			
1	3	3	0	3	3	2
2	0	2	0	1	2	1
3	0	2	2	2	0	2
4	1	0	0	0	1	2
5	1	1	0	1	0	3
6	1	1	0	1	3	0
7	0	1	0	1	0	0
8	0	3	3	2	1	1
9	2	2	1	2	1	4
10	1	1	0	3	0	1
Subperiod			Column-wise Significance Tests[b]			
1	2	9	0	1	2	0
2	0	6	0	5	2	0
3	1	4	2	5	0	0
4	0	2	1	0	1	1
5	2	3	2	2	2	1
6	2	5	2	1	6	0
7	1	4	0	1	1	0
8	0	6	3	2	1	0
9	4	5	0	2	1	1
10	0	4	0	3	0	3

[a]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same row.
[b]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same column.

Misspecification testing showed a high degree of autocorrelation in the residuals of the OLS regressions corresponding to Equation 3.39. The models were re-estimated using the Cochrane-Orcutt iterative procedure and specifying second order autocorrelation in the residuals. Plots of the residuals from the autoregressive models indicated no evidence of remaining autocorrelation in the transformed residuals. No further misspecification adjustments were made for these models.

Table 5.16 presents the MSEs for all 10 models and the results of the tests for differences in MSE. The MSEs from Models 1 and 2 are identical and equal to the MSE of the historical price series since both of these models produce a simulated price path equivalent to the historical price path. From Table 5.16 it can be seen that the smallest MSE for every futures contract is associated with Model 4. This was expected since Model 4 is the most flexible, a subperiod model where all of the market presence variables are allowed to vary simultaneously. For all contract months, the second best reduction in MSE is provided by Model 3, a non-subperiod model that allows all decision variables to vary simultaneously. Among the single-group models (Models 5-10), the group responsible for the largest reduction in MSE differs considerably across futures contracts.

Table 5.17 lists the percentage reduction in MSE from the historical MSE (given by the MSE for Model 1 or 2) for each of the eight models where the trader group market presences were allowed to differ from their historical level. All of the percentage reductions are positive indicating that all models were able to find an optimal trader mix

Table 5.16. Mean Squared Errors (MSEs) for Each Model for Each Contract With Intergroup Response Effects Included.[a]

	Contract							
Model#	Dec. 83	Feb. 84	Apr. 84	Jun. 84	Aug. 84	Oct. 84	Dec. 84	Feb. 85
1	40.98	41.31	39.91	2.32	1.48	2.22	7.27	1.51
2	40.98	41.31	39.91	2.32	1.48	2.22	7.27	1.51
3	32.40*	30.12*	33.97*	1.78*	0.85*	1.30*	4.97*	0.48*
4	19.98*	18.86*	24.96*	0.98*	0.40*	0.57*	2.91	0.33*
5	39.30*	37.33*	35.24*	2.06*	1.36	1.31	6.93*	1.07
6	38.61*	38.19*	36.26*	1.99*	1.20*	2.05	6.46*	1.32*
7	36.90*	35.81	36.70*	1.87*	1.26	1.53*	5.56*	0.71*
8	37.56	40.76	37.79*	2.18*	0.90	1.85*	6.46	1.42*
9	38.67*	39.86	39.11*	1.93*	1.16*	1.82*	6.12*	1.09*
10	34.04*	39.04	37.91*	1.80*	0.90*	1.87*	6.29	1.40

	Contract							
Model#	Apr. 85	Jun. 85	Aug. 85	Oct. 85	Dec. 85	Feb. 86	Apr. 86	Jun. 86
1	31.44	86.88	92.48	12.39	12.67	18.75	13.02	12.83
2	31.44	86.88	92.48	12.39	12.67	18.75	13.02	12.83
3	23.96*	80.96*	84.99*	9.80*	8.14*	16.17*	11.79*	9.84*
4	13.79*	62.33*	65.29*	6.55*	3.47*	10.08*	4.03*	4.76*
5	28.87*	86.81*	88.70	12.19	11.67*	16.37*	10.12*	11.41
6	29.85*	83.95*	90.56*	12.06*	10.81*	18.52	12.09*	11.89*
7	25.22	81.11*	88.85	11.51*	11.73*	15.13*	11.84*	11.73*
8	29.67*	84.27	89.51*	12.37	11.73*	18.44*	11.86*	12.80*
9	27.95*	79.58*	91.86*	12.03*	10.10*	16.91*	12.49	12.62*
10	27.66*	83.27	88.53*	11.00*	10.30*	17.98*	11.50	11.96*

	Contract							
Model#	Aug. 86	Oct. 86	Dec. 86	Feb. 87	Apr. 87	Jun. 87	Aug.87	Oct. 87
1	20.41	47.56	14.71	67.59	103.88	96.84	36.57	53.89
2	20.41	47.56	14.71	67.59	103.88	96.84	36.57	53.89
3	12.26*	38.12*	10.63*	60.70*	91.08*	78.91*	32.31*	46.49*
4	5.72*	24.85*	5.19*	40.25*	61.89*	62.85	27.23*	31.88*
5	18.23*	45.46*	12.31*	62.04*	97.35*	83.00*	34.07	50.67*
6	20.25*	45.62	13.57*	66.01*	99.98*	94.46*	36.22	49.04*
7	19.00	44.24*	11.99*	64.75*	84.61*	85.65*	32.46*	47.27
8	20.26*	46.77*	13.79	66.27*	102.06*	96.52	35.97*	50.71
9	17.27*	42.88*	13.15*	62.86	102.95	93.37*	34.12*	48.15*
10	20.27*	41.01	12.65*	60.49	99.29	92.89*	33.46	53.25*

[a]Asterisks indicate tatistical difference (α=.05) from the historical MSE.

that produced a better price path than the historical from a price discovery perspective. The largest reduction in MSE was the 77.94 percent reduction associated with the Model 4 solution in the February 1985 contract. The smallest reduction in MSE was the 0.09 percent reduction produced by the Model 5 in the June 1985 contract.

There is considerable variation in the degree of MSE reduction each model was able to attain across the 24 futures contracts. Table 5.18 summarizes the data in Table 5.17 providing the average, minimum and maximum percentage reductions in MSE for each of the models in the study. Using the average reduction in MSE as a guide to model success in generating improved prices, Model 4 performed the best followed by Model 3. Among the six models that allowed only one trader group's market presence to vary at a time, performance can be ranked as follows where 1 = best performance:

1. Model 7 (Large Noncommercial)
2. Model 5 (Large Commercial)
3. Model 10 (Small Traders)
4. Model 9 (Funds/Other Traders)
5. Model 6 (Medium Commercial)
6. Model 8 (Medium Noncommercial)

Trader group value to the price discovery process is not measured directly by this ranking since the direction of the change in market presence required to produce smaller MSEs differs between groups. This listing ranks the trader groups for potential to impact prices through marginal increments in market presence. In general, these models rank the groups according to the mean of the absolute values of price pressure (Table 5.3) except for the small trader group. According to Table 5.3, the small trader group has the largest histori-

Table 5.17. Percent Reduction in MSE from Historical MSE for Each Model in Each Contract Month.

Model #	Dec. 83	Feb. 84	Apr. 84	Jun. 84	Aug. 84	Oct. 84	Dec. 84	Feb. 85
3	20.94	27.09	14.89	23.18	42.51	41.23	31.61	68.49
4	51.26	54.34	37.46	57.70	73.01	74.15	59.94	77.94
5	4.12	9.63	11.69	11.09	8.43	40.82	4.66	29.33
6	5.80	7.56	9.14	14.29	18.96	7.49	11.08	12.95
7	9.97	13.32	8.02	19.34	14.91	31.17	23.49	52.97
8	8.34	1.35	5.31	5.91	39.61	16.64	11.12	6.08
9	5.65	3.53	1.98	16.79	22.00	17.73	15.80	27.81
10	16.94	5.51	5.00	22.14	39.47	15.83	13.38	7.27

Model #	Apr. 85	Jun. 85	Aug. 85	Oct. 85	Dec. 85	Feb. 86	Apr. 86	Jun. 86
3	23.79	6.82	8.09	20.91	35.69	13.76	9.46	23.32
4	56.14	28.26	29.40	47.18	72.57	46.26	69.05	62.89
5	8.17	0.09	4.08	1.61	7.85	12.70	22.28	11.11
6	5.07	3.37	2.08	2.69	14.68	1.24	7.17	7.33
7	19.78	6.64	3.92	7.13	7.35	19.35	9.06	8.60
8	5.61	3.01	3.20	0.23	7.37	1.66	8.92	0.26
9	11.08	8.40	0.66	2.94	20.29	9.83	4.02	1.68
10	12.02	4.15	4.27	11.26	18.71	4.11	11.66	6.80

Model #	Aug. 86	Oct. 86	Dec. 86	Feb. 87	Apr. 87	Jun. 87	Aug. 87	Oct. 87
3	39.92	19.85	27.75	10.21	12.33	18.52	11.64	13.73
4	71.98	47.75	64.74	40.46	40.42	35.10	25.55	40.84
5	10.70	4.42	16.32	8.22	6.29	14.29	6.84	5.97
6	0.78	4.10	7.75	2.34	3.76	2.45	0.95	8.99
7	6.95	6.99	18.51	4.20	18.55	11.55	11.25	12.28
8	0.74	1.68	6.32	1.95	1.76	0.33	1.64	5.90
9	15.42	9.84	10.63	7.00	0.90	3.58	6.69	10.65
10	0.72	13.79	14.01	10.51	4.42	4.08	8.50	1.19

Table 5.18. Average, Minimum and Maximum Percentage Reduction in MSE from Historical MSE for Each Model.

	---------- Model Number ----------							
	3	4	5	6	7	8	9	10
Average Reduction in MSE	23.57	52.68	10.86	6.75	14.39	6.04	9.79	10.66
Minimum Reduction in MSE	6.82	25.55	0.09	0.78	3.92	0.23	0.66	0.72
Maximum Reduction in MSE	68.49	77.94	40.82	18.96	52.97	39.61	27.81	39.47

cal market presence, yet it is only ranked third in potential for impacting prices. It is important to note that, averaging over all subperiods in all contracts, the small trader group model (Model 10) is the only model where the optimal solution calls for increased market presence by the trader group in order to reduce MSE.

5.7 Effect of Including Intergroup Response Effects

An important aspect of this study, stated in objective 3, was to identify and include trader group interrelationships in the modeling process. This section examines how these intergroup response effects, once identified and incorporated into the models, influenced the results. To facilitate this analysis, all models were re-formulated so that the price definition constraint in the programming models ignored the intergroup response effects.

This meant that constraints similar to (4.76) replaced the price definition constraint in all models. The models were then re-optimized over all contract months.

A full listing of results from models that omit intergroup responses is given in Appendix B. These result tables are designed to correspond directly to the result tables presented for the original models. Table 5.19 gives the corresponding table numbers and contents.

In addition to the tables mentioned above, Appendix B also contains plots which compare the simulated price path generated both with and without intergroup response effects for Model 4. These figures (Figures B.1 to B.24) are a good place to begin examining the effect of including intergroup responses. Casual inspection of these plots suggests that inclusion of the intergroup responses had only a small effect on the simulated price path in most contract months. However, the intergroup responses were more important in some contracts than in others. For example, they appear to cause relatively larger differences in simulated prices in the April 1985 (Figure B.9) and February 1987 (Figure B.20) than in, for example, the August 1984 (Figure B.5) contract.

The optimal values of the decision variables in all models (where they are allowed to vary) do not differ greatly regardless of whether intergroup responses are included or not. The magnitude of the shadow prices associated with constraints on the decision variables are considerably different between the two model formulations, however. In general, the shadow prices from models which include intergroup responses tend to be smaller for the LC, LN, OTH and ST groups and larger for the MC and MN groups than

Table 5.19. Corresponding Table Numbers for Comparing Results of the Models With and Without Intergroup Responses.

Original Model Result Table	Intergroup Response Ignored Table	Table Contents
5.7	B.1	Shadow prices for individual contracts—Model 1
5.8	B.2	Average shadow prices—Model 1
5.9	B.3	Average shadow prices—Model 2
5.10	B.4	Optimal market presence and shadow prices for individual contracts—Model 3
5.11	B.5	Average optimal market presence and average shadow prices across all contracts—Model 3
5.12	B.6	Average optimal market presence—Model 4
5.13	B.7	Average shadow prices—Model 4
5.14	B.8	Average optimal market presence—Models 5-10
5.15	B.9	Average shadow prices—Models 5-10.
5.16	B.10	MSEs for all models in all contracts.
A.1	B.11	Full listing of shadow prices—Model 2
A.2	B.12	Full listing of optimal market presence and shadow prices—Model 4
A.3	B.13	Full listing of optimal market presence and shadow prices—Models 5-10.

in the models which ignore intergroup responses. When all of the intergroup responses are taken into account, the effect of an exogenous change in price pressure for the LC, LN, OTH, and ST groups tends to be smaller because the price pressure multipliers for these groups are less than one (see Table 5.6). Conversely, an exogenous change in price pressure of the medium groups tends to be enhanced by intergroup response effects because the price pressure multipliers for these groups are greater than one in most contract months.

Differences in shadow prices caused by the inclusion of intergroup responses are best seen by comparing the summary tables for Model 1 results under both specifications (Tables 5.8 and B.2). The inflated nature of the average shadow prices of groups LC, LN, OTH and ST in the no-intergroup-response models is obvious. It is important to note, however, that the relative ranking of these shadow prices is virtually undisturbed by omitting the intergroup response effects. This general pattern of different shadow price magnitudes, but unaffected relative rankings between groups, permeates the results of all the models.

Examination of the optimal value of the objective function under both model specifications can also yield information on the importance of the intergroup response effects. The MSEs of the models where the response effects were omitted are listed in Table B.10. To facilitate comparison of these MSEs with those of the original models, Table 5.20 lists the percentage change in the optimal MSE that results from omitting intergroup response effects. For most, but not all, models this percentage change is negative indicating that omitting the intergroup responses resulted in smaller MSEs. Table 5.21 summarizes the information from Table 5.20 listing the average, smallest and largest percentage change in MSE, by model, resulting from omitting the intergroup response effects. Model 4 was the model most affected by omission of the intergroup responses. Because Figures B.1 through B.24 compare the results between the two model formations for the most flexible model, Model 4, these figures expose some of the largest differences in the simulated price series that could be expected from omission of intergroup effects. Among the single group models (Models 5-10), the largest average percentage difference in MSE occurs in the LC model (Model 5) and the ST model (Model 10). Both groups were previously shown to have a relatively large impact on simulated prices.

Overall, omission of intergroup responses tended to produce results that overstated the ability of an altered trader mix to improve the price discovery process. The influence of ignoring intergroup responses on the simulated price series was small. Inclusion of intergroup responses dramatically altered the magnitude of model shadow prices, but did not disturb the relative ranking of group contributions to price discovery based on these shadow prices.

5.8 Chapter Summary

This chapter began with a description of the statistical properties of the price pressure data used in this study. Simple correlation coefficients indicated linear depend-

Table 5.20. Percentage Change in Optimal MSE that Occurs When Intergroup Response Effects are Ignored.

Model #	Contract Dec. 83	 Feb. 84	 Apr. 84	 Jun. 84	 Aug. 84	 Oct. 84	 Dec. 84	 Feb. 85
3	-4.68	-4.04	-5.33	-8.09	-11.85	-9.52	-2.33	-4.19
4	-18.22	-18.70	-9.92	-18.67	-13.75	-23.91	-13.88	-29.04
5	-7.20	-3.39	-6.26	-6.84	-7.81	-11.36	-10.35	-24.30
6	1.14	2.44	2.68	2.57	-1.08	-0.10	4.02	-10.85
7	-2.89	-1.49	-0.15	-5.14	-7.93	-8.72	1.78	0.56
8	3.18	0.65	2.16	1.01	4.92	11.31	6.78	1.27
9	-1.94	-2.48	-2.48	-9.96	-5.19	-1.10	-7.94	2.84
10	-5.81	-7.08	-3.81	-10.48	-14.16	-33.76	-11.58	-9.19

Model #	Contract Apr. 85	 Jun. 85	 Aug. 85	 Oct. 85	 Dec. 85	 Feb. 86	 Apr. 86	 Jun. 86
3	-5.44	-6.03	-1.13	-13.55	-4.57	0.75	2.83	-17.11
4	-23.95	-13.11	-10.11	-24.99	-18.13	-11.20	-17.65	-43.04
5	-4.85	-7.70	-3.71	-0.83	-11.42	-1.43	-6.20	-3.74
6	-0.19	1.43	0.30	0.48	4.47	0.23	0.93	-5.13
7	1.11	0.02	-0.38	1.29	-0.26	-1.78	-0.21	-1.33
8	3.16	1.18	1.72	0.08	4.77	0.75	2.45	-0.23
9	-1.80	-1.00	-0.08	-0.49	-4.48	-3.07	-1.94	-0.62
10	-20.30	-2.22	-2.57	-10.44	-10.20	-7.12	-13.56	-4.94

Model #	Contract Aug. 86	 Oct. 86	 Dec. 86	 Feb. 87	 Apr. 87	 Jun. 87	 Aug. 87	 Oct. 87
3	-16.73	-6.47	-8.50	-6.07	-3.32	-2.34	-6.33	-3.76
4	-38.02	-25.78	-24.92	-24.60	-14.98	-13.46	-7.75	-6.98
5	-2.46	-4.59	-3.50	-8.84	-2.18	-3.57	-5.10	-5.75
6	-0.11	-0.62	-1.69	-0.87	-0.26	-0.40	-1.24	5.16
7	-1.01	-1.66	-4.95	-2.34	-2.11	0.89	-0.51	0.39
8	0.02	0.59	2.05	0.93	0.85	0.13	0.65	2.61
9	-3.20	-3.14	-3.23	-1.32	-0.20	-1.76	-1.29	-0.17
10	-0.30	-6.54	-7.47	-2.43	-7.25	-7.35	-3.74	-8.05

Table 5.21 Average, Smallest and Largest Percentage Change in Optimal MSE that Occurs When Intergroup Response Effects are Ignored.

	---------- Model Number ----------							
	3	4	5	6	7	8	9	10
Average MSE Pct. Change	-6.16	-19.37	-6.39	0.14	-1.53	2.21	-2.34	-8.76
Smallest MSE Pct. Change	0.75	-6.98	-0.83	-0.10	0.02	0.02	-0.08	-0.30
Largest MSE Pct. Change	-17.11	-43.04	-24.30	-10.85	-8.72	11.31	-9.96	-33.76

encies between many of the price pressure variables, and all of the price pressure variables were found to be characterized by leptokurtic distributions. The two medium trader groups were found to exert considerably less overall pressure on prices than the four remaining groups. The partial derivatives required to include intergroup response effects were estimated with single equation OLS models. The price pressure multipliers calculated from these estimates were within a range consistent with expectations.

Average shadow prices calculated from the 24 Model 1 solutions indicated that the small trader group historically was the most important in restricting price dispersion and the funds/other group was the most important in encouraging dispersion. Model 2 results indicated that the small trader group was most successful in restricting price dispersion up to 60 days prior to contract maturity. In the final 20 days of the contract, the large commercial group was the most important to price discovery. Models 3 and 4 produced optimal trader mixes that called, on average, for a reduction in the market presence of all groups and generated a simulated price path that was smoother and less volatile than the historical price path. Plots comparing the simulated price paths generated by Model 4 with the historical price path indicated large differences between the two series in nearly all contracts. The solutions for Models 5-10 (which allowed alteration of the market presence of only one trader group per model) were similar to the solutions for Model 4 although there was a general trend toward larger optimal market presence by each group in these models.

Comparison of MSEs between the 8 models which allowed changes in trader mix found that while all of the models produced MSEs smaller than that of the historical price series, Model 4 was by far the most successful at reducing MSE. Examination of the percentage reductions in MSE attained by the single group models (Models 5-10) confirmed that the potential for reduction in MSE by altering the presence of any single group is strongly linked to overall historical market presence except in the case of the small trader group.

Including intergroup responses in the simulation models had little effect on the optimal values of the decision variables but did greatly influence the magnitude of the shadow prices. Rankings of trader groups with respect to contribution to improved price discovery were largely unaffected by the inclusion/omission of intergroup responses.

Chapter 6

SUMMARY AND CONCLUSIONS

6.1 Summary

The overall objective of this research was to evaluate the contribution of different types of traders to the price discovery process in live cattle futures. Previously, very little quantitative data on this subject has been available to policy makers. Price discovery is an important social function performed by futures markets and policy makers need to consider the impact of their actions and policies on this process.

This work was based on a conceptual model that describes the way that information becomes incorporated into futures prices. In this model, traders are the conduits through which information passes on its way to form prices. On one end, traders are faced with the universe of all information that might be relevant to the price of a particular commodity. Traders must select and condense this information into an expectation on future prices. Much of the social value that traders supply in the form of aiding price discovery is accomplished through this selection and condensation process.

Various trader characteristics impact the likelihood that a trader will act on any given price expectation. Some of these characteristics are specific to the price expectation itself (e.g., expected value and variance of the expectation), and some may be more specific to the trader (e.g., cash position and risk attitude). Together, a trader's price expectation and his/her willingness to act on the expectation result in trading behavior.

Collectively, the trading behavior of all traders (and potential traders) in a futures market determines price.

The elements of the conceptual model that are of the most interest, different trader information subsets and translating mechanisms, are largely unobservable and thus difficult to measure. However, trading behavior, which depends heavily upon these two elements, is often observable. In order to make some inference as to the value of these unobservables for particular types of traders, a quantitative measure that combined trading behavior with observed price movements was constructed. The resulting index was an estimate of the net pressure that a particular group of traders exerted on prices during a given trading session. Trading behavior data were obtained from the CFTC's large reporting trader database which facilitated the identification of six specific groups of traders in live cattle futures: large commercials, medium commercials, large noncommercials, medium noncommercials, funds/other traders and small (nonreporting) traders.

The price pressure measures were formulated so that, taken together, they precisely defined the daily change in price. This was consistent with the conceptual model which stipulated that the only thing that impacts price in a futures market is the trading behavior of market participants. Any outside event that influences price must be filtered through the behavior of traders.

With a quantitative model of futures price formation in hand, the issue of trader influence on price discovery was investigated by experimenting with alterations in the trader mix. This required two items: a suitable objective measure of the price discovery performance of the market, and a means of simulating futures prices under hypothetical trader mixes that was consistent with the real-world market.

Price discovery performance was measured by the mean squared error (MSE) of the futures price series around the final settlement value in the series. Since futures prices converge to the cash price at maturity, the final settlement price represents the true value of the commodity—the value that the futures market had been working to discover over its trading life. The MSE, being a measure of the dispersion of prices around this true value, was a suitable loss function to use in valuing the futures price series as a price discovery vehicle. The theoretical discussion presented in Section 3.4 indicated that, for linear approximations to market supply and demand curves, the social loss that results from basing economic decisions on inaccurate futures prices is slightly less than proportional to the MSE.

A price simulation tool was constructed in the form of quadratic programming models that minimized the MSE of a hypothetical price series resulting from altering the historical market presence of the six trader groups. These programming models were constrained to behave according to exchange regulations. In addition, interrelationships between the price pressure measures for the six groups were modeled and estimated via econometric methods from the price pressure data. These interrelationships were then concisely characterized by price pressure multipliers constructed from the econometric parameter estimates. The price pressure multipliers were included in the programming models to capture the indirect effects (responses from other groups) of changes in any group's market presence.

Some variations of the programming model held trader group market presence at historical levels so that the simulated price series would be identical to the historical price series. Shadow prices from these models were useful in quantifying the relative influence of each group of traders on MSE, and hence, on price discovery. Other variations of the programming model allowed the optimization algorithm to select an optimal trader mix that differed from the historical mix. Results from these models were further indication of the price discovery value of each group's behavior and gave an indication of the size of the price discovery improvements attainable through trader mix manipulation.

In other versions of the model, market presence was allowed to vary one group at a time in order to study the price discovery value of each group's trading behavior in isolation from the remaining groups. In another modification, the life of the futures contract was divided into ten 20-day intervals with each group allowed a different level of market presence in each subperiod. This alteration was designed to expose any patterns in trader group influence on price as the contract approached maturity. Finally, all of the models were reformulated to exclude the intergroup response effects and solved. Comparison of results between the two sets of models allowed evaluation of the importance of including intergroup responses in the models.

6.2 General Conclusions

The concept of price pressure has long been used by those who analyze futures markets. Analysts often use general terms in referring to price pressure exerted by certain groups of traders. For example, it is often heard that there was a "small amount of buying pressure" or a "great deal of downward pressure on price". This research has made a useful contribution by developing an objective measure of price pressure. An objective measure allows the price pressure concept to be extended to empirical work. Unlike simple data on trader positions, price pressure data measures the desire of a group of traders to take or hold a futures position. This is very important since not all futures contracts are traded with equal fervor.

Other authors have framed theoretical discussions of trader behavior around the concept of supply and demand for futures positions (Garbade; Rowsell). When data such as those used in this work are available, price pressure modeling is a viable method of estimating the net effects of supply and demand interaction over a trading session for identifiable groups of traders.

This research found that, on average, small traders are the most beneficial to price discovery in live cattle futures and that large commercial traders do the most harm to the price discovery process. These results are somewhat surprising and counter-intuitive since small traders have long been assumed to be most poorly-informed traders in futures markets and large commercial traders, with their close connections to the cash industry, the best informed. There are, however, two conclusions that can be drawn from the theoretical parts of this work that may explain these unexpected findings.

First, the theoretical arguments revealed that there can be a divergence between profit maximizing trader behavior and what is socially desirable from a price discovery prospective. In general, traders who are most beneficial to price discovery are those that form accurate long-run expectations of the commodity's value. Traders that seek profits by neglecting the long-run value of the commodity in favor of reaping profits from successful prediction of short-run price fluctuations can be detrimental to price discovery. Small traders, being farther removed from the activity in the pits, would seem to be at a disadvantage when it comes to profitably predicting the trading activity of others. Instead, small traders might do better to focus on detecting long-run supply-demand imbalances in price relationships. This is exactly the type of trading behavior that improves price discovery.

Those very close to the activity in the pits, the funds/other group and large commercial traders might well find profit in predicting short-run price fluctuations caused by the trading activities of others. If they are moving in and out of the market, attempting to capture the peaks or valleys in prices while temporarily neglecting long run price expectations, the behavior of these traders is detrimental to price discovery. Technical trading systems, often used by these types of traders, typically give little consideration to long-run price expectations.

Second, to help understand why large commercial traders might not foster efficient price discovery, it must be recognized that hedgers and speculators can be expected to behave very differently. The E-V analysis in Chapter 3 indicated that the willingness to take a position in the futures market depends upon, among other things, whether the trader is a hedger or speculator. Even with identical price expectations, hedgers and speculators will exhibit differing trading behavior. This justifies segregating traders with respect to commercial status in order to evaluate which group of traders might be more beneficial to price discovery.

One of the most important conclusions that arose from the E-V analysis is that when the variance of the price expectation increases, hedgers seek to increase their futures positions while speculators seek to decrease futures positions. This means that hedgers will have a larger market presence when they are least sure of the direction that prices will take. In contrast, when speculators become more unsure of the direction of prices, they bow out of the market. A rush of futures activity by commercial interests may signal deteriorating price expectations, but a rush of activity by speculators indicates greater confidence in their assessment of future prices.

The mean of the price expectation also motivates market presence. When speculators expect declining (rising) prices they will always be short (long). However, it is possible that a hedger may expect rising prices yet be short because of a large long cash position.

From a theoretical point of view, the presence of a cash position can interfere with the expression of price expectations through trading behavior. In fact, the presence of a cash position results in an asymmetry with respect to willingness to act in futures markets. When the price expectation is in the direction of the cash position, the commercial trader has *less* incentive to take a futures position than one who has no cash position. When the price expectation is in the direction opposite the cash position, the commercial trader has *more* incentive to act in the futures market than would a noncommercial trader. These asymmetries may balance out if the number of commercial traders with long cash positions approximately equals the number of traders with short cash positions, but this is often not the case. In the live cattle futures market, there is much more short hedging activity than long hedging activity (Leuthold, 1983; Rowsell) implying more commercial traders with long cash positions than short cash positions. Thus, on the whole in this market, there is a greater tendency to register declining price expectations than rising price expectations among commercial traders. This cannot be good for effective price discovery. Speculators do not suffer from these asymmetries in their willingness to take a futures position.

The argument that a close connection with the cash trade provides commercial traders with superior fundamental information and their extensive experience makes them better at interpreting this information may indeed be valid. However, it is possible that these advantages are negated by short-run profit maximizing behavior and/or the hinderance to balanced price expectation transmission caused by cash positions. No evidence of commercial traders consistently enhancing price discovery in live cattle futures was found by this research. This suggests that if commercial traders do have the ability to form superior long-run price expectations, they may be neglecting them in search of short-run profits or, their cash position may be interfering with symmetric transmission of their long-run price expectations.

6.2.1 Historical Value to Price Discovery

Models 1 and 2 were designed to measure the historical value to price discovery of the six trader groups. The results of these models indicate that price discovery value is highly variable for all groups. When the results are viewed on a contract-by-contract basis, each group has some contract months where it was helpful to price discovery and some months where its trading activities were harmful to price discovery. *Thus, the most important conclusion of this research is that no specific trader group consistently outperformed the others in facilitating price discovery in the live cattle futures market.* The strongest pattern observed was that the funds/other trader group most frequently exhibited detrimental trading behavior with respect to price discovery.

These results do, however, exhibit trends—groups with several "beneficial" or "harmful" contracts in succession—indicating that, while relative value to price discovery fluctuates over time, at any given time a particular group is either helpful or harmful to most of the contracts being traded. It seems logical that accurate expectations would not be confined to a single contract month, but would carry over to several consecutive contract months trading simultaneously.

Although the results vary widely by contract, on average over the four year period of this study, the behavior of small traders did the most to restrict price divergence from the true value of the commodity. The funds/other group and large commercials behaved in such a way that they did the most to keep price away from its true value. The preceding discussion about profitable prediction of short-run price fluctuations may explain these findings.

Another possible explanation for relatively good performance of small traders in discovering the correct price may be found in the small trader's natural disposition toward long positions. Small traders are more likely to employ a "stock market" approach to futures trading whereby purchases precede sales. Previous research confirms that small traders hold more long than short positions in live cattle futures (Leuthold, 1983; Rowsell). This helps explain the finding of positive average price pressure for small traders in this study. If imbalances in the amount of long and short hedging injects a downward bias in live cattle futures prices, then the small traders, with their predisposition to be long, can help alleviate this bias and improve price discovery.

Both the large and medium noncommercial groups had similar average shadow prices over the four year period. Both were slightly negative and of similar magnitude. (Negative shadow values indicate that increases in the associated group's market presence will reduce the objective function, MSE, which improves price discovery.) Two conclusions arise from these results: (1) the average impact on price discovery of noncommercial traders is independent of the size of the trader and, (2) *on average, speculators do more to restrict price dispersion in the live cattle futures market than to promote it.* This is in opposition to the periodic claims of producer groups and others who believe that speculators destabilize live cattle futures prices.

Apparently, trader size is important when it comes to the commercial trader groups. The Model 1 average shadow price for the large commercial group was positive while the average shadow price for the medium commercial group was negative. Medium commercials exhibit a trading behavior more like the small traders than the large commercials. Perhaps, like the small traders, the smaller commercial traders (medium group) are less able to profit from predicting short-run price changes and must focus more on interpreting long-run fundamentals. Although the identities of individual traders in the CFTC data set are not known, it is possible that the medium commercial and small trader groups include a large proportion of the cattle feeders who trade futures.

The results from the subperiod model designed to measure the historical value of trader groups to the price discovery process (Model 2) also are highly variable from contract to contract. On average, the small trader group is the most beneficial to price discovery until 60 days before maturity. From 20 to 60 days to maturity, large noncommercials are the most beneficial group and within 20 days to maturity, the large commercials help price discovery the most. As maturity approaches, the long-term becomes the short-term and traders must be more aware of supply/demand fundamentals and formulate their price expectations accordingly. When driven to consider end-of-period fundamental conditions, apparently the large noncommercials and commercials are more capable than the small trader group in forming accurate expectations, on average. The subperiod model results support the hypothesis that both large commercial and large noncommercial traders neglect long-term price expectations when maturity is far in the future. Also, it is not surprising that large commercial traders benefit price discovery the most in the delivery month since they are in the best position to take or make delivery and because the potential for delivery has reduced the presence of other traders in the final trading sessions.

6.2.2 Optimal Trader Mixes

In general, solutions from the model formulations which solve for the MSE-minimizing optimal trader mix strongly reiterate the information that was revealed by the shadow prices in the models where trader presence was constrained to historical levels. If a group's trading behavior tended to increase (decrease) price dispersion then that group's market presence was reduced (boosted) in the optimal trader mix.

The optimal mix results provided an indication of the size of the price discovery benefits obtainable from altering the mix of traders. This was measured by the amount of reduction in MSE that resulted from having an optimal trader mix over the life of the contract instead of the historical mix. For the most flexible model, this reduction averaged 53 percent suggesting that if policy makers had complete control over the mix of traders, welfare losses might be cut in half. Of course, policy makers have nothing approaching this type of control over trader mix. The models which allowed manipulation of only one trader group at a time produced more modest six to 15 percent MSE reductions, on average.

Direct manipulation of trader mix to obtain even the small price discovery improvements would be exceedingly difficult if not impossible. This would require a policy that would change the market presence of an individual trader group in each subperiod, raising it in some subperiods and lowering it in others.

The simulation models that generate optimal trader mixes would be useful for establishing upper and lower bounds on the price discovery effect that could be expected from a trader mix change. This would require policy makers to specify how trader mix is expected to change in response to a new policy or to changes in an existing policy.

Since the simulated prices are affected by response effects between groups, it would be important to include these when doing policy analysis of the price effects of altering the trader mix. With respect to establishing the relative importance of the six trader groups to the price discovery process, however, this research found that including intergroup response effects made little difference in group rankings.

6.3 Policy Implications

Realistically, the only trader mix alteration that policy makers could hope to purposefully induce in futures markets would be change the participation level of a single, targeted group of traders. This research suggests that this type of trader mix alteration can produce gains in price discovery over the long-term. The short-term effect of any change in trader mix is difficult to predict. These results provide information that should be considered even for policy changes not directly targeted at price discovery improvement.

Policy should not be formulated to discriminate against small traders with the aim of improving price discovery. Small traders are often assumed to be the most uninformed traders in a market. It may be that they are less informed with respect to the prediction of short-run price fluctuations, but this may make small traders more prone to expending resources on long-run fundamental analysis, precisely the type of information that is most valuable to price discovery. Finding ways to lower the cost of futures activity to small traders could lead to long-run gains in market efficiency and price discovery.

There are valid reasons for avoiding policy that discourages commercial activity in agricultural futures markets. The cash positions of commercials give them much more incentive to be active in the futures market specific to their commodity and thus helps to ensure the survival of that market as well as improve its liquidity. With a futures market in existence, society reaps resource allocation benefits. In the live cattle futures market however, large commercial trader contribution to the price discovery process is not a good argument for encouraging greater participation by these traders.

This research found very different price discovery effects for two different classes of speculators. Individual customer speculators, those included in the large and medium commercial groups, were found to improve price discovery, on average. The funds/other group, also primarily speculators, was found to interfere with the price discovery process. Recalling that the funds/other group included transactions of commodity pool operators and the program trades of futures commission merchants, it is understandable that this group might be shorter-sighted in its price expectation formation. Policy makers should bear in mind that any policy increasing the market presence of these types of traders will likely carry negative price discovery consequences.

6.4 Suggestions for Future Work

Data similar to that used in this study of the live cattle futures market exists for many other futures markets. It would be useful to repeat the type of analysis conducted here for other futures markets and compare the results to those reported here. Recall that Hartzmark found the live cattle futures market to be an oddity among futures markets with respect to profit earned by large traders. It is possible that traders in live cattle futures markets influence price discovery differently than traders in other futures markets. Repeating this study with data over a different time period (preferably a more recent time period) would allow evaluation of the robustness of the results developed here.

Event studies would be a useful application of the price pressure measures developed in this work. By examining the pressure exerted by different groups of traders preceding, during and following events such as the release of government reports or days when price moved its maximum allowable limit, insights into the information utilized by different groups of traders could be obtained.

If technology ever permits collection of trader data at higher frequencies than the daily data used in this study, it would be interesting to study the intraday price pressures of different trader groups. Much could be learned about short-term trading behavior and what losses in the form of constraints on empirical work are involved when price pressure must be aggregated to a daily level.

This work could be extended by an effort to estimate the actual dollar value of the welfare losses that occur when futures prices are not accurate reflections of subsequent cash prices. The models presented here could then be used to generate simulated prices under different trader mixes and the price discovery gains or losses could be expressed as a monetary value to society. This would facilitate cost-benefit policy analysis.

This study has assumed that each day in the life of a futures contract has equal welfare value to society. It is likely, however, that futures prices are more important to society in some time periods than others. For example, futures prices occurring during the periods when cattle producers are making placement decisions might have more social value than those occurring in the delivery period when much less uncertainty surrounds cash prices. A method of weighting the trading days to reflect their differential importance to social welfare would be an improvement to the type of analysis reported here.

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APPENDIX A:

Result Tables and Figures Related
to
Model Solutions Which Include Intergroup Response Effects.

Table A.1. Shadow Prices for Each Trader Group by Contract Subperiod from Model 2 With Intergroup Response Effects Included.

	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
December 83						
1	2.45	0.00	-9.55	0.00	0.00	2.22
2	0.17	-6.31	-9.58	4.90	9.03	2.36
3	-2.34	6.90	3.99	-1.66	3.25	2.18
4	-3.43	0.00	5.95	3.73	0.00	11.79
5	7.29	-1.43	15.08	3.72	-5.82	-15.60
6	1.45	6.63	7.66	7.84	3.76	-4.63
7	2.12	-0.61	5.43	0.20	-7.20	-12.55
8	-0.17	2.35	-0.24	3.58	-0.47	0.98
9	-0.77	-1.30	0.69	-2.76	1.07	0.21
10	-0.15	-0.56	-0.34	0.13	0.14	-0.18
February 84						
1	-1.62	-4.46	29.43	0.00	0.00	-9.51
2	6.12	-5.50	8.24	0.00	0.00	2.13
3	0.35	0.00	17.07	0.00	-3.24	-3.67
4	14.28	-3.46	-1.68	0.00	-2.31	-0.77
5	17.43	2.27	-2.68	-1.64	0.36	-11.74
6	-0.51	1.67	4.20	-0.32	1.69	2.13
7	-1.77	0.31	-2.68	0.97	-1.92	0.14
8	-0.04	-1.00	0.02	-1.04	-0.90	0.31
9	-0.04	0.11	0.03	0.12	-0.02	-0.04
10	-0.10	-0.03	0.01	0.13	0.13	0.01
April 84						
1	11.81	-10.16	3.72	0.00	0.31	-3.25
2	9.67	-2.93	4.01	3.47	-1.57	-2.06
3	3.48	3.43	6.07	-7.28	-1.92	-10.01
4	4.13	1.03	-0.37	1.26	3.84	-3.28
5	-2.92	1.61	-3.90	-0.69	-1.55	-0.03
6	-1.49	-0.74	-0.60	-0.93	0.62	-1.42
7	-0.41	-1.38	0.76	0.50	-0.28	1.71
8	-0.43	0.58	-0.50	-0.24	0.13	0.03
9	-0.05	0.01	-0.00	-0.09	-0.02	0.02
10	0.04	0.03	0.00	0.03	-0.00	-0.01

Table A.1 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
June 84						
1	-0.07	-0.01	0.68	0.00	-0.10	-0.03
2	-0.36	0.28	0.14	0.00	0.13	-0.43
3	0.01	0.07	-0.77	0.01	0.23	1.41
4	0.39	1.34	0.26	-0.08	-0.03	-0.07
5	0.69	-0.26	0.07	-0.16	-1.13	0.55
6	-0.05	0.57	1.07	0.27	0.54	-0.95
7	-0.07	0.04	0.08	-0.05	-0.02	0.09
8	-0.01	-0.09	0.08	0.00	0.09	0.01
9	0.03	-0.12	-0.03	-0.14	0.03	0.14
10	0.01	0.02	0.13	0.01	-0.08	0.16
August 84						
1	-0.08	0.00	0.03	1.53	-0.95	1.96
2	0.01	-0.51	-0.18	-2.75	0.05	2.64
3	-0.45	1.29	-0.86	0.69	0.30	0.23
4	-0.20	0.05	0.97	-0.19	-0.51	0.26
5	-0.19	0.18	-0.58	0.30	-0.09	0.96
6	0.02	-0.11	-0.10	-0.30	-0.18	-0.06
7	0.03	0.05	0.03	-0.09	-0.04	0.05
8	-0.04	-0.01	0.03	0.07	-0.13	0.11
9	0.08	0.03	-0.26	0.56	0.10	0.05
10	0.14	-0.05	0.05	0.03	-0.05	-0.05
October 84						
1	-3.48	0.00	2.04	0.00	0.00	0.36
2	1.59	0.00	-2.68	0.00	-0.48	1.06
3	-0.37	0.12	1.20	0.97	0.43	-0.16
4	-0.90	0.12	-1.93	0.07	-0.38	0.10
5	-0.91	-0.10	-0.53	0.50	0.46	0.62
6	-1.33	-0.85	-0.08	1.63	-0.49	0.85
7	0.18	0.01	-0.43	-0.87	-0.56	0.16
8	0.78	0.42	-0.12	-0.34	0.04	-0.05
9	0.11	0.07	0.03	-0.17	0.27	-0.13
10	0.03	0.06	-0.07	0.01	0.21	-0.05

Table A.1 continued	--------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
December 84						
1	0.06	0.00	0.30	0.00	0.91	-1.25
2	0.73	0.00	4.39	0.00	0.09	-1.42
3	1.19	-0.81	3.58	0.00	-2.63	-2.17
4	0.90	-0.41	-0.12	-3.04	-0.74	-2.19
5	-0.97	3.35	-0.70	-0.20	2.93	1.50
6	-0.53	-0.72	1.50	-0.90	0.63	-1.81
7	-0.27	0.06	-0.29	-0.05	1.26	0.56
8	-0.02	0.85	-0.56	0.22	-0.17	-0.16
9	-0.02	-0.04	-0.04	0.06	0.03	0.09
10	0.01	0.00	-0.06	-0.01	0.02	-0.01
February 85						
1	-0.99	0.00	2.62	0.00	-0.19	-0.26
2	-0.20	0.00	2.91	0.00	0.59	-0.21
3	-0.65	0.53	-1.78	-0.11	1.19	-0.32
4	-0.22	-0.05	1.02	0.13	0.41	0.36
5	-0.33	0.12	-0.38	0.06	-2.04	0.51
6	-1.09	-0.31	0.67	0.31	0.22	0.51
7	-0.89	0.25	2.10	0.06	0.01	0.81
8	-0.17	0.07	-1.06	0.39	0.86	-0.17
9	0.15	0.06	-0.55	-0.00	-0.56	0.00
10	0.18	0.02	-0.03	-0.01	-0.02	-0.04
April 85						
1	-0.42	-1.52	-41.02	0.00	5.77	9.17
2	4.48	0.00	-7.03	0.00	4.36	3.76
3	-1.34	0.39	-5.42	0.00	-2.80	1.51
4	1.82	3.05	8.69	0.00	-0.77	-1.55
5	0.17	-1.75	7.93	3.94	5.41	-1.64
6	-2.67	1.21	-2.26	3.57	-2.38	1.63
7	2.41	-1.06	1.06	-1.24	-4.67	-0.59
8	-0.51	-0.14	1.91	0.46	0.49	-0.67
9	0.86	0.20	-0.54	-1.69	-0.53	-0.97
10	-0.02	0.12	0.15	0.08	0.42	-0.03

Table A.1 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
June 85						
1	0.05	0.00	2.95	0.00	3.13	-10.98
2	0.28	0.00	24.42	1.52	1.72	-1.00
3	-0.13	-2.51	1.39	-5.72	-5.97	7.14
4	-0.04	-5.25	1.69	1.91	10.46	-9.21
5	0.08	2.19	-3.06	2.78	-2.69	11.24
6	0.09	-0.02	-1.26	-1.17	-10.05	7.89
7	0.05	6.25	-4.19	-3.71	6.88	-2.38
8	-0.02	-3.60	-0.24	-4.18	-6.26	-0.20
9	0.01	-1.20	-1.33	1.45	3.92	-1.33
10	0.00	-0.31	-0.00	0.29	-0.35	-0.62
August 85						
1	0.85	-2.57	-6.10	1.25	-0.59	9.30
2	2.44	0.65	17.99	0.00	0.00	-3.93
3	-11.98	-3.42	-0.49	-8.81	2.91	15.86
4	-6.24	4.95	-6.35	0.77	0.51	6.93
5	-4.43	-0.69	9.58	1.38	2.19	-2.70
6	-5.11	-3.10	3.75	2.81	-5.86	1.93
7	6.84	-3.12	-0.04	-0.13	-0.45	-4.72
8	-0.91	-2.14	-0.48	0.31	-2.14	-1.00
9	0.17	0.06	0.05	-0.13	-0.22	0.32
10	-0.05	-0.01	-0.02	0.10	0.10	0.17
October 85						
1	-0.69	0.00	-2.46	0.00	-1.12	1.29
2	0.81	0.67	1.69	-0.75	-1.10	0.30
3	-1.04	0.52	2.68	-0.78	-2.35	1.69
4	2.96	-0.77	-3.29	0.06	0.77	0.69
5	-2.08	-1.63	-0.71	0.28	0.53	0.69
6	0.43	9.58	3.59	-0.12	13.35	-5.37
7	3.79	-1.32	5.71	2.46	-0.71	-0.33
8	-0.15	-2.86	0.11	-0.94	-0.88	2.38
9	0.93	1.32	-1.26	0.48	-1.49	-0.27
10	-0.05	-0.11	-0.10	-0.04	0.12	-0.04

Table A.1 continued	--------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
December 85						
1	0.84	0.12	-1.66	0.00	-0.76	3.26
2	2.84	-2.18	-0.39	0.93	-0.55	0.31
3	-2.73	4.00	3.94	0.00	1.49	-2.61
4	-2.48	1.09	2.36	1.76	10.02	-1.39
5	3.12	0.26	-2.92	-0.01	-0.93	3.56
6	-0.36	0.76	-0.12	0.14	0.78	-1.38
7	-0.13	-0.09	0.47	0.12	0.29	0.83
8	0.50	0.96	0.67	0.67	-0.86	1.01
9	-0.14	1.22	0.29	1.35	1.16	-1.09
10	-0.02	-0.17	-0.00	-0.12	0.25	0.02
February 86						
1	-7.23	0.00	9.70	0.00	-0.65	1.27
2	-6.03	0.41	-10.01	1.30	4.57	0.68
3	-0.15	0.03	-4.75	-0.85	-0.38	-2.49
4	-2.93	2.13	-4.08	0.17	1.54	-0.93
5	2.25	-8.52	-1.34	0.72	1.16	4.00
6	-5.30	1.81	7.94	2.15	-1.69	2.16
7	-1.57	1.21	2.52	1.93	-0.99	-0.39
8	-2.17	0.43	-0.06	-0.14	1.35	0.07
9	0.94	-0.09	0.38	-0.25	0.01	-0.55
10	-0.07	0.09	0.17	-0.03	0.01	0.04
April 86						
1	-1.20	0.00	-4.94	0.00	0.67	-5.09
2	2.47	3.36	-4.73	0.00	0.36	-4.80
3	-12.32	1.22	1.83	8.00	1.55	6.13
4	7.80	-1.34	-3.33	-0.80	2.06	-0.56
5	-4.30	1.63	1.45	-5.83	-1.20	2.05
6	2.52	1.57	-6.53	-0.68	1.16	1.36
7	2.13	1.90	2.96	0.47	0.03	-2.92
8	-2.31	-0.05	0.08	-0.38	0.05	1.05
9	0.28	0.42	0.34	-0.05	-0.04	0.00
10	-0.43	0.32	0.89	0.24	-0.25	0.24

Contract Subperiod	Trader Group					
	LC	MC	LN	MN	OTH	ST
June 86						
1	-10.65	0.58	4.14	0.00	0.37	15.28
2	-2.32	-3.65	2.95	0.00	0.00	-0.20
3	1.28	0.37	-1.28	0.00	-0.18	0.64
4	-0.42	-0.38	-5.27	0.00	0.41	2.52
5	1.66	0.08	-0.59	-0.10	-1.30	0.17
6	-0.28	0.23	0.17	0.02	-0.51	-0.06
7	1.90	-0.19	-0.02	-0.03	-0.09	-0.96
8	0.96	0.34	1.32	-0.30	-1.08	1.78
9	-0.04	-0.07	-0.29	0.02	0.22	0.03
10	-0.82	0.30	0.61	0.07	0.05	0.18
August 86						
1	8.52	-0.07	-10.91	0.00	0.00	3.20
2	-7.05	0.00	-11.05	0.00	30.00	-2.01
3	3.50	1.51	0.13	0.00	0.50	-7.01
4	-4.90	5.19	14.97	0.00	-3.47	-5.35
5	2.52	-2.41	-2.10	0.14	7.51	3.07
6	15.04	-7.60	0.80	2.17	15.93	-5.05
7	9.27	-2.44	0.76	-4.73	-4.26	-1.32
8	0.36	-0.26	-1.51	-0.03	-3.68	1.40
9	-0.66	-0.33	0.40	-0.31	0.99	-0.53
10	0.06	0.09	0.08	0.06	-0.17	-0.01
October 86						
1	-6.00	0.00	-9.10	0.00	0.91	11.91
2	-0.96	0.00	-9.59	0.00	-0.40	18.01
3	1.57	-5.02	7.48	0.00	17.61	-8.64
4	-1.62	3.09	-5.01	-1.41	-3.21	14.08
5	2.26	-4.61	-2.81	0.38	28.70	-10.98
6	1.81	0.15	-5.30	-2.80	4.47	-8.48
7	-0.05	-1.68	-0.98	1.56	-3.37	2.35
8	-0.77	0.21	0.68	-1.75	0.50	0.46
9	0.06	-0.35	0.02	-0.22	-0.60	0.09
10	-0.10	0.14	0.07	0.03	-0.18	0.15

Table A.1 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
December 86						
1	9.93	-1.46	5.80	0.00	2.47	-0.36
2	13.00	-6.63	-9.72	2.81	-3.70	7.38
3	-2.01	5.19	5.01	-0.49	1.95	-3.87
4	-1.07	0.26	-3.37	-1.06	0.97	-2.58
5	4.48	0.43	-2.12	0.12	-0.00	-3.38
6	0.23	-0.57	-0.82	0.50	1.28	-0.68
7	0.39	0.14	0.10	0.11	0.66	-0.43
8	-0.34	-0.03	0.14	0.15	0.27	-0.06
9	0.53	0.07	0.25	-0.21	-0.14	0.23
10	0.05	-0.02	-0.04	0.06	-0.03	0.01
February 87						
1	-9.63	0.00	2.29	0.00	2.17	18.21
2	23.98	-1.44	6.94	0.00	6.68	-53.54
3	5.55	-5.20	3.40	0.00	5.83	-27.04
4	1.04	-0.26	-5.50	5.83	5.04	-6.51
5	-2.97	-1.09	8.98	9.07	4.33	-1.93
6	-0.94	3.00	-14.45	-1.36	19.09	-1.45
7	0.75	0.04	1.46	-1.57	-7.01	-1.19
8	1.00	-1.92	0.19	0.88	9.27	-2.60
9	-1.11	-0.03	-0.03	-0.22	-2.20	2.03
10	-0.01	-0.12	0.12	-0.02	-0.32	-0.33
April 87						
1	49.54	0.00	-91.60	0.00	0.00	0.81
2	3.51	2.29	13.74	0.00	-0.44	-13.03
3	-10.41	9.72	7.42	11.86	1.65	2.50
4	-11.52	7.88	16.33	0.00	6.06	-5.44
5	0.04	-3.32	3.96	-2.78	-4.16	-0.84
6	-2.99	4.21	-2.54	3.30	8.81	1.26
7	-1.32	-3.44	-2.95	-0.92	1.87	-1.47
8	0.58	0.11	-8.67	-3.23	0.08	0.26
9	-0.58	-0.39	-0.28	-0.19	0.67	0.45
10	0.03	-0.01	-0.06	0.01	0.01	0.01

Table A.1 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
June 87						
1	35.66	-5.53	44.26	0.00	5.56	-12.58
2	-17.82	3.44	5.48	0.00	3.61	-3.13
3	14.78	-0.74	2.66	0.00	2.64	-9.26
4	7.45	-2.95	16.46	0.00	0.37	-2.05
5	5.52	-0.95	-11.15	0.22	-5.94	-5.46
6	5.95	-3.28	-1.44	-1.65	1.97	-3.22
7	4.16	-0.05	-8.41	-0.49	2.72	-1.84
8	-0.08	0.16	1.22	-0.79	-0.96	-0.46
9	-0.78	-0.36	-0.23	1.03	0.33	-0.01
10	-0.44	-0.16	0.16	0.03	0.00	0.04
August 87						
1	1.72	0.00	-3.11	0.56	4.21	-1.19
2	2.06	-0.90	-6.32	-0.21	-0.77	5.43
3	3.07	-0.36	-9.96	0.00	-2.43	-7.87
4	6.33	-0.10	-4.08	-0.67	-8.08	0.62
5	2.83	-0.09	3.36	-0.87	-4.65	-1.67
6	2.07	-0.66	-1.48	-2.28	1.67	-3.64
7	-0.21	0.42	-1.57	-0.28	1.33	-1.18
8	0.09	0.07	-0.52	-0.62	-1.29	0.53
9	-0.21	-0.06	0.97	0.21	0.69	0.35
10	-0.09	-0.01	-0.20	-0.01	0.08	0.07
October 87						
1	-3.59	-13.72	-11.40	-4.14	1.89	-2.71
2	9.87	-6.53	-13.59	-20.97	17.27	-0.46
3	-4.07	2.58	1.85	0.78	-2.82	-0.71
4	0.23	-2.71	-7.10	-5.46	6.21	-1.15
5	5.38	4.72	-3.07	-4.92	-1.38	-0.36
6	2.57	-0.78	-4.00	1.43	2.68	-0.62
7	-0.83	1.05	4.33	-0.04	-1.26	-0.04
8	-0.05	-1.04	-1.65	-0.16	-0.65	0.07
9	0.03	0.28	-0.15	0.35	0.12	-0.00
10	0.04	-0.03	0.01	-0.05	-0.01	0.00

Table A.2. Optimal Change in Trader Group Price Pressure and Shadow Prices (in parenthesis) by Contract Subperiod for Model 4 With Intergroup Response Effects Included.

Contract Subperiod	---------- Trader Group ----------					
	LC	MC	LN	MN	OTH	ST
December 83						
1	0.80	1.00	1.20	1.00	1.00	0.80
	(0.74)	(0.00)	(-2.83)	(0.00)	(0.00)	(0.69)
2	0.80	1.20	1.20	0.80	0.80	0.80
	(0.05)	(-1.67)	(-2.73)	(1.32)	(2.48)	(0.76)
3	1.20	0.80	0.80	1.20	0.80	0.80
	(-0.57)	(1.80)	(1.19)	(-0.40)	(0.84)	(0.40)
4	1.20	1.00	0.80	0.80	1.20	0.80
	(-0.71)	(0.00)	(1.38)	(0.82)	(-0.02)	(2.51)
5	0.80	1.20	0.80	0.80	1.20	1.20
	(0.94)	(-0.23)	(2.19)	(0.69)	(-0.95)	(-1.89)
6	0.80	0.80	0.87	0.80	1.20	1.20
	(0.20)	(0.25)	(0.00)	(0.44)	(-0.00)	(-0.39)
7	0.80	1.20	1.20	1.20	0.80	0.80
	(0.04)	(-0.09)	(-0.17)	(-0.48)	(2.33)	(1.18)
8	1.20	1.20	0.80	1.20	0.80	0.90
	(-0.06)	(-1.58)	(0.71)	(-2.32)	(0.45)	(0.00)
9	0.80	0.80	1.20	0.80	1.17	1.20
	(1.83)	(2.39)	(-0.72)	(5.01)	(0.00)	(-1.15)
10	1.20	0.80	0.80	1.20	1.20	0.80
	(-1.09)	(6.46)	(2.82)	(-1.14)	(-0.45)	(17.78)

Table A.2 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
February 84						
1	1.20	1.20	0.80	1.00	1.00	1.20
	(-0.69)	(-2.14)	(14.18)	(0.00)	(0.00)	(-4.57)
2	0.80	1.20	0.80	0.80	0.80	0.80
	(2.92)	(-2.26)	(3.58)	(0.00)	(0.00)	(0.78)
3	1.20	0.80	0.80	1.20	1.20	1.20
	(-0.14)	(0.00)	(6.57)	(0.00)	(-1.23)	(-1.31)
4	0.80	1.20	1.20	0.80	1.20	1.20
	(4.52)	(-1.10)	(-0.65)	(0.00)	(-0.77)	(-0.24)
5	0.80	1.14	1.20	1.20	1.20	1.20
	(4.37)	(0.00)	(-1.37)	(-0.30)	(-0.09)	(-0.57)
6	1.20	0.80	0.88	1.20	0.80	1.20
	(-0.01)	(0.36)	(0.00)	(-0.02)	(0.28)	(-0.11)
7	0.80	1.20	0.80	1.20	0.80	1.20
	(0.53)	(-0.00)	(2.07)	(-0.47)	(1.18)	(-0.46)
8	0.80	0.80	0.80	0.80	0.80	1.20
	(0.83)	(3.91)	(0.01)	(3.81)	(2.01)	(-0.70)
9	0.80	0.80	0.80	1.20	1.20	0.80
	(1.63)	(2.31)	(0.23)	(-1.55)	(-0.16)	(1.66)
10	0.80	1.20	1.20	1.20	1.20	0.80
	(2.77)	(-0.46)	(-0.46)	(-2.06)	(-1.89)	(0.04)
April 84						
1	0.80	1.20	0.80	1.00	0.80	1.20
	(7.45)	(-6.58)	(2.26)	(0.00)	(0.19)	(-1.99)
2	0.80	1.20	0.80	0.80	1.20	1.20
	(5.51)	(-1.75)	(1.64)	(1.97)	(-0.84)	(-1.12)
3	0.80	0.80	0.80	1.20	1.20	0.96
	(0.09)	(1.74)	(2.72)	(-3.80)	(-1.02)	(0.00)
4	0.80	0.80	1.20	0.80	0.80	1.20
	(1.87)	(0.39)	(-0.09)	(0.51)	(1.62)	(-1.34)
5	1.20	0.80	1.20	1.20	1.20	0.80
	(-0.58)	(0.47)	(-1.02)	(-0.01)	(-0.33)	(0.04)
6	0.80	0.80	0.80	0.80	0.80	1.06
	(0.18)	(0.00)	(0.20)	(0.07)	(0.00)	(0.00)
7	0.80	0.80	1.18	0.80	1.20	1.20
	(0.04)	(0.40)	(0.00)	(0.06)	(-0.01)	(-0.32)
8	1.20	1.20	0.80	0.80	0.80	1.20
	(-0.13)	(-0.35)	(1.58)	(0.82)	(0.16)	(-0.18)
9	0.80	0.80	1.20	0.80	0.80	1.20
	(0.65)	(1.14)	(-0.00)	(0.70)	(0.02)	(-0.26)
10	1.20	1.20	0.80	0.80	0.80	0.80
	(-0.68)	(-0.05)	(0.23)	(0.05)	(0.05)	(0.53)

Table A.2 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
June 84						
1	1.20	0.80	0.99	1.00	0.80	0.80
	(-0.03)	(0.17)	(0.00)	(0.00)	(0.07)	(0.00)
2	0.80	0.80	1.20	0.80	1.20	0.80
	(0.18)	(0.02)	(-0.04)	(0.00)	(-0.10)	(0.17)
3	1.20	0.80	1.20	0.80	0.80	0.83
	(-0.02)	(0.00)	(-0.01)	(0.00)	(0.01)	(0.00)
4	0.80	0.80	0.80	1.20	1.20	1.17
	(0.04)	(0.11)	(0.03)	(-0.01)	(-0.00)	(0.00)
5	0.80	0.80	0.80	1.20	1.20	0.80
	(0.04)	(0.02)	(0.01)	(-0.02)	(-0.07)	(0.05)
6	1.20	0.80	0.80	0.80	0.80	1.20
	(-0.01)	(0.06)	(0.14)	(0.06)	(0.07)	(-0.09)
7	0.80	0.80	0.96	0.80	1.20	1.07
	(0.01)	(0.01)	(0.00)	(0.00)	(-0.01)	(0.00)
8	1.20	0.80	0.80	0.80	0.80	0.80
	(-0.09)	(0.01)	(0.23)	(0.12)	(0.17)	(0.03)
9	0.80	1.20	1.20	1.20	0.80	0.80
	(0.03)	(-0.13)	(-0.03)	(-0.13)	(0.04)	(0.14)
10	0.80	0.80	0.80	0.80	0.92	0.80
	(0.06)	(0.01)	(0.06)	(0.01)	(0.00)	(0.07)
August 84						
1	0.88	0.80	1.20	0.80	1.20	0.80
	(0.00)	(0.00)	(-0.00)	(0.04)	(-0.02)	(0.09)
2	0.81	1.20	1.20	1.20	0.80	0.80
	(0.00)	(-0.01)	(-0.00)	(-0.04)	(0.00)	(0.04)
3	0.80	1.02	0.80	0.80	1.04	0.80
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)
4	1.20	0.80	0.80	1.20	0.80	0.80
	(-0.00)	(0.00)	(0.03)	(-0.00)	(0.01)	(0.01)
5	0.80	0.80	0.80	0.88	0.95	1.20
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(-0.01)
6	1.20	0.80	0.80	0.80	0.80	0.80
	(-0.00)	(0.05)	(0.00)	(0.17)	(0.12)	(0.06)
7	1.20	1.20	1.20	0.80	0.80	1.20
	(-0.01)	(-0.02)	(-0.01)	(0.04)	(0.01)	(-0.01)
8	1.20	0.80	0.80	0.80	0.80	1.20
	(-0.01)	(0.01)	(0.01)	(0.01)	(0.10)	(-0.02)
9	1.20	0.80	1.10	0.80	0.80	0.80
	(-0.01)	(0.01)	(0.00)	(0.07)	(0.09)	(0.04)
10	0.80	0.80	1.20	1.20	1.20	0.80
	(0.01)	(0.13)	(-0.01)	(-0.01)	(-0.04)	(0.05)

Table A.2 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
October 84						
1	1.20	0.80	0.80	0.80	1.20	0.80
	(-0.44)	(0.00)	(0.23)	(0.00)	(0.00)	(0.07)
2	0.80	1.20	1.20	1.20	1.20	0.80
	(0.17)	(0.00)	(-0.26)	(0.00)	(-0.03)	(0.11)
3	1.20	0.80	0.80	0.80	0.80	1.20
	(-0.01)	(0.02)	(0.04)	(0.01)	(0.04)	(-0.01)
4	1.01	1.20	0.80	0.80	0.81	0.80
	(0.00)	(-0.00)	(0.03)	(0.01)	(0.00)	(0.00)
5	0.80	0.80	0.82	0.80	0.80	0.98
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)
6	1.20	1.04	0.80	0.80	0.80	0.80
	(-0.03)	(0.00)	(0.01)	(0.05)	(0.00)	(0.02)
7	0.80	0.80	0.80	0.80	0.80	1.20
	(0.02)	(0.00)	(0.04)	(0.03)	(0.12)	(-0.02)
8	0.80	0.80	0.80	1.03	0.80	0.80
	(0.01)	(0.01)	(0.00)	(0.00)	(0.04)	(0.00)
9	0.80	1.20	1.20	0.80	1.20	0.80
	(0.00)	(-0.01)	(-0.01)	(0.06)	(-0.03)	(0.04)
10	0.80	1.20	0.80	0.80	1.20	0.85
	(0.19)	(-0.01)	(0.03)	(0.00)	(-0.06)	(0.00)
December 84						
1	0.80	1.00	0.80	1.00	0.80	1.20
	(0.02)	(0.00)	(0.13)	(0.00)	(0.36)	(-0.52)
2	0.80	1.00	0.80	1.00	0.80	1.20
	(0.20)	(0.00)	(1.38)	(0.00)	(0.03)	(-0.36)
3	0.80	1.20	0.80	1.00	1.20	1.20
	(0.22)	(-0.19)	(0.74)	(0.00)	(-0.58)	(-0.41)
4	0.80	1.20	0.80	1.20	1.20	1.20
	(0.09)	(-0.06)	(0.05)	(-0.32)	(-0.09)	(-0.22)
5	1.20	0.80	1.20	0.80	0.80	0.80
	(-0.07)	(0.27)	(-0.03)	(0.01)	(0.25)	(0.09)
6	1.20	0.80	0.80	0.80	1.20	0.98
	(-0.02)	(0.01)	(0.03)	(0.00)	(-0.01)	(0.00)
7	0.80	0.80	1.20	1.20	1.15	1.20
	(0.00)	(0.00)	(-0.00)	(-0.00)	(0.00)	(-0.00)
8	0.80	1.11	0.80	0.80	1.20	0.80
	(0.02)	(0.00)	(0.12)	(0.01)	(-0.03)	(0.10)
9	0.80	0.80	0.80	0.80	0.80	1.20
	(0.04)	(0.47)	(0.61)	(0.78)	(0.39)	(-0.01)
10	0.80	1.20	1.20	1.20	0.80	1.20
	(0.05)	(-0.13)	(-0.42)	(-0.06)	(0.15)	(-0.12)

Table A.2 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
February 85						
1	1.16	1.00	0.80	1.00	0.80	1.20
	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(-0.00)
2	1.20	1.00	0.80	1.00	0.80	1.20
	(-0.01)	(0.00)	(0.07)	(0.00)	(0.01)	(-0.01)
3	0.80	1.20	0.80	0.80	1.10	0.80
	(0.01)	(-0.01)	(0.01)	(0.00)	(0.00)	(0.01)
4	1.20	1.20	0.80	0.80	0.80	0.80
	(-0.01)	(-0.00)	(0.04)	(0.01)	(0.01)	(0.01)
5	1.20	0.80	0.85	0.80	0.80	0.80
	(-0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
6	1.20	1.20	0.80	0.80	0.80	0.80
	(-0.01)	(-0.01)	(0.01)	(0.01)	(0.02)	(0.01)
7	1.20	0.80	0.80	0.80	0.80	0.80
	(-0.06)	(0.02)	(0.15)	(0.01)	(0.01)	(0.06)
8	1.20	1.20	0.80	1.03	0.80	1.20
	(-0.02)	(-0.00)	(0.01)	(0.00)	(0.01)	(-0.00)
9	1.20	1.20	0.80	0.80	0.80	1.20
	(-0.05)	(-0.02)	(0.24)	(0.03)	(0.16)	(-0.00)
10	1.20	0.80	0.80	0.80	0.80	0.97
	(-0.20)	(0.20)	(0.28)	(0.02)	(0.01)	(0.00)
April 85						
1	1.20	1.20	1.08	1.00	0.80	0.80
	(-0.14)	(-0.73)	(0.00)	(0.00)	(1.75)	(2.51)
2	0.80	1.00	1.20	1.00	0.80	0.80
	(1.98)	(0.00)	(-3.08)	(0.00)	(1.96)	(1.67)
3	1.20	0.80	1.20	0.80	1.20	0.80
	(-0.57)	(0.16)	(-2.23)	(0.00)	(-1.10)	(0.63)
4	0.80	0.80	0.80	0.80	1.20	1.20
	(0.76)	(1.03)	(2.93)	(0.00)	(-0.28)	(-0.54)
5	0.80	1.20	0.80	0.80	0.80	1.20
	(0.10)	(-0.48)	(2.12)	(1.11)	(1.45)	(-0.46)
6	1.20	0.80	1.20	0.80	1.20	0.80
	(-0.57)	(0.22)	(-0.76)	(0.54)	(-0.54)	(0.39)
7	0.90	1.20	1.20	1.20	0.80	1.13
	(0.00)	(-0.11)	(-0.18)	(-0.15)	(0.09)	(0.00)
8	0.80	1.20	0.80	0.80	0.80	1.20
	(0.16)	(-0.05)	(0.29)	(0.31)	(0.83)	(-0.00)
9	1.20	1.20	0.80	0.80	0.80	0.80
	(-1.27)	(-0.26)	(0.56)	(1.94)	(0.34)	(1.84)
10	0.80	0.80	0.80	0.80	1.20	1.20
	(2.71)	(1.62)	(3.32)	(2.45)	(-1.59)	(-1.88)

Table A.2 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
June 85						
1	0.80	1.20	0.80	1.00	0.80	1.20
	(0.04)	(0.00)	(1.91)	(0.00)	(2.16)	(-7.71)
2	0.80	1.00	0.80	0.80	0.80	1.20
	(0.19)	(0.00)	(16.52)	(1.01)	(1.18)	(-0.80)
3	1.20	1.20	0.80	1.20	1.20	0.80
	(-0.08)	(-1.53)	(0.68)	(-3.54)	(-3.77)	(4.43)
4	1.20	1.20	0.80	0.80	0.80	1.20
	(-0.02)	(-3.02)	(1.01)	(1.20)	(5.93)	(-5.34)
5	0.80	0.80	1.20	0.80	1.20	0.80
	(0.04)	(1.27)	(-1.71)	(1.42)	(-1.43)	(5.45)
6	0.80	0.80	1.20	1.20	1.20	0.80
	(0.04)	(0.05)	(-0.17)	(-0.47)	(-3.68)	(2.87)
7	0.80	0.80	1.20	1.20	0.80	1.20
	(0.01)	(1.13)	(-1.07)	(-0.86)	(1.59)	(-0.43)
8	1.20	0.80	1.20	0.80	0.87	0.80
	(-0.00)	(0.50)	(-0.30)	(0.26)	(0.00)	(0.26)
9	1.20	0.80	0.80	1.20	1.20	0.80
	(-0.01)	(1.18)	(0.88)	(-0.67)	(-2.55)	(0.55)
10	0.80	0.80	0.80	1.20	0.80	0.80
	(0.01)	(2.53)	(1.20)	(-0.45)	(4.97)	(2.45)
August 85						
1	0.80	1.20	1.20	0.80	1.20	0.80
	(0.46)	(-1.70)	(-3.88)	(0.87)	(-0.39)	(6.37)
2	0.80	0.80	0.80	0.80	0.80	1.20
	(1.41)	(0.46)	(11.48)	(0.00)	(0.00)	(-2.58)
3	1.20	1.20	1.20	1.20	0.80	0.80
	(-6.96)	(-1.97)	(-0.27)	(-5.24)	(1.61)	(8.92)
4	1.20	0.80	1.20	0.80	0.80	0.80
	(-3.10)	(2.61)	(-2.94)	(0.34)	(0.34)	(3.35)
5	1.20	1.20	0.80	0.80	0.80	1.20
	(-1.72)	(-0.13)	(3.56)	(0.35)	(0.81)	(-1.17)
6	1.20	1.20	0.80	0.80	1.20	0.80
	(-1.16)	(-0.49)	(0.88)	(0.74)	(-1.56)	(0.39)
7	0.98	0.96	1.20	0.80	1.20	1.20
	(0.00)	(0.00)	(-0.21)	(0.25)	(-0.64)	(-0.20)
8	0.80	0.80	0.80	1.20	0.80	0.94
	(3.81)	(2.33)	(1.22)	(-0.65)	(2.17)	(0.00)
9	0.80	0.80	0.80	0.80	1.11	0.80
	(1.15)	(0.63)	(0.72)	(3.61)	(0.00)	(4.90)
10	1.20	0.80	0.80	0.81	1.20	0.80
	(-1.39)	(1.74)	(0.66)	(0.00)	(-0.46)	(2.62)

Table A.2 continued	--------- Trader Group ---------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
October 85						
1	0.80	1.20	0.80	0.80	0.80	1.20
	(0.29)	(0.00)	(0.81)	(0.00)	(0.37)	(-0.50)
2	1.20	1.20	0.80	0.80	0.80	1.20
	(-0.12)	(-0.09)	(0.02)	(0.04)	(0.17)	(-0.02)
3	0.80	1.20	1.01	0.80	0.80	1.20
	(0.05)	(-0.01)	(0.00)	(0.01)	(0.03)	(-0.06)
4	0.80	1.20	1.20	0.80	0.80	0.80
	(0.06)	(-0.01)	(-0.06)	(0.00)	(0.00)	(0.02)
5	1.20	1.20	1.20	0.80	0.80	0.80
	(-0.01)	(-0.02)	(-0.04)	(0.00)	(0.00)	(0.04)
6	0.80	0.80	0.80	0.80	0.80	1.20
	(0.04)	(0.62)	(0.24)	(0.00)	(0.89)	(-0.35)
7	0.80	1.20	0.80	1.13	1.16	1.20
	(0.18)	(-0.03)	(0.01)	(0.00)	(0.00)	(-0.06)
8	0.80	0.80	1.11	0.80	0.88	1.20
	(0.38)	(0.35)	(0.00)	(0.15)	(0.00)	(-0.39)
9	0.80	0.80	0.80	1.14	0.80	1.20
	(0.35)	(0.82)	(2.03)	(0.00)	(2.63)	(-0.35)
10	0.80	0.95	1.20	1.20	1.12	0.80
	(2.38)	(0.00)	(-1.42)	(-0.01)	(0.00)	(6.41)
December 85						
1	0.80	0.80	1.20	1.00	1.20	0.80
	(0.09)	(0.02)	(-0.14)	(0.00)	(-0.10)	(0.41)
2	0.80	1.20	1.20	0.80	1.20	0.80
	(0.49)	(-0.35)	(-0.07)	(0.15)	(-0.09)	(0.04)
3	1.20	0.80	0.80	1.00	0.80	1.20
	(-0.48)	(0.81)	(0.70)	(0.00)	(0.30)	(-0.45)
4	1.20	0.80	0.80	0.80	0.80	1.20
	(-0.62)	(0.27)	(0.68)	(0.44)	(2.42)	(-0.29)
5	0.80	0.80	1.20	0.80	1.18	0.80
	(0.76)	(0.11)	(-0.74)	(0.10)	(0.00)	(0.90)
6	1.20	1.20	1.13	1.20	0.80	0.83
	(-0.09)	(-0.04)	(0.00)	(-0.10)	(0.14)	(0.00)
7	0.80	0.80	0.80	0.80	0.80	1.02
	(0.11)	(0.68)	(0.13)	(0.54)	(0.98)	(0.00)
8	0.80	0.80	0.80	0.80	1.20	0.80
	(0.48)	(0.86)	(0.82)	(0.66)	(-0.93)	(1.19)
9	1.20	0.80	0.80	0.80	0.80	1.20
	(-0.10)	(0.84)	(0.19)	(1.01)	(0.85)	(-0.80)
10	1.20	0.97	0.80	0.80	0.80	1.20
	(-0.00)	(0.00)	(0.09)	(0.01)	(0.09)	(-0.00)

Table A.2 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
February 86						
1	1.20	0.80	0.80	1.00	1.20	0.80
	(-2.27)	(0.00)	(3.54)	(0.00)	(-0.17)	(0.44)
2	1.20	1.20	1.04	0.80	0.80	0.80
	(-1.08)	(-0.09)	(0.00)	(0.13)	(0.48)	(0.01)
3	1.07	0.80	0.80	0.80	1.20	1.20
	(0.00)	(0.01)	(0.15)	(0.01)	(-0.06)	(-0.10)
4	0.80	1.14	1.10	0.80	0.80	0.80
	(0.02)	(0.00)	(0.00)	(0.01)	(0.04)	(0.01)
5	0.80	1.16	0.80	0.80	0.80	0.80
	(0.40)	(0.00)	(0.00)	(0.07)	(0.06)	(0.23)
6	1.20	0.80	0.80	0.80	1.20	0.80
	(-0.23)	(0.05)	(0.62)	(0.13)	(-0.13)	(0.13)
7	1.20	0.80	1.07	1.20	1.20	0.80
	(-0.05)	(0.29)	(0.00)	(-0.12)	(-0.01)	(0.01)
8	0.80	1.06	1.20	0.80	0.80	0.80
	(0.86)	(0.00)	(-0.23)	(0.09)	(0.79)	(0.10)
9	1.02	0.80	0.87	0.80	0.80	0.80
	(0.00)	(0.32)	(0.00)	(0.41)	(0.77)	(1.29)
10	1.20	1.20	0.80	0.80	1.20	0.80
	(-0.86)	(-0.04)	(2.98)	(0.26)	(-2.18)	(0.57)
April 86						
1	1.20	0.80	1.00	1.00	0.80	1.20
	(-0.05)	(0.00)	(0.00)	(0.00)	(0.15)	(-1.63)
2	0.80	0.80	1.20	0.80	0.80	1.20
	(0.45)	(0.57)	(-0.65)	(0.00)	(0.05)	(-0.81)
3	0.96	0.80	0.80	0.80	0.80	0.80
	(0.00)	(0.04)	(0.47)	(1.38)	(0.23)	(0.69)
4	0.80	1.20	1.20	1.20	0.80	1.20
	(1.18)	(-0.18)	(-0.56)	(-0.06)	(0.33)	(-0.08)
5	1.20	0.89	0.80	1.20	1.20	0.80
	(-0.20)	(0.00)	(0.14)	(-0.16)	(-0.03)	(0.16)
6	0.80	0.80	1.12	0.80	1.12	1.20
	(0.15)	(0.05)	(0.00)	(0.02)	(0.00)	(-0.00)
7	1.20	0.80	0.80	0.80	0.80	0.80
	(-0.01)	(0.00)	(0.00)	(0.04)	(0.01)	(0.04)
8	0.80	1.20	0.93	0.80	0.80	1.20
	(0.46)	(-0.09)	(0.00)	(0.14)	(0.16)	(-0.14)
9	1.00	0.80	0.80	1.20	0.80	0.80
	(0.00)	(0.08)	(0.54)	(-0.03)	(0.04)	(0.02)
10	1.20	0.80	0.80	0.80	1.13	0.80
	(-0.40)	(0.04)	(0.54)	(0.15)	(0.00)	(0.26)

Table A.2 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
June 86						
1	1.20	0.99	0.80	1.00	0.80	0.80
	(-3.36)	(0.00)	(2.54)	(0.00)	(0.16)	(6.22)
2	1.20	1.20	0.80	0.80	0.80	1.20
	(-0.49)	(-1.08)	(0.40)	(0.00)	(0.00)	(-0.07)
3	0.80	0.80	1.20	0.80	1.20	0.80
	(0.24)	(0.09)	(-0.31)	(0.00)	(-0.04)	(0.13)
4	0.80	1.20	1.20	1.20	0.80	0.80
	(0.14)	(-0.04)	(-0.58)	(0.00)	(0.02)	(0.18)
5	1.20	1.20	1.13	1.20	0.80	1.20
	(-0.02)	(-0.00)	(0.00)	(-0.00)	(0.01)	(-0.01)
6	0.80	0.80	1.15	0.80	1.07	1.20
	(0.41)	(0.21)	(0.00)	(0.13)	(0.00)	(-0.14)
7	0.80	1.20	1.20	1.20	1.20	1.20
	(1.59)	(-0.16)	(-0.01)	(-0.01)	(-0.11)	(-0.66)
8	0.80	0.80	0.80	1.20	0.95	0.80
	(0.53)	(0.08)	(0.82)	(-0.15)	(0.00)	(1.27)
9	0.80	1.20	1.01	1.20	0.80	0.80
	(0.01)	(-0.01)	(0.00)	(-0.00)	(0.10)	(0.05)
10	1.00	1.20	0.80	0.80	0.84	0.80
	(0.00)	(-0.05)	(0.28)	(0.02)	(0.00)	(0.38)
August 86						
1	0.80	0.80	0.80	1.00	0.80	0.88
	(0.01)	(0.00)	(0.07)	(0.00)	(0.00)	(0.00)
2	1.20	1.20	1.14	0.80	0.80	0.86
	(-0.02)	(0.00)	(0.00)	(0.00)	(0.12)	(0.00)
3	0.80	0.80	0.89	0.80	0.80	1.20
	(0.04)	(0.01)	(0.00)	(0.00)	(0.01)	(-0.07)
4	1.20	0.80	0.80	1.20	1.20	1.20
	(-0.17)	(0.15)	(0.49)	(0.00)	(-0.10)	(-0.15)
5	0.80	1.20	1.20	0.80	0.80	0.80
	(0.09)	(-0.08)	(-0.08)	(0.01)	(0.28)	(0.13)
6	0.94	1.16	1.20	1.20	0.80	0.80
	(0.00)	(0.00)	(-0.10)	(-0.08)	(0.08)	(0.33)
7	1.15	1.20	0.86	0.80	0.80	0.80
	(0.00)	(-0.26)	(0.00)	(0.26)	(0.27)	(1.67)
8	1.20	0.80	0.80	1.20	0.80	0.80
	(-0.12)	(0.04)	(2.24)	(-0.46)	(5.14)	(0.29)
9	0.80	0.80	1.20	0.80	1.14	0.80
	(6.50)	(2.08)	(-2.46)	(0.44)	(0.00)	(0.56)
10	0.80	1.20	0.95	1.20	0.80	1.20
	(5.81)	(-0.83)	(0.00)	(-1.07)	(8.35)	(-0.97)

Table A.2 continued	--------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
October 86						
1	1.20	0.80	1.20	1.00	0.80	0.80
	(-2.70)	(0.00)	(-3.99)	(0.00)	(0.36)	(5.31)
2	1.20	1.20	1.20	0.80	1.20	0.80
	(-0.36)	(0.00)	(-3.39)	(0.00)	(-0.21)	(6.92)
3	0.80	1.20	0.80	0.80	0.80	1.17
	(0.44)	(-1.67)	(1.66)	(0.00)	(5.71)	(0.00)
4	1.20	0.80	0.98	1.20	1.20	0.80
	(-0.45)	(0.83)	(0.00)	(-0.43)	(-1.22)	(4.48)
5	0.99	1.20	1.20	0.80	0.80	1.20
	(0.00)	(-0.60)	(-0.44)	(0.02)	(3.06)	(-0.65)
6	1.20	1.20	0.80	0.80	0.89	0.80
	(-0.80)	(-0.03)	(3.11)	(0.55)	(0.00)	(3.40)
7	1.20	0.80	0.80	1.20	0.80	1.20
	(-0.07)	(2.28)	(1.99)	(-0.86)	(4.81)	(-2.95)
8	0.80	1.20	1.20	0.80	1.20	0.97
	(0.95)	(-0.71)	(-1.72)	(4.32)	(-0.87)	(0.00)
9	1.10	0.80	1.20	0.80	0.80	0.80
	(0.00)	(1.74)	(-0.61)	(1.38)	(3.11)	(0.01)
10	0.80	1.20	1.20	0.80	0.80	1.20
	(3.61)	(-0.58)	(-0.22)	(1.26)	(0.59)	(-0.58)
December 86						
1	0.80	1.20	0.80	1.00	0.80	0.96
	(3.87)	(-0.55)	(2.13)	(0.00)	(0.91)	(0.00)
2	0.80	1.04	1.20	0.80	1.20	0.80
	(3.49)	(0.00)	(-3.03)	(0.90)	(-1.86)	(2.88)
3	1.20	0.80	0.80	1.20	0.80	1.20
	(-0.48)	(0.96)	(1.02)	(-0.08)	(0.36)	(-0.78)
4	1.20	1.20	0.80	1.20	0.80	0.99
	(-0.03)	(-0.11)	(0.09)	(-0.08)	(0.07)	(0.00)
5	1.01	0.80	0.80	0.80	0.96	0.80
	(0.00)	(0.15)	(0.29)	(0.03)	(0.00)	(0.20)
6	0.80	0.80	0.80	1.20	1.20	0.80
	(0.02)	(0.03)	(0.06)	(-0.02)	(-0.03)	(0.01)
7	1.20	1.18	1.01	0.80	0.91	0.80
	(-0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.02)
8	1.20	1.20	0.80	1.06	0.80	1.20
	(-0.00)	(-0.04)	(0.19)	(0.00)	(0.24)	(-0.09)
9	0.80	0.80	0.80	1.20	1.20	0.80
	(0.64)	(0.07)	(0.29)	(-0.27)	(-0.15)	(0.27)
10	0.80	1.20	1.20	0.80	1.20	1.17
	(0.05)	(-0.01)	(-0.01)	(0.07)	(-0.03)	(0.00)

Table A.2 continued	--------- Trader Group ---------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
February 87						
1	1.20 (-5.10)	1.20 (0.00)	0.80 (0.67)	1.00 (0.00)	0.80 (1.06)	0.80 (10.09)
2	0.80 (10.82)	1.20 (-0.61)	1.20 (-5.04)	0.80 (0.00)	0.80 (2.64)	1.07 (0.00)
3	0.80 (2.09)	1.20 (-1.83)	0.80 (1.48)	1.20 (0.00)	0.80 (1.83)	1.20 (-9.95)
4	0.80 (0.15)	1.20 (-0.11)	1.20 (-1.37)	0.80 (1.88)	0.80 (1.59)	1.20 (-1.68)
5	1.20 (-0.68)	1.20 (-0.28)	0.80 (1.95)	0.80 (1.97)	0.80 (1.11)	1.20 (-0.33)
6	1.20 (-0.34)	0.80 (0.28)	1.00 (0.00)	1.20 (-0.26)	0.80 (2.72)	1.20 (-0.47)
7	1.20 (-0.04)	1.20 (-0.01)	1.17 (0.00)	0.80 (0.08)	0.80 (0.58)	1.20 (-0.05)
8	1.20 (-0.43)	0.80 (1.08)	0.80 (0.06)	1.20 (-0.47)	1.20 (-2.39)	0.80 (0.69)
9	0.80 (2.58)	0.80 (0.51)	0.80 (0.03)	0.80 (0.11)	0.80 (3.74)	1.20 (-3.71)
10	0.80 (0.63)	0.80 (1.55)	1.20 (-3.29)	1.20 (-0.39)	0.80 (3.00)	0.80 (7.85)
April 87						
1	0.80 (22.70)	1.20 (0.00)	1.20 (-42.88)	1.00 (0.00)	0.80 (0.00)	0.80 (0.68)
2	0.80 (1.59)	0.80 (0.96)	0.80 (5.93)	0.80 (0.00)	1.20 (-0.25)	1.20 (-5.23)
3	1.20 (-3.21)	0.80 (3.06)	0.80 (2.62)	0.80 (3.02)	0.80 (0.50)	0.80 (1.05)
4	1.20 (-2.33)	0.80 (1.98)	0.80 (4.41)	0.80 (0.00)	0.80 (1.12)	1.20 (-1.21)
5	0.80 (0.05)	1.20 (-0.29)	0.80 (0.62)	1.20 (-0.27)	1.20 (-0.59)	1.20 (-0.13)
6	0.80 (0.49)	1.20 (-0.35)	0.80 (0.79)	1.20 (-0.76)	1.04 (0.00)	1.20 (-0.57)
7	0.80 (0.82)	0.80 (2.50)	0.80 (1.92)	0.80 (0.58)	0.80 (0.27)	0.80 (0.64)
8	1.20 (-1.29)	1.20 (-0.96)	0.80 (17.90)	0.80 (4.32)	0.80 (1.71)	1.20 (-1.00)
9	0.80 (7.20)	0.80 (3.42)	0.80 (1.92)	1.20 (-2.01)	0.80 (2.23)	1.20 (-3.09)
10	1.20 (-1.90)	0.80 (4.08)	1.20 (-0.70)	1.20 (-1.69)	1.20 (-0.24)	0.80 (5.12)

Table A.2 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
June 87						
1	0.80	1.20	0.80	1.00	0.80	1.20
	(22.05)	(-3.40)	(26.39)	(0.00)	(3.38)	(-7.69)
2	1.20	0.80	0.80	0.80	0.80	1.20
	(-9.54)	(1.81)	(2.92)	(0.00)	(2.07)	(-1.86)
3	0.80	1.20	0.80	0.80	0.80	1.20
	(7.06)	(-0.35)	(1.13)	(0.00)	(1.23)	(-4.41)
4	0.80	1.20	0.80	0.80	1.20	1.20
	(2.62)	(-1.22)	(6.53)	(0.00)	(-0.01)	(-0.58)
5	0.80	1.20	0.96	1.20	1.20	1.20
	(0.67)	(-0.15)	(0.00)	(-0.48)	(-1.82)	(-0.16)
6	1.20	1.20	1.20	1.20	0.80	1.20
	(-0.30)	(-0.09)	(-0.06)	(-0.01)	(0.41)	(-0.04)
7	1.17	1.20	0.80	0.80	0.86	0.80
	(0.00)	(-0.01)	(2.57)	(1.47)	(0.00)	(0.49)
8	0.80	1.20	1.20	0.80	0.80	0.80
	(0.56)	(-0.08)	(-1.40)	(1.03)	(1.35)	(0.57)
9	0.80	0.80	0.80	1.16	1.20	0.80
	(3.25)	(1.01)	(1.60)	(0.00)	(-2.03)	(0.81)
10	0.80	0.80	1.20	1.20	0.80	1.20
	(6.71)	(0.20)	(-2.08)	(-0.41)	(1.40)	(-0.33)
August 87						
1	0.80	1.20	1.20	0.80	0.80	1.20
	(1.14)	(0.00)	(-2.11)	(0.35)	(2.72)	(-0.84)
2	0.80	1.20	1.20	1.20	1.20	0.80
	(1.18)	(-0.61)	(-3.53)	(-0.13)	(-0.42)	(3.24)
3	1.20	1.20	1.09	0.80	1.20	1.20
	(-0.36)	(-0.17)	(0.00)	(0.00)	(-1.04)	(-0.70)
4	0.80	1.20	1.20	1.20	0.97	0.80
	(1.83)	(-0.03)	(-1.80)	(-0.17)	(0.00)	(0.26)
5	0.80	1.20	0.80	1.20	1.20	1.20
	(0.54)	(-0.03)	(0.72)	(-0.28)	(-0.61)	(-0.18)
6	0.98	0.80	0.97	1.20	0.80	1.20
	(0.00)	(0.00)	(0.00)	(-0.02)	(0.03)	(-0.05)
7	0.80	1.20	0.80	0.80	1.07	0.80
	(0.02)	(-0.02)	(0.17)	(0.09)	(0.00)	(0.05)
8	1.20	1.20	0.80	0.80	0.80	1.20
	(-0.00)	(-0.00)	(0.04)	(0.07)	(0.11)	(-0.04)
9	0.80	1.20	1.20	0.80	0.80	0.91
	(0.01)	(-0.00)	(-0.03)	(0.00)	(0.01)	(0.00)
10	0.80	1.20	0.80	1.20	0.80	1.20
	(0.72)	(-0.05)	(0.14)	(-0.07)	(0.48)	(-0.47)

Table A.2 continued	--------- Trader Group ---------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
October 87						
1	1.20	1.20	1.20	1.20	0.80	1.20
	(-1.70)	(-7.20)	(-6.33)	(-1.92)	(0.87)	(-1.50)
2	0.80	0.80	1.20	1.17	0.80	1.20
	(4.18)	(6.20)	(-5.04)	(0.00)	(8.59)	(-0.56)
3	1.20	0.80	0.80	0.80	1.20	1.20
	(-1.38)	(0.97)	(0.96)	(0.26)	(-0.69)	(-0.32)
4	0.80	1.20	1.20	1.20	0.80	1.20
	(0.07)	(-0.79)	(-1.70)	(-1.10)	(1.57)	(-0.29)
5	0.80	0.80	1.20	1.20	1.20	1.20
	(0.98)	(0.70)	(-0.48)	(-0.71)	(-0.21)	(-0.08)
6	0.80	0.80	1.20	0.80	0.80	1.20
	(0.21)	(0.01)	(-0.39)	(0.12)	(0.14)	(-0.05)
7	1.20	1.20	0.96	0.80	0.80	1.20
	(-0.03)	(-0.01)	(0.00)	(0.33)	(0.53)	(-0.04)
8	1.20	0.80	0.80	1.20	0.80	0.80
	(-0.02)	(1.54)	(1.06)	(-0.10)	(0.23)	(0.03)
9	0.80	0.80	1.20	0.80	0.80	1.20
	(0.01)	(0.54)	(-0.15)	(1.49)	(0.67)	(-0.01)
10	0.80	1.20	0.80	1.20	1.20	1.20
	(0.06)	(-0.07)	(0.01)	(-0.14)	(-0.00)	(-0.01)

Table A.3. Optimal Change in Trader Group Price Pressure and Shadow Prices (in parenthesis) by Contract Subperiod for Models 5-10 With Intergroup Response Effects Included.

	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
December 83						
1	0.80	1.00	1.20	1.00	1.00	0.80
	(0.72)	(0.00)	(-2.27)	(0.00)	(0.00)	(1.39)
2	0.80	1.20	1.20	0.80	0.80	0.80
	(0.05)	(-2.29)	(-2.17)	(3.58)	(5.28)	(1.51)
3	1.20	0.80	0.80	1.20	0.80	0.80
	(-0.48)	(2.46)	(0.98)	(-1.19)	(1.86)	(1.15)
4	1.20	1.00	0.80	0.80	1.20	0.80
	(-0.52)	(0.00)	(0.88)	(2.62)	(-0.01)	(6.54)
5	0.93	1.20	0.91	0.80	1.20	1.20
	(0.00)	(-0.31)	(0.00)	(2.53)	(-2.84)	(-7.43)
6	1.00	0.98	1.20	0.80	1.00	1.00
	(0.00)	(0.00)	(-2.32)	(4.69)	(0.00)	(0.00)
7	1.20	1.20	1.20	1.20	0.81	1.05
	(-0.52)	(-0.09)	(-1.99)	(-0.15)	(0.00)	(0.00)
8	1.20	1.20	0.80	1.07	0.80	1.04
	(-0.34)	(-2.55)	(1.89)	(0.00)	(0.49)	(0.00)
9	0.80	0.80	1.20	0.80	0.80	1.20
	(3.50)	(3.64)	(-1.58)	(1.22)	(0.26)	(-0.79)
10	1.20	1.00	0.80	1.20	1.20	0.80
	(-1.84)	(0.00)	(5.13)	(-0.56)	(-0.38)	(13.06)

Table A.3 continued	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
February 84						
1	1.20	1.20	0.80	1.00	1.00	1.20
	(-0.60)	(0.00)	(5.87)	(0.00)	(0.00)	(-4.61)
2	0.80	1.20	0.80	0.80	0.80	0.80
	(2.70)	(-0.20)	(0.91)	(0.00)	(0.00)	(0.69)
3	1.20	0.80	1.03	1.20	1.20	1.20
	(-0.42)	(0.00)	(0.00)	(0.00)	(-2.52)	(-1.08)
4	0.80	1.20	1.20	0.80	1.20	1.20
	(2.19)	(-3.09)	(-0.05)	(0.00)	(-1.73)	(-0.16)
5	0.98	0.94	0.92	1.20	0.80	0.97
	(0.00)	(0.00)	(0.00)	(-1.56)	(0.14)	(0.00)
6	0.80	0.80	1.20	1.20	0.80	1.20
	(0.30)	(1.45)	(-5.51)	(-0.30)	(1.06)	(-1.43)
7	0.80	0.80	0.80	0.80	0.99	1.20
	(2.50)	(-0.06)	(11.19)	(0.86)	(0.00)	(-1.23)
8	0.80	0.94	1.00	1.00	1.00	1.20
	(2.25)	(0.00)	(0.00)	(0.00)	(0.00)	(-1.93)
9	1.00	0.80	0.80	0.94	1.20	1.00
	(0.00)	(0.55)	(0.39)	(0.00)	(-0.10)	(0.00)
10	0.80	1.20	1.20	1.20	1.20	0.80
	(8.31)	(-0.12)	(-2.06)	(-0.01)	(-1.62)	(0.11)
April 84						
1	0.80	1.20	0.80	1.00	0.80	1.20
	(7.68)	(-8.60)	(2.24)	(0.00)	(0.13)	(-2.48)
2	0.80	1.20	0.80	0.80	1.20	1.20
	(5.69)	(-2.42)	(1.40)	(2.44)	(-0.47)	(-1.47)
3	0.86	0.80	0.80	1.20	1.20	1.04
	(0.00)	(2.74)	(3.16)	(-4.82)	(-0.37)	(0.00)
4	0.80	0.80	1.07	0.80	0.88	1.20
	(1.79)	(0.73)	(0.00)	(0.66)	(0.00)	(-1.88)
5	0.82	0.80	1.20	0.99	0.80	0.80
	(0.00)	(1.04)	(-0.08)	(0.00)	(1.00)	(0.04)
6	0.80	1.20	0.80	0.80	1.20	0.93
	(1.31)	(-0.28)	(1.04)	(0.29)	(-0.95)	(0.00)
7	1.00	0.94	1.00	1.00	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
8	1.20	1.20	0.80	0.80	0.80	1.20
	(-0.05)	(-0.27)	(6.30)	(2.15)	(0.61)	(-0.42)
9	0.80	0.80	1.20	1.00	1.00	1.20
	(2.12)	(1.41)	(-0.18)	(0.00)	(0.00)	(-0.59)
10	1.20	1.20	0.80	0.83	0.80	0.80
	(-2.58)	(-0.09)	(0.86)	(0.00)	(0.36)	(1.34)

Table A.3 continued	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
June 84						
1	1.20	0.80	1.00	1.00	1.08	0.89
	(-0.01)	(0.20)	(0.00)	(0.00)	(0.00)	(0.00)
2	1.20	0.80	0.80	0.80	0.80	0.97
	(-0.09)	(0.04)	(0.07)	(0.00)	(0.02)	(0.00)
3	1.20	0.80	1.20	0.80	0.80	0.80
	(-0.01)	(0.01)	(-0.55)	(0.01)	(0.14)	(0.47)
4	0.80	0.80	0.80	1.20	1.20	1.20
	(0.24)	(0.24)	(0.19)	(-0.07)	(-0.02)	(-0.02)
5	0.80	0.80	0.80	1.20	1.20	0.80
	(0.41)	(0.03)	(0.05)	(-0.15)	(-0.71)	(0.21)
6	1.20	0.90	0.80	0.80	0.80	1.20
	(-0.02)	(0.00)	(0.83)	(0.26)	(0.35)	(-0.32)
7	0.88	0.80	0.80	1.20	1.20	1.16
	(0.00)	(0.04)	(0.06)	(-0.05)	(-0.02)	(0.00)
8	1.20	0.80	0.80	1.09	0.80	0.80
	(-0.12)	(0.11)	(0.08)	(0.00)	(0.18)	(0.06)
9	0.80	1.20	1.20	1.20	0.80	0.80
	(0.04)	(-0.68)	(-0.02)	(-0.10)	(0.04)	(0.36)
10	1.20	0.80	0.80	0.80	1.20	0.80
	(-0.10)	(0.15)	(0.03)	(0.01)	(-0.10)	(0.44)
August 84						
1	1.20	0.80	0.80	0.80	1.20	0.80
	(-0.05)	(0.00)	(0.01)	(0.50)	(-0.68)	(0.44)
2	0.80	1.20	1.20	1.20	0.80	0.80
	(0.01)	(0.00)	(-0.10)	(-0.86)	(0.03)	(0.50)
3	1.20	0.80	1.20	0.80	0.80	0.80
	(-0.21)	(0.29)	(-0.29)	(0.17)	(0.20)	(0.03)
4	1.20	0.80	0.80	1.20	1.20	1.00
	(-0.08)	(0.01)	(0.24)	(-0.03)	(-0.30)	(0.00)
5	1.20	0.99	0.89	1.20	1.20	1.20
	(-0.04)	(0.00)	(0.00)	(-0.01)	(-0.05)	(-0.39)
6	1.08	0.80	0.80	0.80	0.84	0.80
	(0.00)	(0.11)	(0.01)	(0.26)	(0.00)	(0.17)
7	1.20	1.20	1.20	0.80	1.20	1.20
	(-0.02)	(0.00)	(-0.02)	(0.07)	(-0.00)	(-0.05)
8	1.20	0.80	0.80	1.20	0.80	1.20
	(-0.01)	(0.02)	(0.01)	(-0.00)	(0.00)	(-0.17)
9	1.20	0.80	0.80	1.16	0.80	0.80
	(-0.07)	(0.01)	(0.14)	(0.00)	(0.12)	(0.10)
10	1.20	0.80	1.20	1.20	1.20	0.80
	(-0.04)	(0.45)	(-0.08)	(-0.04)	(-0.06)	(0.34)

Table A.3 continued	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
October 84						
1	1.20	0.80	0.80	0.80	1.20	0.80
	(-1.14)	(0.00)	(0.51)	(0.00)	(0.00)	(0.18)
2	0.80	1.20	1.20	1.20	1.20	0.80
	(0.48)	(0.00)	(-0.62)	(0.00)	(-0.36)	(0.47)
3	1.20	0.80	0.80	0.80	0.80	1.20
	(-0.07)	(0.09)	(0.08)	(0.43)	(0.31)	(-0.05)
4	1.20	0.80	0.92	0.80	1.20	0.80
	(-0.13)	(0.07)	(0.00)	(0.08)	(-0.24)	(0.04)
5	1.20	1.20	0.80	0.80	0.80	0.80
	(-0.03)	(-0.05)	(0.03)	(0.20)	(0.28)	(0.08)
6	0.86	1.20	1.20	0.80	1.20	1.01
	(0.00)	(-0.39)	(-0.00)	(0.37)	(-0.28)	(0.00)
7	0.80	0.80	0.80	0.86	1.03	1.20
	(0.03)	(0.01)	(0.46)	(0.00)	(0.00)	(-0.14)
8	1.20	1.09	0.80	0.80	0.80	0.80
	(-0.47)	(0.00)	(0.32)	(0.14)	(0.05)	(0.03)
9	1.20	1.20	1.20	0.80	0.96	0.80
	(-0.10)	(-0.04)	(-0.16)	(0.38)	(0.00)	(0.47)
10	0.80	1.20	0.80	1.20	1.20	0.80
	(0.94)	(-0.13)	(0.72)	(-0.03)	(-0.20)	(0.16)
December 84						
1	0.80	1.00	0.80	1.00	0.80	1.20
	(0.02)	(0.00)	(0.20)	(0.00)	(0.59)	(-0.77)
2	0.80	1.00	0.80	1.00	0.80	1.20
	(0.21)	(0.00)	(2.54)	(0.00)	(0.05)	(-0.72)
3	0.80	1.20	0.80	1.00	1.20	1.20
	(0.20)	(-0.45)	(1.82)	(0.00)	(-1.40)	(-0.98)
4	0.87	1.20	0.80	1.20	1.20	1.20
	(0.00)	(-0.20)	(0.00)	(-2.45)	(-0.33)	(-0.77)
5	1.00	0.80	1.00	1.20	0.80	0.91
	(0.00)	(1.03)	(0.00)	(-0.14)	(0.96)	(0.00)
6	0.80	0.92	0.80	1.20	0.98	0.81
	(0.17)	(0.00)	(0.28)	(-0.64)	(0.00)	(0.00)
7	0.80	0.80	0.81	1.20	1.20	1.20
	(0.38)	(0.01)	(0.00)	(-0.04)	(-0.33)	(-0.18)
8	0.99	1.00	0.99	0.96	1.00	0.80
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.35)
9	0.80	0.80	0.80	0.80	0.80	1.20
	(0.29)	(1.48)	(1.56)	(0.47)	(1.09)	(-0.05)
10	0.80	1.20	1.20	1.20	0.80	1.20
	(0.36)	(-0.61)	(-1.28)	(-0.04)	(0.57)	(-0.56)

Table A.3 continued	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
February 85						
1	1.20	1.00	0.80	1.00	1.20	1.20
	(-0.23)	(-1.80)	(0.11)	(0.00)	(-0.04)	(-0.07)
2	1.20	1.00	0.80	1.00	0.80	1.20
	(-0.05)	(0.00)	(0.15)	(0.00)	(0.09)	(-0.05)
3	1.20	0.80	0.80	1.20	0.80	1.20
	(-0.06)	(-2.09)	(0.02)	(-0.05)	(0.07)	(-0.03)
4	1.20	1.20	0.80	0.80	0.80	0.80
	(-0.03)	(-0.04)	(0.03)	(0.06)	(0.03)	(0.05)
5	1.20	0.80	0.80	0.80	1.15	0.80
	(-0.02)	(-0.06)	(0.00)	(0.03)	(0.00)	(0.03)
6	1.20	1.00	0.80	0.80	0.80	1.00
	(-0.07)	(0.00)	(0.03)	(0.11)	(0.05)	(0.00)
7	0.85	0.80	0.80	0.80	0.80	1.20
	(0.00)	(0.17)	(0.00)	(0.02)	(0.01)	(-0.12)
8	1.20	0.80	0.80	1.09	1.20	0.80
	(-0.04)	(0.00)	(0.23)	(0.00)	(-0.26)	(0.03)
9	1.20	1.06	0.80	0.80	0.80	1.20
	(-0.35)	(0.00)	(1.09)	(0.12)	(0.85)	(-0.01)
10	1.20	0.80	0.80	0.80	0.80	0.80
	(-0.95)	(0.00)	(0.87)	(0.06)	(0.08)	(0.08)
April 85						
1	1.20	1.20	1.11	1.00	0.80	0.80
	(-0.35)	(-0.87)	(0.00)	(0.00)	(3.85)	(6.08)
2	0.80	1.00	1.20	1.00	0.80	0.80
	(3.90)	(0.00)	(-1.49)	(0.00)	(2.79)	(2.40)
3	1.20	0.80	1.20	1.20	1.20	0.80
	(-1.16)	(0.19)	(-0.86)	(0.00)	(-1.64)	(0.93)
4	0.80	0.80	0.83	0.80	1.20	1.20
	(1.57)	(1.16)	(0.00)	(0.00)	(-0.42)	(-0.85)
5	0.80	1.20	1.20	0.80	0.80	1.20
	(0.16)	(-0.48)	(-1.32)	(3.15)	(2.39)	(-0.77)
6	1.20	0.80	1.20	0.80	1.20	0.80
	(-2.12)	(0.11)	(-0.30)	(2.60)	(-0.94)	(0.70)
7	0.80	1.03	1.20	1.20	0.87	1.20
	(1.66)	(0.00)	(-2.22)	(-0.89)	(0.00)	(0.00)
8	1.20	1.20	1.20	0.80	0.80	1.20
	(-0.27)	(-0.07)	(-0.99)	(0.46)	(1.37)	(-0.02)
9	1.13	1.20	0.80	0.98	0.80	0.80
	(0.00)	(-0.72)	(2.56)	(0.00)	(0.52)	(3.10)
10	0.80	0.80	0.80	0.80	1.20	1.20
	(1.26)	(4.22)	(13.16)	(1.45)	(-2.91)	(-3.37)

Table A.3 continued	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
June 85						
1	0.80	1.20	0.80	1.00	0.80	1.20
	(0.03)	(0.00)	(1.84)	(0.00)	(2.48)	(-5.46)
2	0.80	1.00	0.80	0.80	0.80	1.20
	(0.12)	(0.00)	(15.97)	(1.23)	(1.35)	(-0.68)
3	1.20	1.20	0.80	1.20	1.20	0.80
	(-0.05)	(-2.00)	(0.59)	(-4.45)	(-4.45)	(2.44)
4	1.03	1.20	0.80	0.80	0.80	1.20
	(0.00)	(-4.05)	(0.94)	(1.50)	(7.22)	(-2.30)
5	0.80	0.80	1.20	0.80	1.20	0.99
	(0.00)	(1.70)	(-1.56)	(1.92)	(-1.76)	(0.00)
6	1.20	0.80	0.80	1.20	1.20	1.20
	(-0.03)	(0.03)	(0.24)	(-0.70)	(-4.89)	(-2.69)
7	1.20	0.80	0.92	1.20	0.80	0.80
	(-0.03)	(2.54)	(0.00)	(-1.55)	(2.27)	(2.41)
8	0.80	1.02	1.20	0.91	1.05	0.80
	(0.04)	(0.00)	(-0.67)	(0.00)	(0.00)	(1.63)
9	1.20	0.80	0.80	1.20	1.20	1.00
	(-0.07)	(1.14)	(3.40)	(-0.92)	(-3.74)	(0.00)
10	0.80	0.80	0.80	1.20	0.80	1.00
	(0.05)	(2.89)	(3.03)	(-0.63)	(6.51)	(0.00)
August 85						
1	0.80	1.20	1.20	0.80	1.20	0.80
	(0.44)	(0.00)	(-3.04)	(1.22)	(-0.38)	(4.06)
2	0.80	0.80	0.80	0.80	0.80	1.20
	(1.35)	(0.48)	(8.99)	(0.00)	(0.00)	(-1.52)
3	1.20	1.20	1.20	1.20	0.80	0.80
	(-6.64)	(0.00)	(-0.18)	(-8.55)	(1.44)	(2.98)
4	1.20	0.80	1.20	0.80	0.80	0.99
	(-2.75)	(2.76)	(-1.27)	(0.74)	(0.35)	(0.00)
5	1.20	1.20	1.19	0.80	0.80	0.80
	(-1.22)	(0.00)	(0.00)	(1.30)	(0.43)	(0.36)
6	1.00	1.04	1.20	0.80	0.89	1.20
	(0.00)	(0.00)	(-1.20)	(2.67)	(0.00)	(-1.67)
7	1.20	0.80	1.20	1.20	1.01	0.80
	(-3.34)	(0.49)	(-0.67)	(-0.11)	(0.00)	(6.86)
8	0.99	0.99	1.00	1.00	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
9	0.99	0.80	0.80	0.81	1.00	0.99
	(0.00)	(1.28)	(2.30)	(0.00)	(0.00)	(0.00)
10	1.20	0.99	1.00	1.00	1.00	0.98
	(-2.21)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Table A.3 continued	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
October 85						
1	0.80	1.20	0.80	0.80	0.80	1.20
	(0.44)	(0.00)	(1.06)	(0.00)	(0.67)	(-0.43)
2	1.20	1.20	1.14	0.80	0.80	1.15
	(-0.23)	(-0.28)	(0.00)	(0.05)	(0.40)	(0.00)
3	0.80	1.20	0.86	1.20	0.80	0.80
	(0.16)	(-0.11)	(0.00)	(-0.00)	(0.30)	(0.08)
4	0.81	0.80	1.20	0.80	1.20	0.80
	(0.00)	(0.07)	(-0.18)	(0.00)	(-0.08)	(0.14)
5	1.00	1.00	1.20	0.80	1.20	0.80
	(0.00)	(0.00)	(-0.09)	(0.03)	(-0.02)	(0.14)
6	0.81	0.84	0.80	1.11	0.87	1.20
	(0.00)	(0.00)	(0.50)	(0.00)	(0.00)	(-1.37)
7	0.98	0.80	1.00	0.95	0.80	1.20
	(0.00)	(0.07)	(0.00)	(0.00)	(0.04)	(-0.11)
8	0.99	0.80	1.00	0.80	1.00	1.00
	(0.00)	(1.05)	(0.00)	(0.04)	(0.00)	(0.00)
9	1.00	0.99	0.80	1.00	1.00	1.05
	(0.00)	(0.00)	(2.40)	(0.00)	(0.00)	(0.00)
10	1.00	1.00	1.00	1.20	1.00	0.80
	(0.00)	(0.00)	(0.00)	(-0.01)	(0.00)	(4.32)
December 85						
1	0.80	0.80	1.20	1.00	1.20	0.80
	(0.06)	(0.10)	(-0.10)	(0.00)	(-0.04)	(0.70)
2	0.80	1.20	1.20	0.80	1.20	0.80
	(0.24)	(-1.91)	(-0.01)	(0.93)	(-0.03)	(0.07)
3	1.20	0.80	0.80	1.00	0.80	1.20
	(-0.18)	(3.54)	(0.32)	(0.00)	(0.03)	(-0.57)
4	1.12	0.80	1.15	0.80	0.80	1.20
	(0.00)	(0.98)	(0.00)	(1.78)	(0.00)	(-0.28)
5	1.20	0.80	1.00	0.94	0.80	0.82
	(-0.67)	(0.23)	(0.00)	(0.00)	(0.87)	(0.00)
6	0.99	0.98	1.00	0.80	1.00	0.99
	(0.00)	(0.00)	(0.00)	(0.19)	(0.00)	(0.00)
7	0.99	1.00	1.00	0.88	0.99	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
8	0.80	0.80	0.80	0.80	1.20	0.80
	(2.56)	(0.90)	(3.81)	(0.53)	(-4.46)	(4.37)
9	1.00	0.80	0.98	0.80	0.80	1.20
	(0.00)	(1.04)	(0.00)	(1.06)	(6.04)	(-4.80)
10	1.20	0.93	1.00	0.87	1.00	1.00
	(-0.89)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Table A.3 continued	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
February 86						
1	1.20	0.80	0.80	1.00	1.20	0.80
	(-3.03)	(-0.00)	(4.09)	(0.00)	(-0.57)	(0.63)
2	1.20	1.15	1.16	0.80	0.80	0.80
	(-2.17)	(0.00)	(0.00)	(0.37)	(3.90)	(0.31)
3	1.00	0.80	0.86	1.20	1.20	1.20
	(0.00)	(0.01)	(0.00)	(-0.08)	(-0.32)	(-0.42)
4	1.20	0.80	1.16	0.80	0.80	1.20
	(-0.12)	(0.00)	(0.00)	(0.03)	(1.30)	(-0.04)
5	0.80	1.00	0.99	0.80	0.98	1.00
	(0.33)	(0.00)	(0.00)	(0.07)	(0.00)	(0.00)
6	0.87	1.20	0.93	1.13	1.20	1.14
	(0.00)	(0.00)	(0.00)	(0.00)	(-1.47)	(0.00)
7	1.00	0.80	1.00	1.00	1.20	0.99
	(0.00)	(0.00)	(0.00)	(0.00)	(-0.85)	(0.00)
8	0.80	1.00	1.20	0.99	1.00	0.99
	(2.00)	(0.00)	(-0.56)	(0.00)	(0.00)	(0.00)
9	1.00	1.00	1.00	1.00	1.00	0.99
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
10	1.20	1.20	0.80	0.80	1.17	0.80
	(-3.12)	(0.00)	(10.03)	(0.91)	(0.00)	(2.19)
April 86						
1	1.00	0.80	1.00	1.00	0.80	1.20
	(0.00)	(0.00)	(0.00)	(0.00)	(0.31)	(-0.78)
2	0.80	0.80	1.20	0.80	0.80	1.20
	(1.37)	(1.43)	(-2.11)	(0.00)	(0.14)	(-0.10)
3	1.01	0.85	0.80	0.80	0.80	0.96
	(0.00)	(0.00)	(0.82)	(1.61)	(0.58)	(0.00)
4	0.80	1.20	1.20	0.80	0.80	0.80
	(3.94)	(-0.46)	(-1.47)	(0.02)	(0.74)	(0.05)
5	1.20	1.00	0.80	1.00	0.87	1.00
	(-1.57)	(0.00)	(0.44)	(0.00)	(0.00)	(0.00)
6	0.80	1.03	0.84	0.80	1.20	1.20
	(0.93)	(0.00)	(0.00)	(0.50)	(-0.38)	(-1.27)
7	0.99	1.06	1.00	1.07	1.20	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(-0.28)	(0.00)
8	0.80	1.01	1.00	0.80	0.99	1.20
	(2.74)	(0.00)	(0.00)	(2.91)	(0.00)	(-4.80)
9	1.00	1.00	1.00	1.01	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
10	1.20	0.94	0.99	1.00	1.00	0.99
	(-2.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Table A.3 continued	--------- Trader Group ---------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
June 86						
1	1.00	1.00	0.80	1.00	0.80	0.99
	(0.00)	(0.00)	(1.19)	(0.00)	(0.28)	(0.00)
2	1.20	1.20	0.96	0.80	0.80	1.20
	(-2.06)	(-3.46)	(0.00)	(0.00)	(0.00)	(-0.15)
3	0.80	0.80	1.20	0.80	1.20	0.80
	(1.13)	(0.35)	(-0.27)	(0.00)	(-0.10)	(0.38)
4	1.20	1.20	0.99	0.80	0.80	0.80
	(-0.26)	(-0.36)	(0.00)	(0.00)	(0.07)	(0.86)
5	0.80	0.80	0.80	1.20	1.00	0.94
	(1.30)	(0.08)	(0.70)	(-0.14)	(0.00)	(0.00)
6	1.00	0.99	1.00	1.00	1.00	1.20
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(-0.24)
7	0.80	1.20	1.20	1.20	1.20	1.20
	(1.46)	(-0.16)	(-0.07)	(-0.02)	(-0.39)	(-1.75)
8	1.00	1.00	1.00	1.02	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
9	0.99	1.01	1.00	0.99	1.00	0.99
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
10	1.07	0.81	0.80	0.96	0.80	1.17
	(0.00)	(0.00)	(2.75)	(0.00)	(0.21)	(0.00)
August 86						
1	0.80	1.20	1.09	1.00	0.80	0.80
	(0.17)	(0.00)	(0.00)	(0.00)	(0.00)	(0.07)
2	1.20	1.20	1.20	0.80	0.82	1.20
	(-0.13)	(0.00)	(-0.09)	(0.00)	(0.00)	(-0.02)
3	0.84	0.80	0.80	0.80	1.20	1.04
	(0.00)	(0.03)	(0.07)	(0.00)	(-0.01)	(0.00)
4	0.84	0.93	1.09	0.80	0.80	0.80
	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)	(0.38)
5	1.20	0.80	1.00	0.80	1.00	1.00
	(-0.29)	(0.29)	(0.00)	(0.13)	(0.00)	(0.00)
6	1.00	1.00	1.00	0.95	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
7	1.00	0.99	1.09	1.00	0.91	0.99
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
8	1.20	1.00	0.80	1.20	0.80	1.05
	(-0.45)	(0.00)	(5.77)	(-0.05)	(12.53)	(0.00)
9	1.00	0.99	1.00	1.01	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
10	0.80	1.00	1.00	1.00	1.00	0.99
	(8.99)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Table A.3 continued	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
October 86						
1	1.20	1.20	1.20	1.00	0.80	0.80
	(-5.17)	(0.00)	(-1.79)	(0.00)	(0.39)	(2.42)
2	1.20	1.20	1.20	0.80	1.20	0.80
	(-0.81)	(0.00)	(-0.56)	(0.00)	(-0.23)	(1.89)
3	0.99	1.20	0.89	0.80	0.80	1.20
	(0.00)	(-1.65)	(0.00)	(0.00)	(6.08)	(-0.26)
4	1.19	0.80	1.00	1.20	1.00	0.90
	(0.00)	(0.70)	(0.00)	(-1.23)	(0.00)	(0.00)
5	0.80	1.17	0.80	0.99	0.90	1.00
	(1.57)	(0.00)	(1.03)	(0.00)	(0.00)	(0.00)
6	1.00	1.20	0.93	1.20	1.20	0.80
	(0.00)	(-0.09)	(0.00)	(-2.00)	(-0.79)	(15.26)
7	1.20	0.80	0.98	0.98	0.80	1.20
	(-0.07)	(4.66)	(0.00)	(0.00)	(8.89)	(-9.67)
8	0.98	1.20	1.20	0.98	1.02	1.00
	(0.00)	(-1.26)	(-5.73)	(0.00)	(0.00)	(0.00)
9	1.00	1.00	1.20	0.80	0.80	1.00
	(0.00)	(0.00)	(-1.30)	(0.22)	(4.90)	(0.00)
10	0.80	1.20	1.20	0.80	0.80	1.20
	(1.40)	(-1.20)	(-0.73)	(0.40)	(1.13)	(-1.79)
December 86						
1	0.80	1.20	1.00	1.00	0.80	1.00
	(7.01)	(-1.12)	(0.00)	(0.00)	(1.91)	(0.00)
2	1.00	1.00	1.20	0.80	1.20	0.80
	(0.00)	(0.00)	(-6.20)	(2.19)	(-2.94)	(5.54)
3	1.20	0.80	0.80	1.20	0.80	1.20
	(-1.22)	(3.23)	(2.65)	(-0.33)	(1.28)	(-2.50)
4	1.00	1.09	1.00	1.20	0.99	1.00
	(0.00)	(0.00)	(0.00)	(-0.61)	(0.00)	(0.00)
5	0.99	1.00	1.09	0.98	1.11	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
6	0.80	0.80	0.80	0.83	1.06	0.82
	(0.01)	(0.10)	(0.23)	(0.00)	(0.00)	(0.00)
7	1.00	1.20	1.00	1.00	1.00	1.00
	(0.00)	(-0.11)	(0.00)	(0.00)	(0.00)	(0.00)
8	0.81	1.20	0.80	1.09	0.80	1.20
	(0.00)	(-0.16)	(0.47)	(0.00)	(0.55)	(-0.21)
9	0.80	0.81	0.80	1.20	1.20	0.80
	(2.30)	(0.00)	(1.00)	(-0.83)	(-0.56)	(0.85)
10	0.80	1.20	1.20	1.20	0.80	0.80
	(0.19)	(-0.41)	(-1.30)	(-0.41)	(0.15)	(0.52)

Table A.3 continued	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
February 87						
1	1.20	1.20	0.80	1.00	0.80	1.00
	(-2.52)	(0.00)	(0.99)	(0.00)	(1.65)	(0.00)
2	0.80	1.20	1.00	0.80	0.80	1.00
	(3.15)	(-0.78)	(0.00)	(0.00)	(4.75)	(0.00)
3	0.93	1.20	0.80	1.20	0.80	1.19
	(0.00)	(-0.28)	(1.93)	(0.00)	(3.82)	(0.00)
4	1.20	1.20	1.20	0.80	0.80	1.20
	(-0.62)	(-0.06)	(-1.80)	(1.33)	(3.31)	(-5.11)
5	0.80	1.20	0.80	0.89	0.80	1.20
	(1.22)	(-0.06)	(2.34)	(0.00)	(2.65)	(-1.45)
6	0.99	0.99	0.94	0.80	0.99	1.20
	(0.00)	(-0.23)	(0.00)	(0.07)	(0.00)	(-1.15)
7	1.20	0.80	1.20	0.80	1.20	1.20
	(-1.28)	(0.00)	(-0.28)	(1.31)	(-1.53)	(-0.83)
8	1.20	1.00	0.80	1.20	1.11	1.20
	(-3.47)	(-0.02)	(0.03)	(-2.13)	(0.00)	(-1.43)
9	0.80	0.80	0.80	0.80	0.80	1.18
	(12.19)	(0.38)	(0.06)	(0.53)	(3.18)	(0.00)
10	0.80	0.80	1.20	1.20	0.89	0.80
	(2.52)	(-0.23)	(-6.39)	(-1.11)	(0.00)	(2.47)
April 87						
1	0.80	1.20	1.20	1.00	0.80	0.80
	(13.16)	(0.00)	(-29.13)	(0.00)	(0.00)	(0.76)
2	0.80	0.80	0.80	0.80	1.20	1.20
	(0.92)	(1.36)	(3.65)	(0.00)	(-0.29)	(-9.19)
3	0.93	0.80	0.80	0.80	0.80	0.80
	(0.00)	(4.79)	(1.07)	(3.07)	(0.49)	(1.80)
4	0.80	0.80	0.91	0.80	0.80	1.20
	(2.70)	(3.33)	(0.00)	(0.00)	(0.69)	(-3.14)
5	0.80	1.20	1.20	1.12	1.20	1.20
	(0.12)	(-0.75)	(-0.88)	(0.00)	(-0.18)	(-0.45)
6	0.80	0.99	0.80	1.20	1.20	1.01
	(3.52)	(0.00)	(3.08)	(-1.86)	(-1.99)	(0.00)
7	0.80	0.80	0.80	0.80	0.87	1.20
	(3.02)	(2.67)	(5.60)	(1.12)	(0.00)	(-0.03)
8	1.00	1.20	0.80	0.99	0.97	1.20
	(0.00)	(-1.17)	(41.85)	(0.00)	(0.00)	(-0.73)
9	0.96	0.99	0.80	1.00	0.99	1.20
	(0.00)	(0.00)	(4.17)	(0.00)	(0.00)	(-2.36)
10	1.20	0.80	1.20	1.20	1.20	0.80
	(-4.69)	(4.94)	(-1.44)	(-2.79)	(-0.44)	(4.17)

Table A.3 continued	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
June 87						
1	0.80	1.20	0.80	1.00	0.80	1.20
	(25.74)	(-4.04)	(29.48)	(0.00)	(3.90)	(-8.07)
2	1.20	0.80	0.80	0.80	0.80	1.20
	(-11.64	(2.24)	(3.31)	(0.00)	(2.42)	(-1.96)
3	0.80	1.20	0.80	0.80	0.80	1.20
	(8.89)	(-0.44)	(1.29)	(0.00)	(1.46)	(-4.40)
4	0.80	1.20	0.80	0.80	1.20	1.20
	(3.57)	(-1.56)	(7.45)	(0.00)	(-0.02)	(-0.38)
5	0.99	1.20	1.00	0.99	1.20	0.83
	(0.00)	(-0.19)	(0.00)	(0.00)	(-1.52)	(0.00)
6	0.97	0.95	0.89	1.20	0.80	1.00
	(0.00)	(0.00)	(0.00)	(-1.14)	(0.51)	(0.00)
7	1.12	0.80	0.80	0.80	1.03	0.80
	(0.00)	(0.29)	(5.23)	(0.24)	(0.00)	(1.79)
8	0.80	1.20	1.20	1.13	0.80	0.80
	(0.74)	(-0.14)	(-2.56)	(0.00)	(2.66)	(1.48)
9	0.80	0.80	0.80	1.00	1.20	1.20
	(4.89)	(2.46)	(0.64)	(0.00)	(-1.88)	(-0.62)
10	0.80	0.80	1.20	1.20	0.80	1.20
	(9.04)	(0.42)	(-3.83)	(-0.20)	(2.68)	(-0.82)
August 87						
1	0.80	1.20	1.20	0.80	0.80	1.20
	(1.32)	(0.00)	(-2.32)	(0.42)	(3.44)	(-0.92)
2	0.80	1.20	1.20	1.20	1.20	0.80
	(1.44)	(0.00)	(-4.11)	(-0.15)	(-0.59)	(3.74)
3	0.80	1.20	1.16	0.80	1.20	1.20
	(1.65)	(0.00)	(0.00)	(0.00)	(-1.80)	(-4.32)
4	0.92	1.20	1.20	1.20	1.01	0.84
	(0.00)	(0.00)	(-2.20)	(-0.27)	(0.00)	(0.00)
5	0.80	1.20	0.80	1.20	1.20	1.20
	(0.89)	(0.00)	(1.05)	(-0.42)	(-2.09)	(-0.27)
6	0.82	1.20	1.11	1.14	0.80	1.05
	(0.00)	(0.00)	(0.00)	(0.00)	(0.57)	(0.00)
7	0.80	1.11	0.80	1.01	0.86	1.00
	(0.25)	(0.00)	(0.74)	(0.00)	(0.00)	(0.00)
8	1.20	1.20	0.80	0.80	0.80	1.20
	(-0.06)	(0.00)	(0.44)	(0.86)	(0.51)	(-0.63)
9	0.80	0.80	1.20	1.20	1.20	1.20
	(0.56)	(0.07)	(-2.46)	(-0.24)	(-0.38)	(-1.21)
10	0.80	1.20	0.80	1.20	0.80	1.20
	(3.99)	(0.00)	(1.11)	(-0.55)	(1.61)	(-2.95)

Table A.3 continued	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
October 87						
1	1.20	1.20	1.20	1.20	0.80	1.20
	(-1.83)	(-12.41)	(-7.53)	(-3.91)	(1.25)	(-1.37)
2	0.80	1.02	1.20	1.02	0.80	1.20
	(4.93)	(0.00)	(-7.63)	(0.00)	(12.07)	(-0.36)
3	1.20	0.80	0.80	0.80	1.20	1.20
	(-1.29)	(2.25)	(1.18)	(0.72)	(-1.33)	(-0.26)
4	0.80	1.20	1.20	1.20	0.80	1.03
	(0.06)	(-2.31)	(-2.31)	(-4.96)	(2.92)	(0.00)
5	0.95	0.80	1.17	1.08	1.20	0.80
	(0.00)	(3.82)	(0.00)	(0.00)	(-0.45)	(0.03)
6	1.20	1.20	1.01	0.80	0.81	0.80
	(-1.16)	(-0.56)	(0.00)	(1.28)	(0.00)	(0.54)
7	0.97	1.00	1.00	1.00	0.80	1.20
	(0.00)	(0.00)	(0.00)	(0.00)	(1.97)	(-0.23)
8	1.20	0.99	0.80	1.20	0.80	0.80
	(-0.14)	(0.00)	(5.38)	(-0.10)	(0.73)	(0.27)
9	0.99	0.80	1.20	0.80	0.80	1.20
	(0.00)	(0.60)	(-3.74)	(0.17)	(4.26)	(-0.12)
10	0.80	1.20	1.20	0.88	1.20	1.20
	(6.03)	(-0.23)	(-2.80)	(0.00)	(-2.08)	(-0.02)

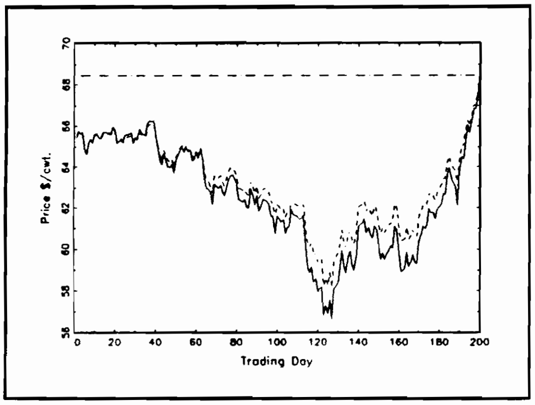

Figure A.1. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Dec. 1983 Live Cattle Contract.

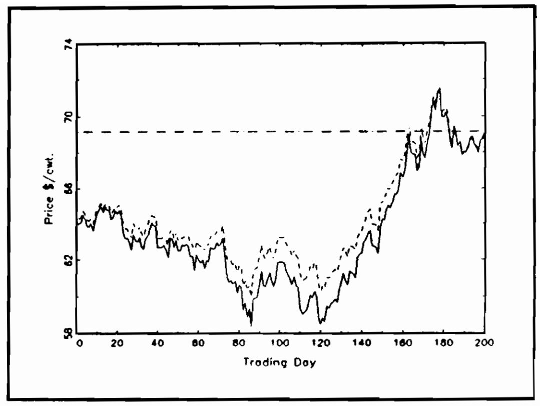

Figure A.2. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Feb. 1984 Live Cattle Contract.

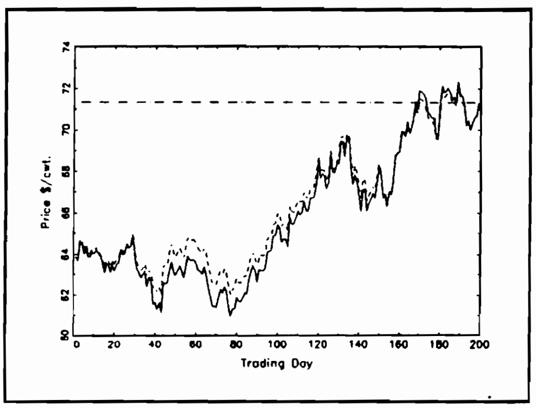

Figure A.3. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Apr. 1984 Live Cattle Contract.

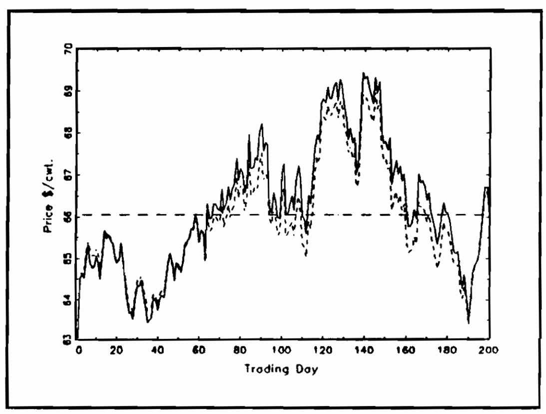

Figure A.4. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Jun. 1984 Live Cattle Contract.

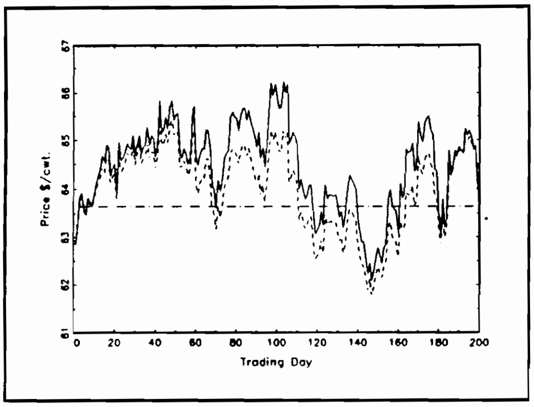

Figure A.5. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Aug. 1984 Live Cattle Contract.

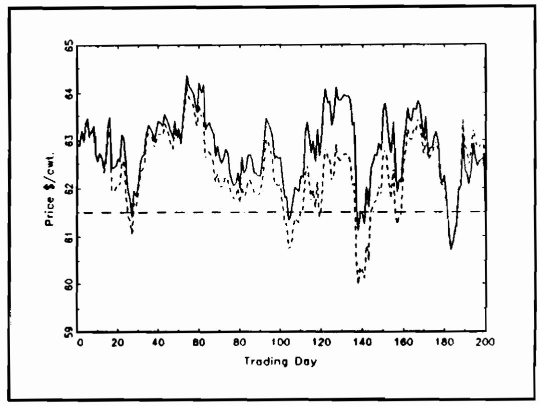

Figure A.6. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Oct. 1984 Live Cattle Contract.

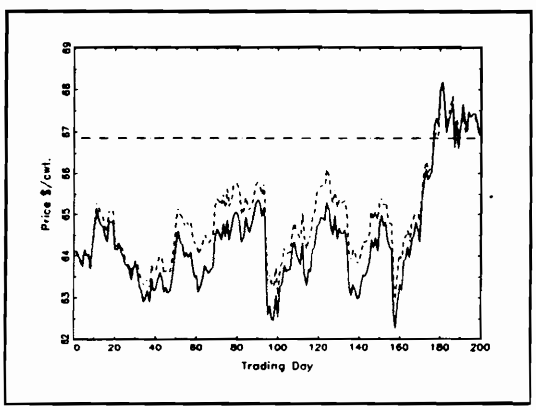

Figure A.7. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Dec. 1984 Live Cattle Contract.

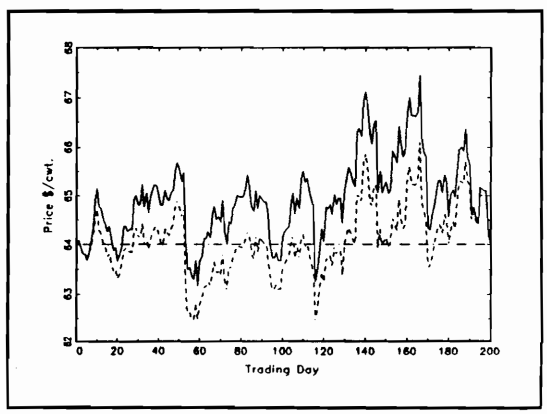

Figure A.8. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Feb. 1985 Live Cattle Contract.

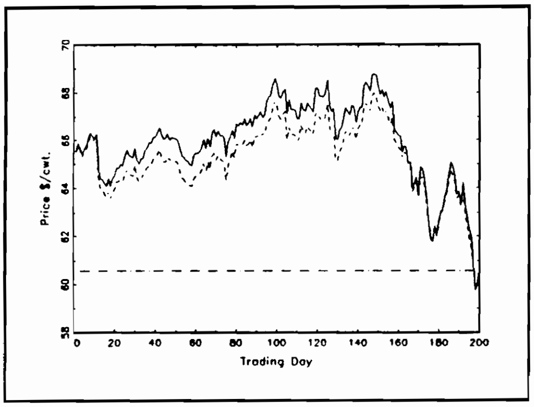

Figure A.9. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Apr. 1985 Live Cattle Contract.

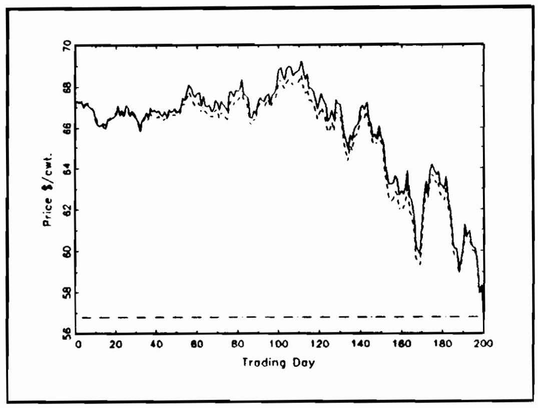

Figure A.10. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Jun. 1985 Live Cattle Contract.

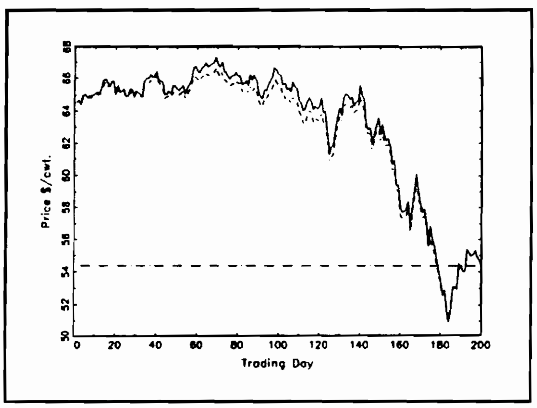

Figure A.11. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Aug. 1985 Live Cattle Contract.

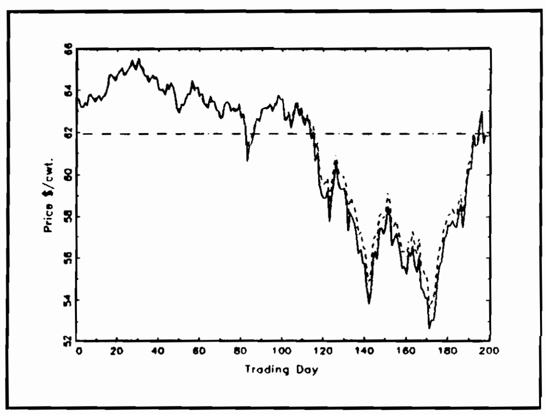

Figure A.12. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Oct. 1985 Live Cattle Contract.

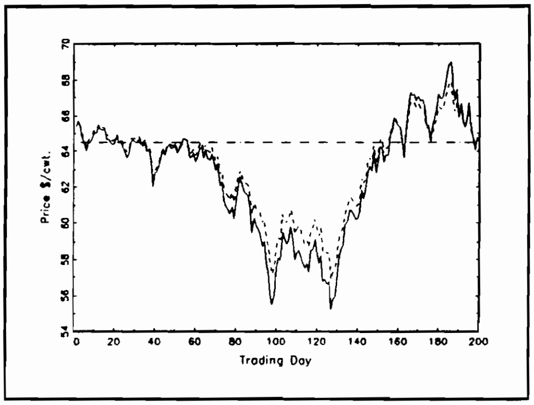

Figure A.13. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Dec. 1985 Live Cattle Contract.

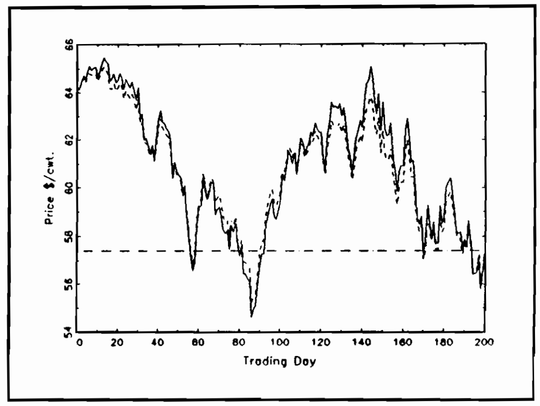

Figure A.14. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Feb. 1986 Live Cattle Contract.

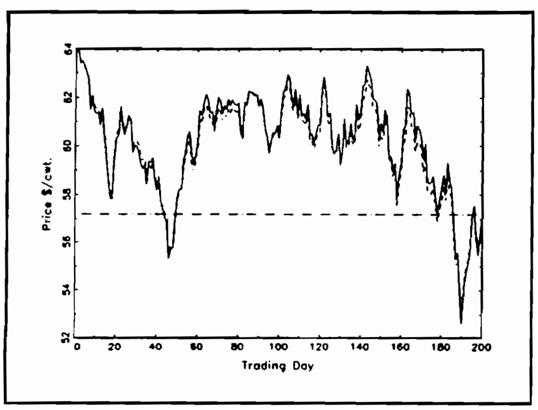

Figure A.15. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Apr. 1986 Live Cattle Contract.

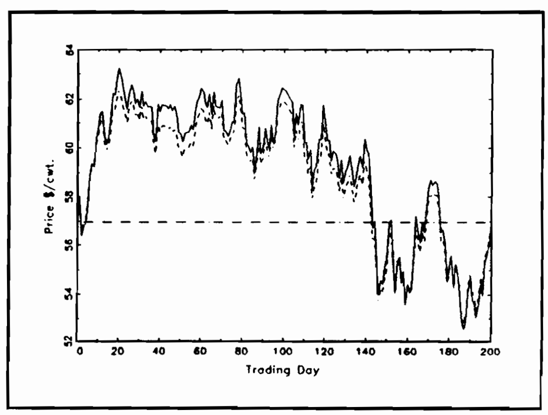

Figure A.16. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Jun. 1986 Live Cattle Contract.

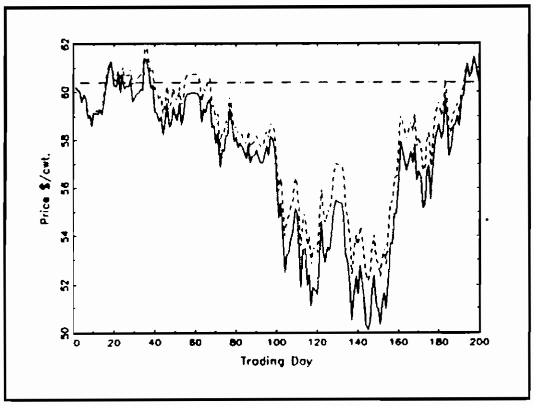

Figure A.17. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Aug. 1986 Live Cattle Contract.

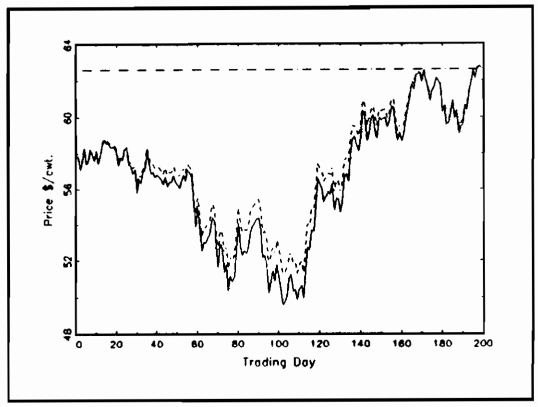

Figure A.18. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Oct. 1986 Live Cattle Contract.

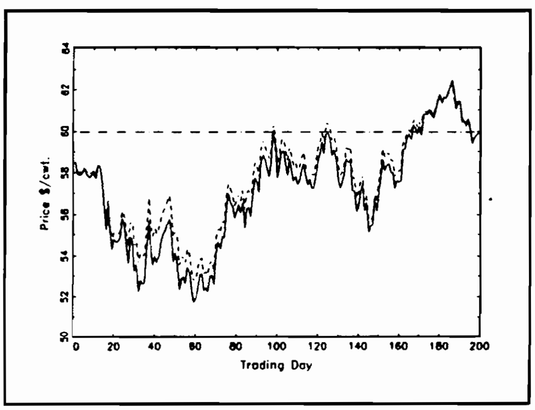

Figure A.19. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Dec. 1986 Live Cattle Contract.

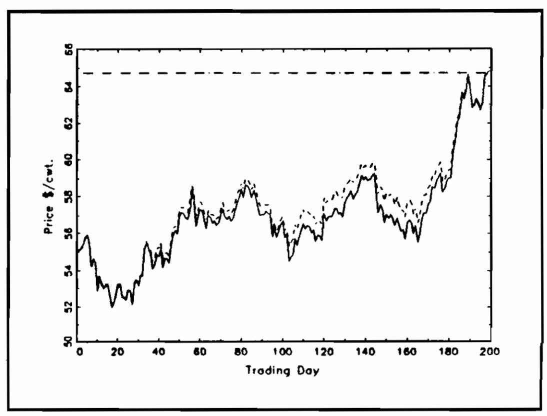

Figure A.20. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Feb. 1987 Live Cattle Contract.

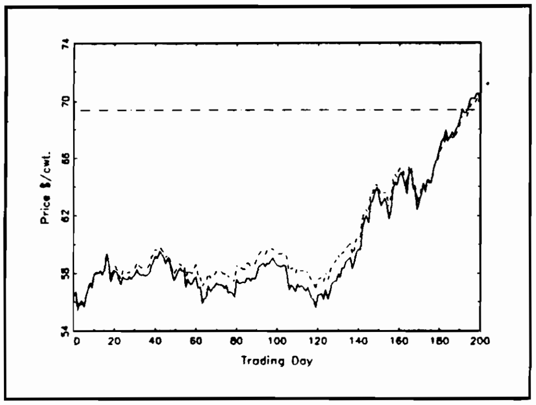

Figure A.21. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Apr. 1987 Live Cattle Contract.

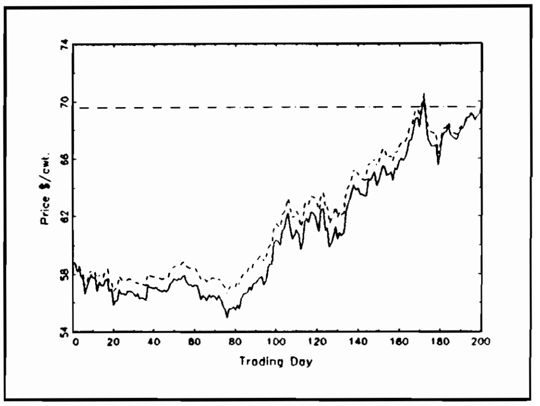

Figure A.22. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Jun. 1987 Live Cattle Contract.

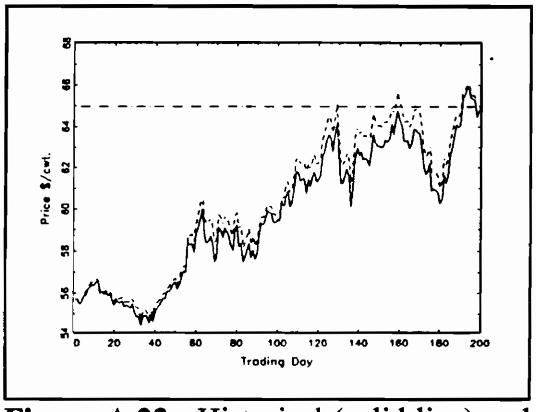

Figure A.23. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Aug. 1987 Live Cattle Contract.

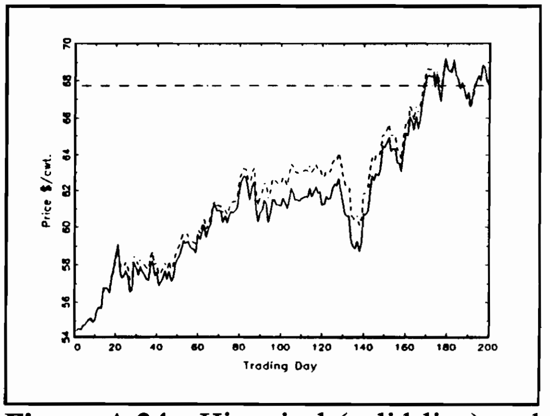

Figure A.24. Historical (solid line) and Simulated (dashed line) Price Paths, Model 3, Oct. 1987 Live Cattle Contract.

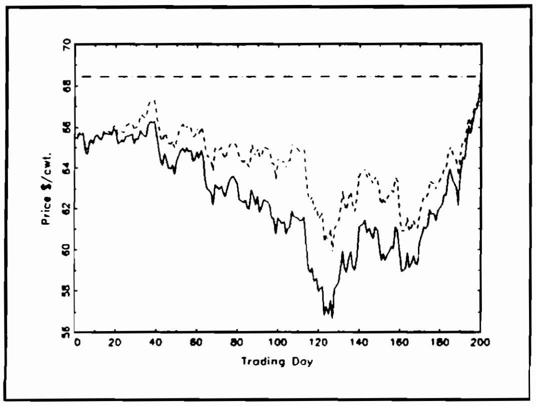

Figure A.25. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Dec. 1983 Live Cattle Contract.

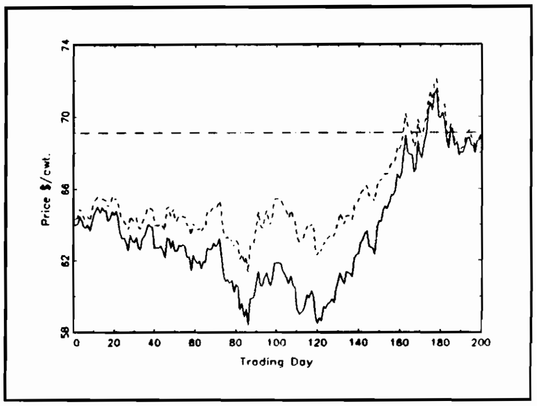

Figure A.26. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Feb. 1984 Live Cattle Contract.

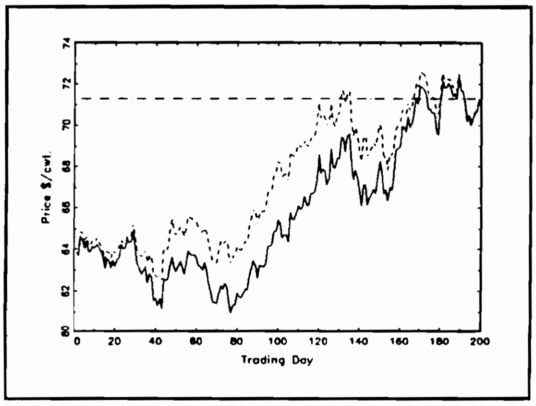

Figure A.27. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Apr. 1984 Live Cattle Contract.

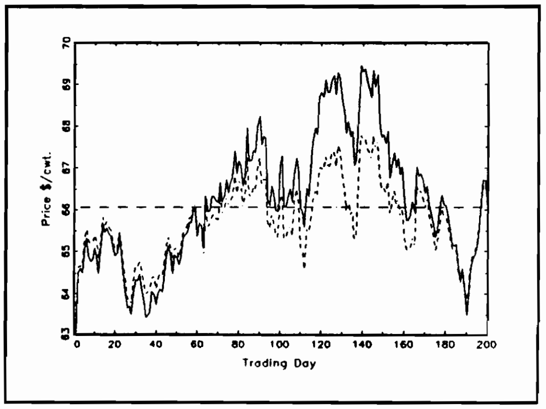

Figure A.28. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Jun. 1984 Live Cattle Contract.

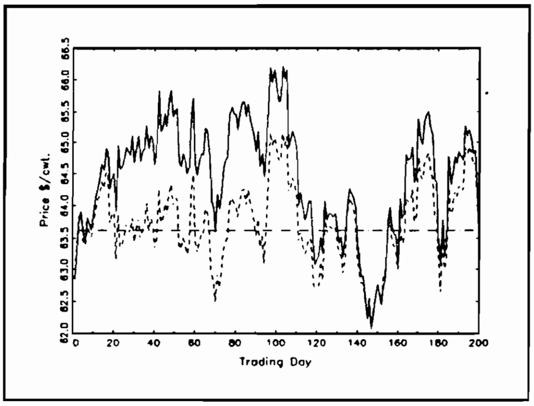

Figure A.29. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Aug. 1984 Live Cattle Contract.

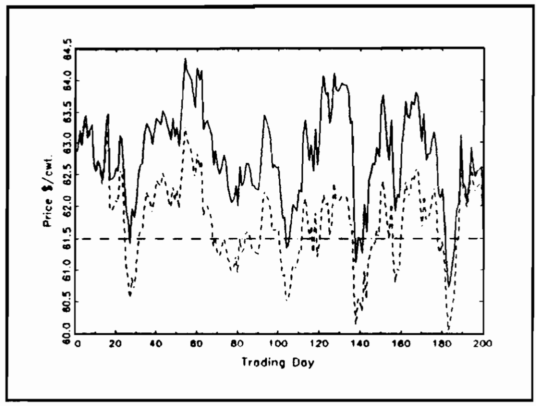

Figure A.30. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Oct. 1984 Live Cattle Contract.

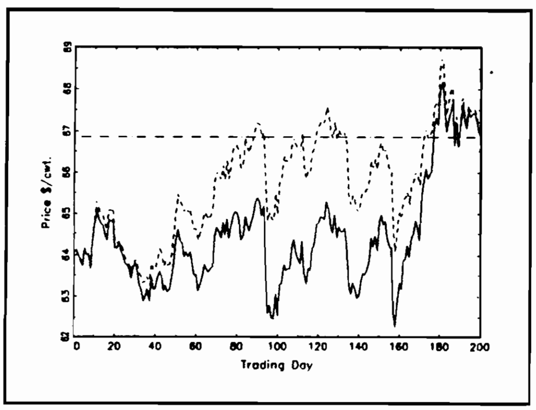

Figure A.31. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Dec. 1984 Live Cattle Contract.

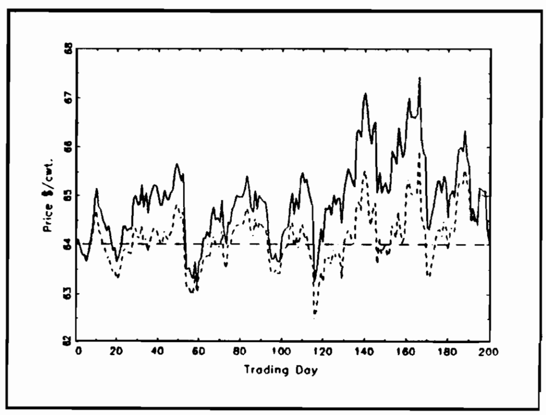

Figure A.32. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Feb. 1985 Live Cattle Contract.

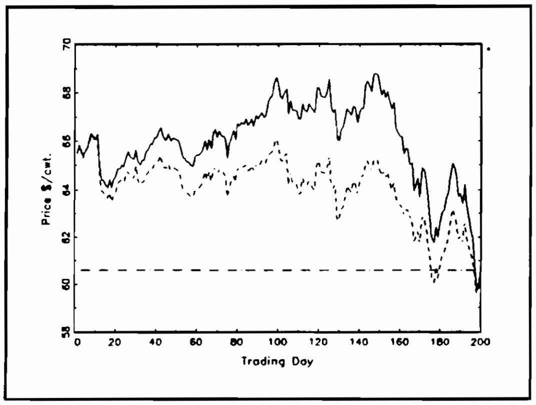

Figure A.33. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Apr. 1985 Live Cattle Contract.

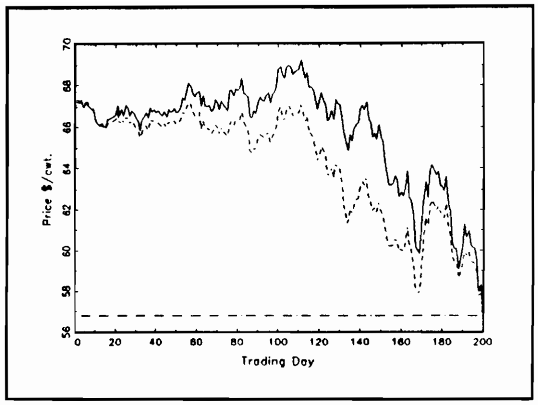

Figure A.34. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Jun. 1985 Live Cattle Contract.

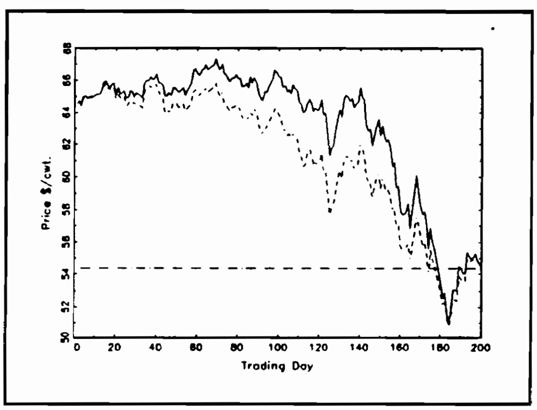

Figure A.35. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Aug. 1985 Live Cattle Contract.

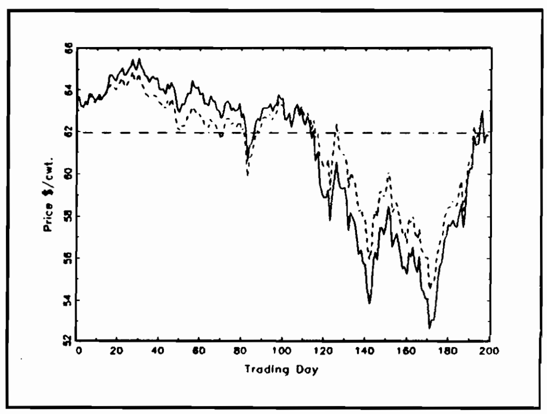

Figure A.36. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Oct. 1985 Live Cattle Contract.

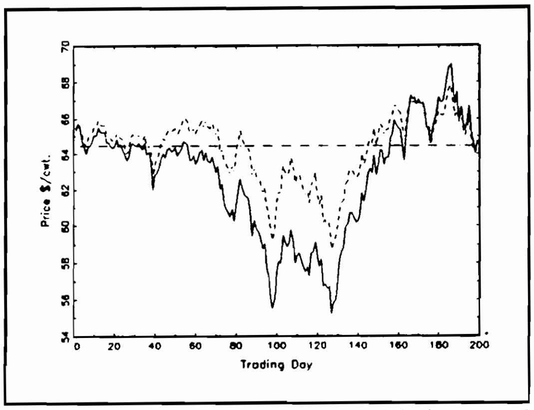

Figure A.37. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Dec. 1985 Live Cattle Contract.

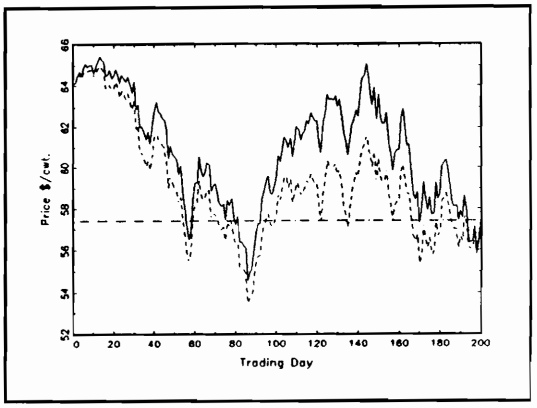

Figure A.38. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Feb. 1986 Live Cattle Contract.

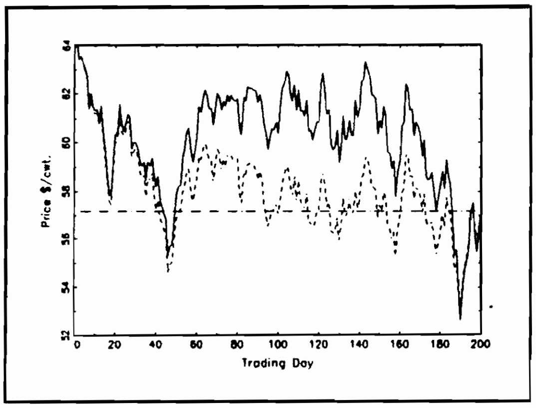

Figure A.39. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Apr. 1986 Live Cattle Contract.

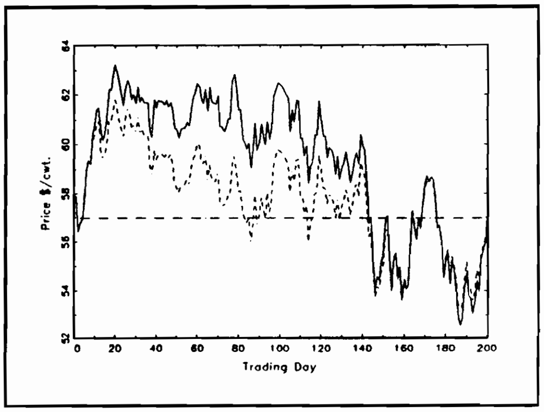

Figure A.40. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Jun. 1986 Live Cattle Contract.

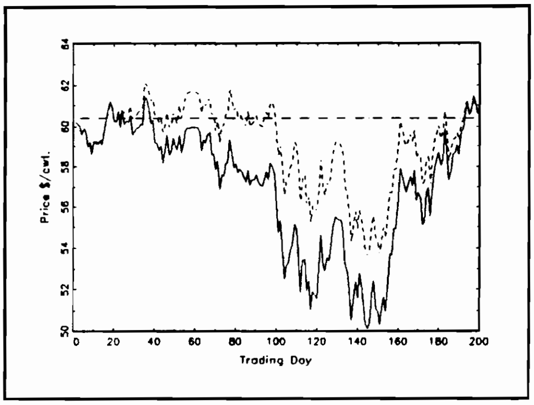

Figure A.41. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Aug. 1986 Live Cattle Contract.

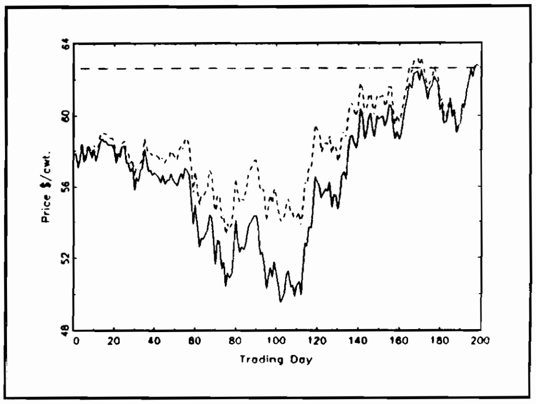

Figure A.42. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Oct. 1986 Live Cattle Contract.

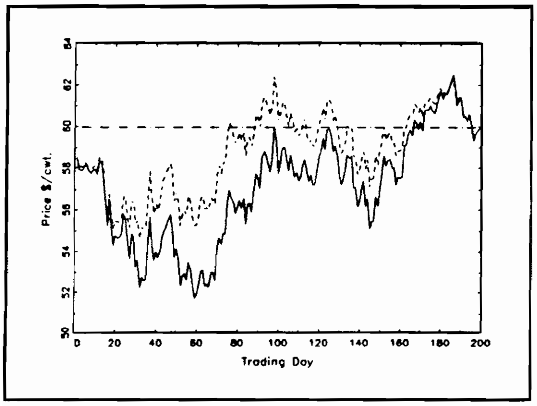

Figure A.43. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Dec. 1986 Live Cattle Contract.

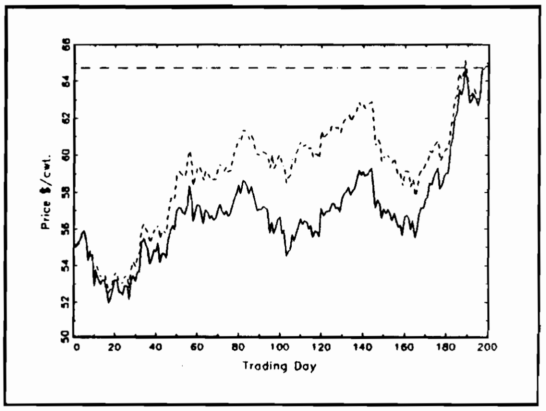

Figure A.44. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Feb. 1987 Live Cattle Contract.

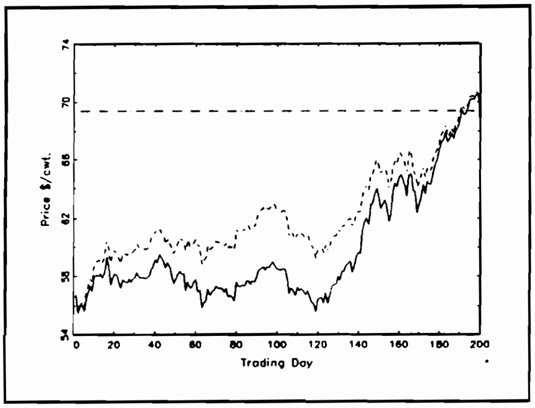

Figure A.45. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Apr. 1987 Live Cattle Contract.

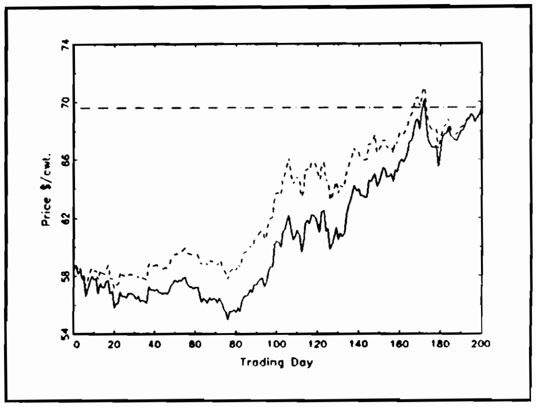

Figure A.46. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Jun. 1987 Live Cattle Contract.

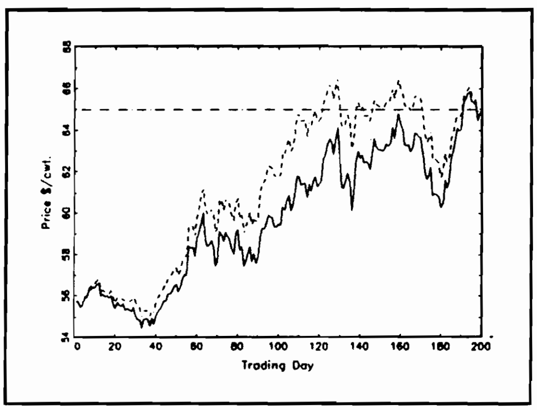

Figure A.47. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Aug. 1987 Live Cattle Contract.

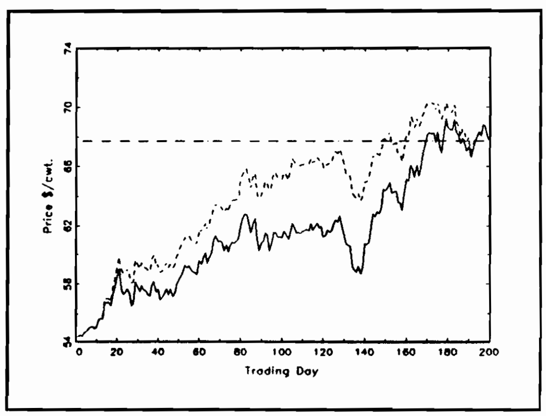

Figure A.48. Historical (solid line) and Simulated (dashed line) Price Paths, Model 4, Oct. 1987 Live Cattle Contract.

APPENDIX B:

Result Tables and Figures Related
to
Model Solutions Which Omit Intergroup Response Effects.

Table B.1. Shadow Prices for Each Trader Group for Each Contract from Model 1 Omitting Intergroup Response Effects.

Contract	---------- Trader Group ----------					
	LC	MC	LN	MN	OTHER	ST
December 1983	19.37	4.58	24.43	12.63	5.07	-17.38
February 1984	45.41	-6.89	57.34	-0.93	-10.51	-47.43
April 1984	36.47	-6.18	9.35	-2.41	-1.01	-34.71
June 1984	1.05	1.53	2.14	-0.10	-0.56	1.41
August 1984	-1.58	0.97	-1.44	-0.14	-1.82	8.18
October 1984	-5.30	-0.15	-3.21	0.73	-0.53	9.38
December 1984	3.53	1.51	7.49	-1.73	3.44	-12.94
February 1985	-7.91	1.24	5.46	0.65	0.41	3.55
April 1985	7.53	0.51	-34.31	2.37	6.11	28.04
June 1985	-32.48	-2.60	20.31	-4.21	0.89	0.84
August 1985	-35.61	-7.98	19.61	-1.17	-4.02	36.73
October 1985	8.01	4.42	4.92	0.41	8.52	1.97
December 1985	3.73	4.34	2.73	1.89	13.08	3.82
February 1986	-24.91	-2.00	0.52	2.67	6.49	11.25
April 1986	-6.73	6.40	-12.30	0.69	6.64	-5.83
June 1986	-11.90	-4.14	2.03	-0.61	-2.92	37.65
August 1986	32.72	-8.57	-13.40	-2.37	53.06	-23.28
October 1986	-8.31	-9.26	-32.69	-2.69	58.37	30.30
December 1986	30.32	-3.24	-6.03	1.35	4.83	-6.00
February 1987	37.14	-9.61	5.29	6.65	51.49	-119.22
April 1987	37.11	18.18	-71.01	4.13	18.23	-40.81
June 1987	67.04	-12.10	45.54	-0.99	15.32	-108.43
August 1987	34.63	-3.89	-24.22	-2.51	-11.12	-13.64
October 1987	18.89	-7.24	-33.71	-13.98	22.39	-47.28

Table B.2. Average Shadow Prices Across All 24 Futures Contracts for Model 1 Omitting Intergroup Response Effects.

	---------- Trader Group ----------					
	LC	MC	LN	MN	OTH	ST
Avg. Shadow Value	10.343	-1.674	-1.049	0.014	10.077	-12.659
Sig. Test[a]	4	3	2	3	4	4

[a]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the row.

Table B.3. Average Shadow Prices Across All 24 Futures Contracts for Model 2 Omitting Intergroup Response Effects.

	---------- Trader Group ----------					
Subperiod	LC	MC	LN	MN	OTH	ST
1	3.663	-1.148	-4.074	0.023	1.278	0.995
2	3.269	-1.002	-0.036	-0.113	3.391	-3.597
3	-0.750	0.679	2.156	-0.060	0.847	-3.845
4	0.523	0.748	0.865	0.093	1.525	-1.292
5	2.287	-0.674	0.803	0.130	1.020	-2.121
6	0.147	0.268	-0.677	0.308	3.099	-1.256
7	1.575	-0.302	0.320	-0.182	-0.952	-1.804
8	-0.132	-0.205	-0.441	-0.195	-0.326	0.389
9	-0.130	-0.039	-0.037	-0.024	0.193	-0.122
10	-0.110	-0.000	0.072	0.033	0.001	-0.006
Subperiod	Row-wise Significance Tests[a]					
1	1	3	0	2	2	0
2	1	2	0	1	3	1
3	0	1	2	2	1	4
4	0	0	0	1	1	0
5	3	2	0	2	0	1
6	1	1	1	1	5	1
7	4	2	1	2	1	4
8	0	0	1	1	0	2
9	0	0	0	0	0	0
10	3	1	1	1	0	0
Subperiod	Column-wise Significance Tests[b]					
1	0	7	0	0	4	0
2	3	5	0	0	4	0
3	0	3	4	0	0	3
4	0	7	0	0	3	0
5	3	4	0	0	0	1
6	0	2	1	1	4	0
7	3	2	0	0	6	3
8	3	2	1	2	4	3
9	3	4	1	0	4	2
10	3	4	1	1	5	2

[a]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same row.
[b]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same column.

Table B.4. Optimal Change in Trader Group Price Pressure and Shadow Prices by Contract for Model 3 Omitting Intergroup Response Effects.

	---------- Trader Group ----------					
Contract	LC	MC	LN	MN	OTH	ST
Dec. 83	0.80	0.80	0.80	0.80	0.80	0.87
	(12.74)	(4.81)	(14.78)	(8.17)	(5.86)	(0.00)
Feb. 84	0.80	0.80	0.80	1.11	0.80	0.93
	(22.54)	(8.92)	(21.07)	(0.00)	(3.42)	(0.00)
Apr. 84	0.80	1.09	0.80	0.84	1.20	0.96
	(23.88)	(0.00)	(8.42)	(0.00)	(-0.83)	(0.00)
Jun. 84	0.86	0.80	0.94	1.20	1.00	0.80
	(0.00)	(0.33)	(0.00)	(-0.04)	(0.00)	(2.06)
Aug. 84	1.05	0.80	0.80	0.83	0.80	0.82
	(0.00)	(0.23)	(0.68)	(0.00)	(1.17)	(0.00)
Oct. 84	1.01	1.20	0.80	0.80	0.98	0.80
	(0.00)	(-0.25)	(1.11)	(0.41)	(0.00)	(1.27)
Dec. 84	0.80	0.98	0.80	0.80	0.89	1.04
	(5.47)	(0.00)	(2.37)	(2.47)	(0.00)	(0.00)
Feb. 85	1.05	0.80	0.80	0.86	0.80	1.02
	(0.00)	(0.27)	(0.70)	(0.00)	(0.20)	(0.00)
Apr. 85	0.80	0.80	1.02	0.80	0.80	0.80
	(8.92)	(5.51)	(0.00)	(8.29)	(4.91)	(12.22)
Jun. 85	1.20	0:89	0.80	1.20	0.80	0.99
	(-25.60)	(0.00)	(21.06)	(-3.74)	(1.17)	(0.00)
Aug. 85	0.97	1.04	0.80	1.08	0.80	0.83
	(0.00)	(0.00)	(15.79)	(0.00)	(7.09)	(0.00)
Oct. 85	0.80	0.95	0.88	1.20	0.80	0.80
	(9.43)	(0.00)	(0.00)	(-0.12)	(4.01)	(3.36)
Dec. 85	0.80	0.80	0.93	0.80	0.80	0.80
	(3.25)	(3.61)	(0.00)	(1.21)	(12.03)	(1.02)
Feb. 86	1.02	0.85	0.81	0.80	0.80	0.95
	(0.00)	(0.00)	(0.00)	(3.11)	(8.13)	(0.00)
Apr. 86	0.97	0.80	0.99	0.80	0.96	0.95
	(0.00)	(1.89)	(0.00)	(2.34)	(0.00)	(0.00)

Table B.4 Continued	LC	MC	LN	MN	OTH	ST
Jun. 86	0.85	0.80	0.80	1.20	0.95	0.80
	(0.00)	(4.66)	(4.87)	(-0.26)	(0.00)	(10.42)
Aug. 86	0.80	0.94	0.98	1.01	0.80	0.82
	(11.32)	(0.00)	(0.00)	(0.00)	(29.29)	(0.00)
Oct. 86	0.83	0.80	0.97	0.80	0.80	0.80
	(0.00)	(1.63)	(0.00)	(4.45)	(26.50)	(20.95)
Dec. 86	0.80	0.98	1.02	0.80	0.90	0.80
	(18.80)	(0.00)	(0.00)	(0.19)	(0.00)	(2.43)
Feb. 87	0.80	0.80	0.95	1.20	0.80	0.97
	(24.76)	(10.55)	(0.00)	(-0.56)	(12.88)	(0.00)
Apr. 87	0.80	0.80	0.94	0.80	0.80	1.14
	(40.40)	(19.87)	(0.00)	(1.84)	(5.81)	(0.00)
Jun. 87	0.80	0.80	0.80	1.04	0.80	0.98
	(38.70)	(5.87)	(33.03)	(0.00)	(10.66)	(0.00)
Aug. 87	0.80	1.20	1.12	1.06	0.80	0.91
	(16.12)	(-2.94)	(0.00)	(0.00)	(0.47)	(0.00)
Oct. 87	0.80	0.80	1.03	0.80	0.80	1.11
	(11.03)	(5.94)	(0.00)	(5.12)	(16.97)	(0.00)

Table B.5. Average Optimal Values and Average Shadow Prices Across All 24 Futures Contracts for Model 3 Omitting Intergroup Response Effects.

	---------- Trader Group ----------					
	LC	MC	LN	MN	OTH	ST
Avg. Optimal Value	0.875	0.888	0.890	0.943	0.853	0.903
Sig. Test[a]	1	0	0	2	2	1
Avg. Shadow Price	9.240	2.954	5.162	1.370	6.239	2.239
Sig. Test[a]	3	2	1	3	3	2

[a]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the row.

Table B.6. Average Optimal Values Across All 24 Futures Contracts for Model 4 Omitting Intergroup Response Effects.

	---------- Trader Group ----------					
Subperiod	LC	MC	LN	MN	OTH	ST
1	1.012	1.090	0.944	0.967	0.897	0.974
2	0.936	1.062	0.987	0.892	0.917	1.004
3	1.001	0.963	0.878	0.933	0.996	1.023
4	0.932	1.029	0.956	0.950	0.969	1.021
5	0.938	1.014	0.935	0.917	0.954	1.011
6	1.026	0.900	0.927	0.917	0.990	0.943
7	0.969	1.008	0.971	0.919	0.921	1.017
8	1.000	0.993	0.885	0.933	0.882	0.971
9	0.909	0.900	0.922	0.950	0.925	0.988
10	0.954	0.980	0.970	0.993	0.991	0.982
Subperiod	Row-wise Significance Tests[a]					
1	2	5	1	2	4	2
2	1	4	2	3	2	2
3	1	1	4	1	1	2
4	2	2	0	1	0	1
5	0	2	2	2	0	2
6	4	2	1	1	1	1
7	0	2	0	2	2	2
8	2	2	3	0	3	2
9	1	1	0	0	0	2
10	0	0	0	0	0	0
Subperiod	Column-wise Significance Tests[b]					
1	3	7	0	1	4	0
2	2	4	2	2	1	0
3	1	2	4	0	4	1
4	2	2	2	0	2	1
5	1	3	0	0	1	0
6	4	7	0	0	2	3
7	0	3	2	0	1	1
8	1	3	4	0	5	0
9	4	7	0	0	0	0
10	0	4	2	1	2	0

[a]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same row.
[b]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same column.

Table B.7. Average Shadow Prices Across All 24 Futures Contracts for Model 4 Omitting Intergroup Response Effects.

	---------- Trader Group ----------					
Subperiod	LC	MC	LN	MN	OTH	ST
1	2.007	-0.609	-0.586	-0.003	0.641	-0.435
2	0.950	-0.127	0.566	0.011	0.589	-0.143
3	-0.180	0.024	0.740	-0.182	0.109	-0.167
4	0.329	0.082	0.334	0.058	0.368	-0.034
5	0.118	-0.032	0.242	0.051	0.033	0.032
6	-0.148	0.030	0.256	0.033	-0.025	0.257
7	0.136	0.203	0.349	0.046	0.576	-0.031
8	0.402	0.228	1.012	0.269	0.625	0.128
9	1.335	0.785	0.163	0.187	0.518	0.066
10	0.979	0.549	0.033	-0.120	0.612	2.284
Subperiod	Row-wise Significance Tests[a]					
1	2	3	0	3	2	0
2	0	1	0	1	2	0
3	0	1	2	1	0	0
4	0	0	0	0	0	0
5	0	1	1	0	0	0
6	4	1	2	2	0	1
7	1	0	2	2	3	2
8	0	0	0	0	0	0
9	4	2	2	2	1	1
10	2	2	2	4	1	3
Subperiod	Column-wise Significance Tests[b]					
1	1	9	0	1	2	1
2	0	5	0	0	1	1
3	1	3	2	6	0	1
4	1	3	0	2	0	1
5	2	5	0	2	4	1
6	5	3	0	3	5	1
7	3	4	0	2	2	1
8	2	4	0	4	2	1
9	6	8	1	2	2	1
10	3	6	1	6	0	9

[a]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same row.
[b]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same column.

Table B.8. Average Optimal Values Across All 24 Futures Contracts for Models 5-10 Omitting Intergroup Response Effects.

	---------- Trader Group ----------					
Subperiod	LC	MC	LN	MN	OTH	ST
1	0.988	1.067	0.963	0.967	0.917	0.997
2	0.958	1.067	1.029	0.885	0.918	1.008
3	1.025	0.933	0.917	1.000	0.967	1.014
4	0.981	0.997	1.004	0.917	0.979	1.046
5	0.985	0.993	0.981	0.979	1.008	0.978
6	0.958	0.987	0.953	0.957	0.999	1.032
7	0.969	0.932	0.983	0.996	0.992	1.080
8	1.035	1.025	0.935	0.989	0.932	1.006
9	0.954	0.920	0.958	0.963	0.956	1.033
10	1.002	0.994	0.992	1.039	0.993	0.951
Subperiod		Row-wise Significance Tests[a]				
1	1	4	1	1	2	1
2	2	3	2	4	3	2
3	2	2	3	1	0	2
4	0	1	1	3	0	1
5	0	0	0	0	0	0
6	1	0	1	1	0	3
7	1	2	1	2	1	5
8	2	2	3	1	4	2
9	1	1	1	1	1	5
10	0	0	0	1	0	1
Subperiod		Column-wise Significance Tests[b]				
1	0	6	0	2	4	1
2	1	6	3	8	4	1
3	2	3	4	2	0	1
4	0	1	2	4	0	2
5	0	3	0	1	3	2
6	2	3	1	2	3	1
7	1	3	1	2	3	6
8	4	3	2	2	3	1
9	2	7	0	2	0	1
10	0	3	1	5	2	4

[a]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same row.
[b]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same column.

Table B.9. Average Shadow Prices Across All 24 Futures Contracts for Models 5-10 Omitting Intergroup Response Effects.

	---------- Trader Group ----------					
Subperiod	LC	MC	LN	MN	OTH	ST
1	1.903	-0.847	-0.121	-0.015	0.996	-1.258
2	0.387	-0.299	0.441	0.240	1.346	-0.444
3	0.078	0.497	0.521	-0.311	0.211	-0.058
4	0.564	0.037	-0.033	0.005	0.602	-0.774
5	0.180	0.124	0.143	0.074	-0.034	-0.585
6	0.192	-0.005	-0.163	0.154	-0.418	-0.458
7	0.203	0.426	0.781	0.014	0.507	-0.455
8	0.061	-0.150	2.205	0.138	0.792	-0.083
9	2.057	0.437	0.391	0.037	0.865	-0.244
10	0.740	0.382	0.673	-0.088	0.293	1.366
Subperiod	Row-wise Significance Tests[a]					
1	3	3	0	3	3	2
2	0	2	0	2	2	0
3	0	1	1	2	0	0
4	1	0	0	1	2	2
5	1	1	1	1	0	4
6	2	2	0	2	3	3
7	0	1	1	2	0	0
8	0	3	1	1	1	0
9	4	2	1	3	2	2
10	0	1	0	2	0	1
Subperiod	Column-wise Significance Tests[b]					
1	0	8	0	1	2	1
2	0	4	0	5	2	0
3	1	4	1	4	0	0
4	0	1	0	0	1	1
5	1	3	0	0	3	1
6	1	5	1	1	6	1
7	1	4	0	1	1	1
8	1	6	0	2	1	0
9	5	5	0	2	2	1
10	0	4	0	2	0	6

[a]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same row.
[b]Number of significant differences (α=.05) between the corresponding element and the remaining elements in the same column.

Table B.10. Mean Squared Errors (MSEs) for Each Model for Each Contract Omitting Intergroup Response Effects.[a]

	---------- Contract ----------							
Model#	Dec. 83	Feb. 84	Apr. 84	Jun. 84	Aug. 84	Oct. 84	Dec. 84	Feb. 85
1	40.98	41.31	39.91	2.32	1.48	2.22	7.27	1.51
2	40.98	41.31	39.91	2.32	1.48	2.22	7.27	1.51
3	30.89*	28.90*	32.15*	1.64*	0.75*	1.18*	4.85*	0.46*
4	16.34*	15.34*	22.48*	0.80*	0.34*	0.44*	2.51	0.24*
5	36.47*	36.07*	33.03*	1.92	1.25	1.16	6.21*	0.81
6	39.05*	39.12*	37.23*	2.04*	1.19*	2.05	6.72*	1.18*
7	35.83*	35.27	36.65*	1.77*	1.16	1.39*	5.66*	0.72*
8	38.76	41.02	38.60*	2.20	0.94	2.06*	6.90	1.44*
9	37.91*	38.87	38.14*	1.74*	1.10*	1.80*	5.63*	1.12*
10	32.06*	36.27	36.47*	1.61*	0.77*	1.24	5.57	1.27

	---------- Contract ----------							
Model#	Apr. 85	Jun. 85	Aug. 85	Oct. 85	Dec. 85	Feb. 86	Apr. 86	Jun. 86
1	31.44	86.88	92.48	12.39	12.67	18.75	13.02	12.83
2	31.44	86.88	92.48	12.39	12.67	18.75	13.02	12.83
3	22.66*	76.07*	84.03*	8.47*	7.77*	16.30*	12.12*	8.16*
4	10.49*	54.16*	58.69*	4.91*	2.84*	8.95*	3.32*	2.71*
5	27.47*	80.12*	85.41	12.09	10.34*	16.14*	9.49*	10.98*
6	29.79*	85.15*	90.83*	12.12*	11.29*	18.57	12.20*	11.28*
7	25.50	81.12*	88.51	11.66*	11.70*	14.86*	11.81*	11.57*
8	30.61*	85.26	91.05*	12.38	12.29*	18.58*	12.15*	12.77
9	27.45*	78.78*	91.79*	11.97*	9.64*	16.39*	12.25*	12.54*
10	22.05*	81.42	86.25*	9.85*	9.25*	16.70*	9.94*	11.37

	---------- Contract ----------							
Model#	Aug. 86	Oct. 86	Dec. 86	Feb. 87	Apr. 87	Jun. 87	Aug.87	Oct. 87
1	20.41	47.56	14.71	67.59	103.88	96.84	36.57	53.89
2	20.41	47.56	14.71	67.59	103.88	96.84	36.57	53.89
3	10.21*	35.66*	9.73*	57.01*	88.05*	77.06*	30.27*	44.74*
4	3.54*	18.45*	3.90*	30.35*	52.62*	54.39	25.12*	29.66
5	17.78*	43.38*	11.88*	56.55	95.22*	80.03*	32.33*	47.76*
6	20.23*	45.33	13.35*	65.43*	99.72*	94.08*	35.77	51.57*
7	18.80*	43.50*	11.40*	63.24*	82.83*	86.41*	32.29*	47.46
8	20.27*	47.04*	14.07	66.89*	102.92*	96.64	36.20*	52.03
9	16.71*	41.54*	12.73*	62.03	102.74	91.73*	33.68*	48.07*
10	20.20	38.33	11.71*	59.02*	92.08	86.06*	32.21	48.96

[a]Asterisks indicate statistical difference (α=.05) from the historical MSE.

Table B.11. Shadow Prices for Each Trader Group by Contract Subperiod from Model 2 Omitting Intergroup Response Effects.

	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
December 83						
1	7.18	0.00	-12.24	0.00	0.00	2.92
2	0.51	-5.10	-12.27	3.15	12.10	3.11
3	-6.84	5.57	5.11	-1.07	4.36	2.87
4	-10.05	0.00	7.62	2.39	0.00	15.51
5	21.35	-1.15	19.31	2.39	-7.80	-20.52
6	4.23	5.35	9.81	5.04	5.04	-6.08
7	6.20	-0.49	6.95	0.13	-9.64	-16.51
8	-0.48	1.90	-0.31	2.30	-0.63	1.29
9	-2.26	-1.05	0.89	-1.77	1.44	0.28
10	-0.45	-0.45	-0.44	0.08	0.19	-0.24
February 84						
1	-2.16	-3.04	32.48	0.00	0.00	-21.47
2	8.14	-3.76	9.10	0.00	0.00	4.80
3	0.47	0.00	18.83	0.00	-5.50	-8.29
4	19.02	-2.36	-1.85	0.00	-3.91	-1.74
5	23.21	1.55	-2.96	-0.85	0.61	-26.50
6	-0.67	1.14	4.63	-0.17	2.87	4.81
7	-2.35	0.21	-2.96	0.51	-3.25	0.33
8	-0.05	-0.68	0.02	-0.54	-1.52	0.70
9	-0.06	0.08	0.03	0.06	-0.03	-0.08
10	-0.13	-0.02	0.02	0.07	0.22	0.03
April 84						
1	18.07	-7.38	3.79	0.00	0.69	-6.17
2	14.79	-2.13	4.08	2.12	-3.54	-3.91
3	5.33	2.50	6.17	-4.44	-4.33	-18.97
4	6.31	0.75	-0.38	0.77	8.65	-6.22
5	-4.48	1.17	-3.97	-0.42	-3.50	-0.05
6	-2.27	-0.54	-0.61	-0.57	1.40	-2.69
7	-0.63	-1.00	0.78	0.30	-0.62	3.23
8	-0.65	0.42	-0.51	-0.15	0.29	0.05
9	-0.07	0.01	-0.00	-0.06	-0.04	0.04
10	0.07	0.02	0.00	0.02	-0.01	-0.02

Table B.11 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
June 84						
1	-0.12	-0.01	0.86	0.00	-0.17	-0.04
2	-0.65	0.23	0.18	0.00	0.21	-0.68
3	0.02	0.06	-0.98	0.01	0.39	2.23
4	0.71	1.12	0.33	-0.06	-0.05	-0.10
5	1.26	-0.22	0.08	-0.13	-1.88	0.87
6	-0.08	0.48	1.35	0.23	0.90	-1.50
7	-0.13	0.03	0.10	-0.04	-0.03	0.15
8	-0.02	-0.08	0.10	0.00	0.15	0.01
9	0.05	-0.10	-0.04	-0.12	0.04	0.23
10	0.01	0.02	0.16	0.01	-0.13	0.25
August 84						
1	-0.17	0.00	0.04	1.37	-1.16	2.60
2	0.02	-0.54	-0.29	-2.46	0.07	3.50
3	-1.04	1.36	-1.41	0.62	0.36	0.31
4	-0.47	0.05	1.59	-0.17	-0.62	0.35
5	-0.45	0.19	-0.96	0.27	-0.10	1.27
6	0.05	-0.11	-0.17	-0.27	-0.22	-0.08
7	0.06	0.05	0.04	-0.08	-0.04	0.06
8	-0.09	-0.01	0.06	0.07	-0.16	0.15
9	0.19	0.03	-0.42	0.50	0.12	0.07
10	0.31	-0.05	0.08	0.02	-0.07	-0.06
October 84						
1	-4.30	0.00	2.53	0.00	0.00	1.23
2	1.97	0.00	-3.32	0.00	-0.51	3.61
3	-0.46	0.13	1.49	0.39	0.45	-0.56
4	-1.12	0.12	-2.40	0.03	-0.40	0.35
5	-1.12	-0.10	-0.66	0.20	0.48	2.12
6	-1.64	-0.87	-0.10	0.66	-0.52	2.88
7	0.23	0.01	-0.53	-0.35	-0.59	0.53
8	0.97	0.42	-0.15	-0.14	0.05	-0.18
9	0.13	0.07	0.04	-0.07	0.29	-0.43
10	0.04	0.06	-0.09	0.01	0.22	-0.17

Table B.11 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
December 84						
1	0.19	0.00	0.28	0.00	1.34	-2.36
2	2.39	0.00	4.11	0.00	0.13	-2.68
3	3.92	-0.53	3.35	0.00	-3.88	-4.10
4	2.96	-0.27	-0.11	-1.34	-1.09	-4.13
5	-3.21	2.22	-0.65	-0.09	4.32	2.82
6	-1.75	-0.48	1.40	-0.40	0.93	-3.41
7	-0.88	0.04	-0.28	-0.02	1.86	1.06
8	-0.06	0.56	-0.53	0.10	-0.26	-0.30
9	-0.06	-0.03	-0.03	0.03	0.05	0.17
10	0.03	0.00	-0.06	-0.00	0.03	-0.03
February 85						
1	-1.87	0.00	2.59	0.00	-0.17	-0.76
2	-0.38	0.00	2.88	0.00	0.53	-0.63
3	-1.22	0.97	-1.77	-0.09	1.06	-0.94
4	-0.42	-0.10	1.01	0.10	0.36	1.06
5	-0.61	0.21	-0.38	0.05	-1.84	1.50
6	-2.04	-0.57	0.67	0.24	0.20	1.51
7	-1.67	0.46	2.08	0.04	0.01	2.40
8	-0.31	0.14	-1.05	0.31	0.77	-0.49
9	0.28	0.10	-0.54	-0.00	-0.51	0.01
10	0.34	0.03	-0.03	-0.01	-0.02	-0.12
April 85						
1	-0.66	-1.58	-38.52	0.00	6.63	24.22
2	7.05	0.00	-6.60	0.00	5.01	9.93
3	-2.11	0.40	-5.10	0.00	-3.22	4.00
4	2.87	3.16	8.16	0.00	-0.88	-4.09
5	0.26	-1.82	7.44	1.82	6.22	-4.34
6	-4.21	1.25	-2.12	1.65	-2.74	4.30
7	3.79	-1.10	0.99	-0.57	-5.37	-1.55
8	-0.80	-0.14	1.79	0.21	0.57	-1.78
9	1.36	0.21	-0.51	-0.78	-0.60	-2.56
10	-0.03	0.12	0.14	0.04	0.48	-0.09

Table B.11 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
June 85						
1	-4.45	0.00	2.94	0.00	3.51	-16.79
2	-23.78	0.00	24.36	0.94	1.93	-1.53
3	10.92	-1.47	1.39	-3.52	-6.69	10.91
4	2.95	-3.08	1.69	1.18	11.73	-14.08
5	-7.04	1.28	-3.05	1.71	-3.01	17.19
6	-7.85	-0.01	-1.26	-0.72	-11.27	12.06
7	-3.92	3.66	-4.18	-2.29	7.71	-3.65
8	1.85	-2.11	-0.24	-2.57	-7.02	-0.30
9	-1.01	-0.70	-1.33	0.89	4.40	-2.03
10	-0.15	-0.18	-0.00	0.18	-0.40	-0.94
August 85						
1	1.64	-2.19	-6.69	0.59	-0.66	15.42
2	4.71	0.55	19.73	0.00	0.00	-6.51
3	-23.17	-2.90	-0.54	-4.20	3.29	26.30
4	-12.06	4.20	-6.96	0.36	0.58	11.49
5	-8.56	-0.59	10.50	0.66	2.48	-4.48
6	-9.88	-2.64	4.11	1.34	-6.64	3.20
7	13.22	-2.65	-0.05	-0.06	-0.51	-7.83
8	-1.76	-1.81	-0.53	0.15	-2.43	-1.66
9	0.33	0.05	0.05	-0.06	-0.24	0.52
10	-0.09	-0.01	-0.02	0.05	0.12	0.28
October 85						
1	-1.12	0.00	-2.03	0.00	-1.35	2.45
2	1.32	0.55	1.39	-0.47	-1.33	0.57
3	-1.69	0.42	2.21	-0.49	-2.83	3.21
4	4.81	-0.63	-2.72	0.04	0.92	1.31
5	-3.39	-1.33	-0.59	0.18	0.64	1.32
6	0.71	7.84	2.97	-0.07	16.04	-10.22
7	6.17	-1.08	4.71	1.54	-0.85	-0.63
8	-0.25	-2.34	0.09	-0.59	-1.06	4.54
9	1.52	1.08	-1.04	0.30	-1.79	-0.51
10	-0.07	-0.09	-0.09	-0.03	0.14	-0.07

Table B.11 continued	--------- Trader Group ---------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
December 85						
1	2.18	0.09	-1.72	0.00	-0.91	4.93
2	7.36	-1.58	-0.41	0.36	-0.66	0.47
3	-7.05	2.91	4.08	0.00	1.79	-3.95
4	-6.42	0.80	2.44	0.69	12.03	-2.10
5	8.07	0.18	-3.02	-0.01	-1.11	5.38
6	-0.93	0.55	-0.12	0.06	0.94	-2.09
7	-0.34	-0.07	0.48	0.05	0.35	1.26
8	1.29	0.70	0.70	0.26	-1.04	1.52
9	-0.37	0.89	0.30	0.53	1.39	-1.65
10	-0.05	-0.12	-0.00	-0.05	0.30	0.03
February 86						
1	-8.09	0.00	10.60	0.00	-0.85	3.70
2	-6.74	0.33	-10.93	0.70	6.02	1.99
3	-0.17	0.02	-5.19	-0.46	-0.50	-7.23
4	-3.27	1.70	-4.45	0.09	2.03	-2.70
5	2.52	-6.81	-1.47	0.38	1.53	11.63
6	-5.93	1.44	8.68	1.15	-2.23	6.29
7	-1.76	0.97	2.75	1.03	-1.30	-1.14
8	-2.43	0.34	-0.07	-0.08	1.77	0.21
9	1.05	-0.07	0.42	-0.13	0.01	-1.59
10	-0.08	0.07	0.18	-0.01	0.01	0.10
April 86						
1	-1.50	0.00	-5.07	0.00	1.01	-11.70
2	3.11	2.38	-4.86	0.00	0.55	-11.03
3	-15.49	0.86	1.88	5.71	2.35	14.08
4	9.81	-0.95	-3.42	-0.57	3.11	-1.29
5	-5.40	1.15	1.49	-4.17	-1.81	4.72
6	3.16	1.11	-6.70	-0.48	1.75	3.13
7	2.68	1.34	3.04	0.33	0.05	-6.71
8	-2.91	-0.03	0.09	-0.27	0.07	2.42
9	0.36	0.30	0.34	-0.04	-0.07	0.00
10	-0.55	0.23	0.91	0.17	-0.38	0.55

Table B.11 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
June 86						
1	-14.51	1.00	4.79	0.00	0.51	29.68
2	-3.16	-6.29	3.41	0.00	0.00	-0.40
3	1.75	0.64	-1.48	0.00	-0.25	1.23
4	-0.57	-0.66	-6.10	0.00	0.56	4.89
5	2.26	0.14	-0.68	-0.20	-1.80	0.33
6	-0.38	0.39	0.20	0.04	-0.70	-0.11
7	2.58	-0.33	-0.02	-0.05	-0.12	-1.86
8	1.30	0.59	1.52	-0.58	-1.49	3.47
9	-0.06	-0.13	-0.33	0.04	0.30	0.06
10	-1.12	0.51	0.71	0.14	0.07	0.36
August 86						
1	10.45	-0.09	-17.34	0.00	0.00	5.48
2	-8.65	0.00	-17.56	0.00	36.71	-3.43
3	4.29	2.05	0.20	0.00	0.61	-11.99
4	-6.01	7.04	23.80	0.00	-4.25	-9.16
5	3.10	-3.27	-3.33	0.12	9.19	5.26
6	18.46	-10.32	1.27	1.90	19.50	-8.64
7	11.37	-3.31	1.21	-4.13	-5.21	-2.26
8	0.45	-0.35	-2.41	-0.03	-4.50	2.40
9	-0.80	-0.45	0.64	-0.27	1.21	-0.90
10	0.07	0.13	0.12	0.05	-0.20	-0.02
October 86						
1	-13.13	0.00	-12.12	0.00	1.20	19.03
2	-2.10	0.00	-12.77	0.00	-0.52	28.77
3	3.44	-5.76	9.97	0.00	23.13	-13.80
4	-3.54	3.54	-6.68	-0.90	-4.21	22.50
5	4.95	-5.29	-3.75	0.24	37.70	-17.53
6	3.95	0.18	-7.06	-1.79	5.87	-13.55
7	-0.11	-1.93	-1.31	1.00	-4.43	3.76
8	-1.69	0.24	0.91	-1.12	0.66	0.74
9	0.13	-0.41	0.03	-0.14	-0.79	0.14
10	-0.21	0.16	0.10	0.02	-0.23	0.25

Table B.11 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
December 86						
1	11.95	-1.79	7.31	0.00	3.19	-0.58
2	15.65	-8.16	-12.26	1.92	-4.77	11.85
3	-2.42	6.38	6.32	-0.33	2.52	-6.21
4	-1.28	0.33	-4.24	-0.72	1.25	-4.14
5	5.40	0.53	-2.67	0.08	-0.00	-5.43
6	0.28	-0.70	-1.04	0.34	1.66	-1.08
7	0.47	0.17	0.12	0.08	0.85	-0.69
8	-0.42	-0.04	0.18	0.10	0.35	-0.10
9	0.64	0.08	0.32	-0.14	-0.18	0.36
10	0.06	-0.03	-0.06	0.04	-0.04	0.02
February 87						
1	-20.29	0.00	3.58	0.00	2.61	29.20
2	50.49	-1.98	10.84	0.00	8.02	-85.86
3	11.68	-7.13	5.32	0.00	7.00	-43.36
4	2.20	-0.36	-8.60	3.08	6.05	-10.44
5	-6.25	-1.49	14.03	4.79	5.19	-3.09
6	-1.99	4.12	-22.58	-0.72	22.93	-2.32
7	1.57	0.05	2.28	-0.83	-8.42	-1.91
8	2.10	-2.63	0.29	0.46	11.13	-4.16
9	-2.34	-0.04	-0.05	-0.12	-2.64	3.25
10	-0.03	-0.16	0.18	-0.01	-0.39	-0.53
April 87						
1	68.37	0.00	-100.64	0.00	0.00	2.14
2	4.85	2.44	15.10	0.00	-0.55	-34.36
3	-14.36	10.37	8.16	6.09	2.07	6.60
4	-15.89	8.41	17.94	0.00	7.60	-14.35
5	0.06	-3.55	4.36	-1.43	-5.21	-2.23
6	-4.13	4.50	-2.79	1.69	11.04	3.33
7	-1.82	-3.67	-3.24	-0.47	2.34	-3.87
8	0.81	0.12	-9.53	-1.66	0.10	0.69
9	-0.80	-0.42	-0.30	-0.10	0.84	1.19
10	0.04	-0.02	-0.06	0.01	0.01	0.04

Table B.11 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
June 87						
1	43.96	-6.41	41.14	0.00	8.26	-35.93
2	-21.97	3.99	5.09	0.00	5.37	-8.92
3	18.22	-0.86	2.47	0.00	3.93	-26.44
4	9.19	-3.42	15.30	0.00	0.56	-5.86
5	6.80	-1.10	-10.37	0.13	-8.82	-15.60
6	7.33	-3.81	-1.34	-0.99	2.92	-9.21
7	5.12	-0.06	-7.82	-0.29	4.04	-5.25
8	-0.10	0.18	1.13	-0.47	-1.42	-1.31
9	-0.96	-0.42	-0.21	0.62	0.49	-0.03
10	-0.55	-0.18	0.15	0.02	0.01	0.12
August 87						
1	3.37	0.00	-3.29	0.34	5.08	-1.89
2	4.04	-2.08	-6.68	-0.13	-0.93	8.66
3	6.03	-0.84	-10.53	0.00	-2.93	-12.55
4	12.42	-0.23	-4.31	-0.41	-9.73	0.98
5	5.55	-0.20	3.55	-0.52	-5.60	-2.66
6	4.05	-1.51	-1.56	-1.38	2.01	-5.81
7	-0.41	0.98	-1.67	-0.17	1.60	-1.89
8	0.18	0.16	-0.55	-0.37	-1.55	0.84
9	-0.41	-0.13	1.03	0.13	0.83	0.56
10	-0.18	-0.04	-0.21	-0.01	0.10	0.11
October 87						
1	-7.08	-6.14	-11.05	-1.75	1.92	-21.43
2	19.47	-2.92	-13.18	-8.84	17.54	-3.66
3	-8.03	1.15	1.79	0.33	-2.86	-5.64
4	0.46	-1.21	-6.88	-2.30	6.31	-9.05
5	10.63	2.11	-2.97	-2.08	-1.41	-2.86
6	5.07	-0.35	-3.88	0.60	2.72	-4.87
7	-1.65	0.47	4.20	-0.02	-1.28	-0.33
8	-0.10	-0.46	-1.59	-0.07	-0.66	0.59
9	0.05	0.13	-0.14	0.15	0.12	-0.03
10	0.07	-0.01	0.01	-0.02	-0.01	0.01

Table B.12. Optimal Change in Trader Group Price Pressure and Shadow Prices (in parenthesis) by Contract Subperiod for Model 4 Omitting Intergroup Response Effects.

	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
December 83						
1	0.80	1.00	1.20	1.00	1.00	0.80
	(1.75)	(0.00)	(-2.90)	(0.00)	(0.00)	(0.73)
2	0.80	1.20	1.20	0.80	0.80	0.80
	(0.11)	(-1.05)	(-2.76)	(0.66)	(2.61)	(0.81)
3	1.20	0.80	0.80	1.20	0.80	0.80
	(-1.26)	(1.13)	(1.23)	(-0.20)	(0.88)	(0.37)
4	1.20	1.00	0.80	0.80	1.20	0.80
	(-1.52)	(0.00)	(1.33)	(0.39)	(-0.02)	(2.43)
5	0.80	1.20	0.80	0.80	1.20	1.20
	(1.75)	(-0.13)	(1.85)	(0.31)	(-0.86)	(-1.55)
6	0.80	0.80	1.20	0.80	1.20	1.10
	(0.26)	(0.20)	(-0.21)	(0.19)	(-0.12)	(0.00)
7	0.81	1.20	1.20	1.20	0.80	0.80
	(0.00)	(-0.06)	(-0.33)	(-0.30)	(3.16)	(1.78)
8	1.20	1.20	0.80	1.20	0.80	0.94
	(-0.14)	(-1.25)	(0.85)	(-1.43)	(0.58)	(0.00)
9	0.80	0.80	1.20	0.80	1.20	1.20
	(5.18)	(1.87)	(-0.90)	(3.12)	(-0.01)	(-1.46)
10	1.20	0.80	0.80	1.20	1.20	0.80
	(-3.02)	(4.99)	(3.46)	(-0.70)	(-0.58)	(22.32)

Table B.12 continued	--------- Trader Group ---------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
February 84						
1	1.20	1.20	0.80	1.00	1.00	1.20
	(-0.78)	(-1.27)	(13.63)	(0.00)	(0.00)	(-8.99)
2	0.80	1.20	0.80	0.80	0.80	0.80
	(3.38)	(-1.30)	(3.37)	(0.00)	(0.00)	(1.43)
3	1.20	0.80	0.80	1.20	1.20	1.20
	(-0.22)	(0.00)	(6.01)	(0.00)	(-1.73)	(-2.40)
4	0.80	1.20	1.20	0.80	1.20	1.20
	(4.81)	(-0.60)	(-0.59)	(0.00)	(-1.04)	(-0.43)
5	0.80	1.20	1.20	1.20	1.20	1.09
	(4.44)	(-0.09)	(-1.30)	(-0.11)	(-0.16)	(0.00)
6	1.02	0.80	1.13	1.20	0.80	1.17
	(0.00)	(0.10)	(0.00)	(-0.01)	(0.28)	(0.00)
7	0.80	1.20	0.80	1.20	0.80	1.20
	(0.73)	(-0.01)	(2.26)	(-0.25)	(2.00)	(-1.00)
8	0.80	0.80	0.80	0.80	0.80	1.20
	(1.07)	(2.60)	(0.01)	(1.93)	(3.32)	(-1.54)
9	0.80	0.80	0.80	1.20	1.20	0.80
	(2.09)	(1.51)	(0.26)	(-0.78)	(-0.26)	(3.60)
10	0.80	1.20	1.20	1.20	1.20	1.00
	(3.50)	(-0.30)	(-0.50)	(-0.94)	(-2.75)	(0.00)
April 84						
1	0.80	1.20	0.80	1.00	0.80	1.20
	(10.66)	(-4.50)	(2.13)	(0.00)	(0.40)	(-3.50)
2	0.80	1.20	0.80	0.80	1.20	1.20
	(7.75)	(-1.18)	(1.43)	(1.10)	(-1.73)	(-1.93)
3	0.80	0.80	0.80	1.20	1.20	0.96
	(0.10)	(1.15)	(2.52)	(-2.10)	(-2.05)	(0.00)
4	0.80	0.80	1.20	0.80	0.80	1.20
	(2.52)	(0.24)	(-0.07)	(0.27)	(3.19)	(-2.19)
5	1.20	0.80	1.20	0.80	1.20	0.80
	(-0.71)	(0.29)	(-0.85)	(0.01)	(-0.59)	(0.06)
6	0.80	0.80	0.80	0.80	1.06	0.80
	(0.25)	(0.01)	(0.17)	(0.04)	(0.00)	(0.01)
7	0.80	0.80	1.09	0.80	1.19	1.20
	(0.05)	(0.23)	(0.00)	(0.04)	(0.00)	(-0.49)
8	1.20	1.20	0.80	0.80	0.80	1.20
	(-0.18)	(-0.21)	(1.35)	(0.42)	(0.31)	(-0.28)
9	0.80	0.80	0.83	0.80	0.80	1.20
	(0.83)	(0.69)	(0.00)	(0.36)	(0.04)	(-0.41)
10	1.20	1.20	0.80	0.80	0.80	0.80
	(-0.79)	(-0.01)	(0.21)	(0.05)	(0.09)	(0.72)

Table B.12 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
June 84						
1	1.20	0.80	0.98	1.00	0.80	0.80
	(-0.04)	(0.13)	(0.00)	(0.00)	(0.10)	(0.01)
2	0.80	0.80	1.20	0.80	1.20	0.80
	(0.29)	(0.02)	(-0.04)	(0.00)	(-0.14)	(0.23)
3	1.20	0.80	1.20	0.80	0.80	0.90
	(-0.03)	(0.00)	(-0.01)	(0.00)	(0.02)	(0.00)
4	0.80	0.80	0.80	1.20	1.20	0.80
	(0.04)	(0.06)	(0.02)	(-0.00)	(-0.01)	(0.00)
5	0.80	0.80	0.80	1.20	1.13	0.80
	(0.01)	(0.03)	(0.02)	(-0.01)	(0.00)	(0.02)
6	1.12	0.80	0.80	0.80	0.80	1.20
	(0.00)	(0.01)	(0.07)	(0.03)	(0.05)	(-0.02)
7	0.80	0.80	1.20	0.80	1.20	0.93
	(0.03)	(0.01)	(-0.00)	(0.01)	(-0.00)	(0.00)
8	1.20	0.80	0.80	0.80	0.80	0.80
	(-0.15)	(0.01)	(0.25)	(0.09)	(0.25)	(0.04)
9	0.80	1.20	1.20	1.20	0.80	0.80
	(0.04)	(-0.09)	(-0.04)	(-0.09)	(0.05)	(0.18)
10	0.80	0.80	0.80	0.80	0.88	0.80
	(0.10)	(0.01)	(0.07)	(0.01)	(0.00)	(0.10)
August 84						
1	0.88	0.80	1.20	0.80	1.20	0.80
	(0.00)	(0.00)	(-0.00)	(0.02)	(-0.01)	(0.08)
2	0.97	1.20	0.80	1.20	0.80	0.80
	(0.00)	(-0.00)	(0.00)	(-0.01)	(0.00)	(0.03)
3	0.80	0.93	0.80	0.80	1.13	0.80
	(0.01)	(0.00)	(0.02)	(0.01)	(0.00)	(0.01)
4	1.20	0.80	0.80	0.80	0.80	0.80
	(-0.00)	(0.00)	(0.04)	(0.00)	(0.01)	(0.01)
5	0.80	0.80	0.80	0.80	0.96	1.07
	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)
6	1.20	0.80	0.80	0.80	0.80	0.80
	(-0.01)	(0.04)	(0.00)	(0.13)	(0.13)	(0.07)
7	1.20	1.20	1.20	0.80	0.80	1.20
	(-0.02)	(-0.02)	(-0.01)	(0.03)	(0.01)	(-0.01)
8	1.20	0.80	0.80	0.80	0.80	1.20
	(-0.02)	(0.01)	(0.02)	(0.01)	(0.11)	(-0.02)
9	1.20	0.80	1.17	0.80	0.80	0.80
	(-0.03)	(0.01)	(0.00)	(0.06)	(0.10)	(0.04)
10	0.80	0.80	1.20	1.20	1.20	0.80
	(0.03)	(0.12)	(-0.01)	(-0.01)	(-0.04)	(0.06)

Table B.12 continued	--------- Trader Group ---------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
October 84						
1	1.20	0.80	0.80	0.80	1.20	0.80
	(-0.26)	(0.00)	(0.12)	(0.00)	(0.00)	(0.16)
2	0.80	1.20	1.20	1.20	0.80	0.80
	(0.08)	(0.00)	(-0.11)	(0.00)	(0.01)	(0.16)
3	1.20	0.80	0.80	0.80	0.80	1.20
	(-0.00)	(0.01)	(0.02)	(0.00)	(0.02)	(-0.01)
4	0.80	1.20	0.80	0.80	0.80	1.20
	(0.01)	(-0.00)	(0.05)	(0.00)	(0.00)	(-0.00)
5	0.80	0.80	0.83	0.80	0.80	1.08
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)
6	1.20	0.80	0.80	0.80	0.80	0.80
	(-0.03)	(0.00)	(0.01)	(0.02)	(0.00)	(0.06)
7	0.80	0.80	0.80	0.80	0.80	1.20
	(0.02)	(0.00)	(0.03)	(0.01)	(0.08)	(-0.03)
8	0.80	0.80	0.99	1.20	0.80	0.89
	(0.04)	(0.01)	(0.00)	(-0.00)	(0.04)	(0.00)
9	0.80	1.20	1.20	0.80	1.20	0.80
	(0.01)	(-0.00)	(-0.01)	(0.02)	(-0.01)	(0.09)
10	0.80	0.87	0.80	0.80	1.20	1.02
	(0.16)	(0.00)	(0.01)	(0.00)	(-0.01)	(0.00)
December 84						
1	0.80	1.00	0.80	1.00	0.80	1.20
	(0.05)	(0.00)	(0.10)	(0.00)	(0.41)	(-0.76)
2	0.80	1.00	0.80	1.00	0.80	1.20
	(0.42)	(0.00)	(0.89)	(0.00)	(0.02)	(-0.40)
3	0.80	1.20	0.80	1.00	1.20	1.20
	(0.30)	(-0.07)	(0.34)	(0.00)	(-0.44)	(-0.32)
4	0.80	1.20	0.80	1.20	1.20	1.20
	(0.02)	(-0.01)	(0.04)	(-0.02)	(-0.03)	(-0.03)
5	1.20	0.80	0.80	0.80	0.80	1.00
	(-0.06)	(0.06)	(0.03)	(0.00)	(0.12)	(0.00)
6	0.80	0.80	0.86	0.80	1.20	0.80
	(0.01)	(0.01)	(0.00)	(0.00)	(-0.00)	(0.03)
7	0.80	0.80	1.20	1.20	1.02	1.20
	(0.01)	(0.00)	(-0.00)	(-0.00)	(0.00)	(-0.01)
8	0.80	1.10	0.80	0.80	1.20	0.80
	(0.05)	(0.00)	(0.11)	(0.01)	(-0.03)	(0.18)
9	0.80	0.80	0.80	0.80	0.80	1.20
	(0.12)	(0.30)	(0.56)	(0.34)	(0.56)	(-0.02)
10	0.80	1.20	1.20	1.20	0.80	1.20
	(0.16)	(-0.08)	(-0.39)	(-0.03)	(0.21)	(-0.22)

Table B.12 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
February 85						
1	1.01	1.00	0.80	1.00	0.80	1.20
	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(-0.00)
2	1.20	1.00	0.80	1.00	0.80	1.20
	(-0.01)	(0.00)	(0.06)	(0.00)	(0.01)	(-0.01)
3	0.80	1.20	0.80	0.80	1.01	0.80
	(0.02)	(-0.01)	(0.01)	(0.00)	(0.00)	(0.03)
4	1.20	1.20	0.80	0.80	0.80	0.80
	(-0.01)	(-0.00)	(0.03)	(0.00)	(0.01)	(0.03)
5	0.80	0.80	0.80	0.80	0.80	0.82
	(0.00)	(0.00)	(0.01)	(0.00)	(0.03)	(0.00)
6	1.04	0.80	0.80	0.80	0.80	0.80
	(0.00)	(0.00)	(0.01)	(0.01)	(0.03)	(0.00)
7	1.20	0.80	0.80	0.80	0.80	0.80
	(-0.07)	(0.02)	(0.09)	(0.00)	(0.01)	(0.10)
8	1.20	1.20	0.80	0.80	0.80	0.80
	(-0.00)	(-0.01)	(0.01)	(0.00)	(0.02)	(0.01)
9	1.19	1.20	0.80	0.80	0.80	1.20
	(0.00)	(-0.01)	(0.06)	(0.01)	(0.06)	(-0.01)
10	1.20	0.80	0.80	0.80	0.80	1.20
	(-0.09)	(0.17)	(0.11)	(0.01)	(0.00)	(-0.02)
April 85						
1	1.20	1.20	1.05	1.00	0.80	0.80
	(-0.18)	(-0.67)	(0.00)	(0.00)	(1.79)	(5.85)
2	0.80	1.00	1.20	1.00	0.80	0.80
	(2.71)	(0.00)	(-2.51)	(0.00)	(1.97)	(3.85)
3	1.20	0.80	1.20	0.80	1.20	0.80
	(-0.78)	(0.14)	(-1.81)	(0.00)	(-1.09)	(1.45)
4	0.80	0.80	0.80	0.80	1.20	1.20
	(1.02)	(0.92)	(2.36)	(0.00)	(-0.27)	(-1.21)
5	0.80	1.20	0.80	0.80	0.80	1.20
	(0.14)	(-0.43)	(1.70)	(0.44)	(1.42)	(-1.05)
6	1.20	0.80	1.20	0.80	1.20	0.80
	(-0.77)	(0.20)	(-0.58)	(0.22)	(-0.52)	(0.87)
7	0.80	1.20	1.20	1.20	0.84	1.08
	(0.05)	(-0.12)	(-0.15)	(-0.06)	(0.00)	(0.00)
8	0.80	1.20	0.80	0.80	0.80	1.20
	(0.18)	(-0.04)	(0.23)	(0.11)	(0.73)	(-0.03)
9	1.20	1.20	0.80	0.80	0.80	0.80
	(-1.41)	(-0.19)	(0.40)	(0.65)	(0.30)	(3.41)
10	0.80	0.80	0.80	0.80	1.20	1.20
	(2.88)	(1.14)	(2.12)	(0.77)	(-1.23)	(-3.36)

Table B.12 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
June 85						
1	1.20	1.20	0.80	1.00	0.80	1.20
	(-2.70)	(0.00)	(1.52)	(0.00)	(2.02)	(-9.91)
2	1.20	1.00	0.80	0.80	0.80	1.20
	(-13.01)	(0.00)	(13.55)	(0.51)	(1.09)	(-1.10)
3	0.80	1.20	0.80	1.20	1.20	0.80
	(5.62)	(-0.69)	(0.44)	(-1.70)	(-3.33)	(5.29)
4	0.80	1.20	0.80	0.80	0.80	1.20
	(0.96)	(-1.31)	(0.77)	(0.58)	(4.87)	(-6.08)
5	1.20	0.80	1.20	0.80	1.20	0.80
	(-2.41)	(0.55)	(-1.23)	(0.59)	(-1.11)	(5.30)
6	1.20	0.80	0.80	1.20	1.20	0.80
	(-1.47)	(0.04)	(0.14)	(-0.15)	(-1.83)	(1.93)
7	1.20	1.20	1.20	1.20	0.93	0.80
	(-0.42)	(-0.24)	(-0.13)	(-0.01)	(0.00)	(0.23)
8	1.20	0.80	1.20	0.80	0.80	0.80
	(-0.42)	(1.13)	(-0.38)	(1.08)	(2.28)	(0.69)
9	0.86	0.80	0.80	1.20	1.20	0.80
	(0.00)	(3.32)	(2.54)	(-0.32)	(-1.62)	(0.71)
10	1.20	0.80	0.80	1.20	0.80	0.80
	(-1.42)	(2.20)	(1.73)	(-0.47)	(8.15)	(5.71)
August 85						
1	0.80	1.20	1.20	0.80	1.20	0.80
	(0.80)	(-1.35)	(-3.97)	(0.39)	(-0.42)	(9.99)
2	0.80	0.80	0.80	0.80	0.80	1.20
	(2.51)	(0.37)	(11.78)	(0.00)	(0.00)	(-4.01)
3	1.20	1.20	1.20	1.20	0.80	0.80
	(-12.38)	(-1.53)	(-0.27)	(-2.30)	(1.66)	(13.54)
4	1.20	0.80	1.20	0.80	0.80	0.80
	(-5.39)	(2.01)	(-2.88)	(0.14)	(0.36)	(4.99)
5	1.20	1.20	0.80	0.80	0.80	1.20
	(-2.92)	(-0.09)	(3.42)	(0.14)	(0.81)	(-1.71)
6	1.20	1.20	0.80	0.80	1.20	0.80
	(-1.89)	(-0.34)	(0.82)	(0.30)	(-1.51)	(0.55)
7	1.10	0.97	1.20	0.80	1.20	1.20
	(0.00)	(0.00)	(-0.18)	(0.11)	(-0.61)	(-0.27)
8	0.80	0.80	0.80	1.20	0.80	0.96
	(6.28)	(1.70)	(1.15)	(-0.26)	(2.12)	(0.00)
9	0.80	0.80	0.80	0.80	1.07	0.80
	(1.82)	(0.45)	(0.66)	(1.44)	(0.00)	(6.71)
10	1.20	0.80	0.80	0.90	1.05	0.80
	(-1.90)	(1.13)	(0.74)	(0.00)	(0.00)	(3.15)

Table B.12 continued	--------- Trader Group ---------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
October 85						
1	0.80	1.20	0.80	0.80	0.80	1.20
	(0.40)	(0.00)	(0.56)	(0.00)	(0.37)	(-0.81)
2	1.20	1.20	0.80	0.80	0.80	1.20
	(-0.14)	(-0.06)	(0.05)	(0.01)	(0.15)	(-0.02)
3	0.80	1.20	0.80	0.80	0.96	1.20
	(0.03)	(-0.00)	(0.02)	(0.00)	(0.00)	(-0.04)
4	0.80	1.20	1.20	0.80	0.80	0.80
	(0.13)	(-0.01)	(-0.07)	(0.00)	(0.01)	(0.05)
5	1.20	1.20	1.20	0.80	0.80	0.80
	(-0.04)	(-0.04)	(-0.04)	(0.00)	(0.01)	(0.07)
6	0.80	0.80	0.80	0.80	0.80	1.20
	(0.09)	(0.67)	(0.26)	(0.00)	(1.38)	(-0.86)
7	0.80	1.19	0.80	0.80	1.20	1.20
	(0.47)	(0.00)	(0.28)	(0.09)	(-0.03)	(-0.03)
8	0.80	0.80	1.04	0.80	0.99	1.20
	(0.43)	(0.04)	(0.00)	(0.02)	(0.00)	(-0.30)
9	0.80	0.80	0.80	1.20	0.80	1.20
	(0.33)	(0.66)	(1.03)	(-0.12)	(2.40)	(-0.56)
10	0.80	0.96	1.20	0.93	1.20	0.80
	(4.26)	(0.00)	(-0.87)	(0.00)	(-1.31)	(6.29)
December 85						
1	1.20	1.20	0.80	1.00	1.12	0.82
	(-0.01)	(-0.00)	(0.02)	(0.00)	(0.00)	(0.00)
2	0.80	1.20	0.80	0.80	1.20	1.09
	(0.03)	(-0.01)	(0.01)	(0.00)	(-0.00)	(0.00)
3	1.20	0.80	0.80	1.00	0.80	1.20
	(-0.01)	(0.08)	(0.02)	(0.00)	(0.05)	(-0.00)
4	1.20	0.80	0.80	0.80	0.80	1.20
	(-0.45)	(0.05)	(0.27)	(0.05)	(0.82)	(-0.07)
5	0.80	0.80	1.20	0.80	0.80	0.80
	(0.47)	(0.05)	(-0.20)	(0.03)	(0.22)	(0.36)
6	1.20	1.20	0.96	1.20	1.11	0.80
	(-0.10)	(-0.21)	(0.00)	(-0.08)	(0.00)	(0.64)
7	0.80	0.80	0.80	0.80	0.80	0.98
	(0.41)	(0.71)	(0.12)	(0.30)	(1.61)	(0.00)
8	0.80	0.80	0.80	0.80	1.20	0.80
	(1.46)	(0.71)	(1.02)	(0.30)	(-1.31)	(2.14)
9	1.20	0.80	0.80	0.80	0.80	1.20
	(-0.29)	(0.69)	(0.22)	(0.45)	(1.16)	(-1.37)
10	1.20	0.88	0.80	0.80	0.80	1.20
	(-0.01)	(0.00)	(0.10)	(0.02)	(0.11)	(0.00)

Table B.12 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
February 86						
1	1.20	1.20	0.80	1.00	1.20	0.80
	(-2.36)	(0.00)	(3.65)	(0.00)	(-0.21)	(1.21)
2	1.20	1.20	0.97	0.80	0.80	0.80
	(-1.13)	(-0.07)	(0.00)	(0.06)	(0.51)	(0.09)
3	1.09	0.80	0.80	0.80	1.20	1.20
	(0.00)	(0.01)	(0.23)	(0.01)	(-0.05)	(-0.18)
4	0.80	1.20	0.80	0.80	0.80	0.80
	(0.05)	(-0.01)	(0.02)	(0.00)	(0.02)	(0.05)
5	0.80	1.14	0.80	0.80	0.80	0.80
	(0.32)	(0.00)	(0.02)	(0.03)	(0.06)	(0.57)
6	1.20	0.80	0.80	0.80	1.20	0.80
	(-0.27)	(0.05)	(0.64)	(0.07)	(-0.16)	(0.38)
7	1.20	0.80	0.80	0.85	1.20	1.20
	(-0.03)	(0.13)	(0.06)	(0.00)	(-0.01)	(-0.01)
8	0.80	1.13	1.20	0.80	0.80	0.80
	(0.42)	(0.00)	(-0.12)	(0.04)	(0.55)	(0.11)
9	0.97	0.80	0.91	0.80	0.80	0.80
	(0.00)	(0.05)	(0.00)	(0.09)	(0.46)	(1.22)
10	1.20	1.20	0.80	0.80	1.20	0.80
	(-0.06)	(-0.01)	(0.32)	(0.03)	(-0.20)	(0.16)
April 86						
1	1.20	1.20	1.04	1.00	0.80	1.20
	(-0.01)	(0.00)	(0.00)	(0.00)	(0.12)	(-2.24)
2	0.80	0.80	1.20	0.80	0.80	1.15
	(0.18)	(0.15)	(-0.32)	(0.00)	(0.02)	(0.00)
3	0.94	0.80	0.80	0.80	0.80	0.80
	(0.00)	(0.01)	(0.42)	(0.46)	(0.16)	(0.59)
4	0.80	1.20	1.20	1.20	0.80	1.20
	(0.68)	(-0.05)	(-0.28)	(-0.01)	(0.24)	(-0.07)
5	1.20	0.80	0.80	1.20	0.81	0.80
	(-0.01)	(0.00)	(0.01)	(-0.08)	(0.00)	(0.14)
6	0.80	0.80	0.80	0.80	0.88	1.01
	(0.09)	(0.02)	(0.01)	(0.01)	(0.00)	(0.00)
7	1.20	0.80	0.80	0.80	0.80	1.02
	(-0.01)	(0.03)	(0.05)	(0.06)	(0.03)	(0.00)
8	0.80	1.20	0.80	0.80	0.80	1.20
	(0.23)	(-0.03)	(0.02)	(0.04)	(0.14)	(-0.09)
9	1.01	0.80	0.80	1.20	0.83	0.80
	(0.00)	(0.09)	(0.47)	(-0.02)	(0.00)	(0.02)
10	1.20	0.80	0.80	0.80	1.05	0.80
	(-0.39)	(0.04)	(0.46)	(0.09)	(0.00)	(0.46)

Table B.12 continued	--------- Trader Group ---------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
June 86						
1	1.20	1.15	0.80	1.00	0.80	0.80
	(-2.62)	(0.00)	(1.66)	(0.00)	(0.14)	(7.36)
2	1.20	1.20	0.97	0.80	0.80	1.20
	(-0.20)	(-0.86)	(0.00)	(0.00)	(0.00)	(-0.08)
3	0.80	0.80	1.20	0.80	1.20	0.80
	(0.10)	(0.07)	(-0.12)	(0.00)	(-0.02)	(0.08)
4	0.80	0.90	1.20	1.20	1.20	0.92
	(0.10)	(0.00)	(-0.03)	(0.00)	(-0.01)	(0.00)
5	1.01	1.20	0.80	0.80	0.80	1.20
	(0.00)	(-0.00)	(0.01)	(0.00)	(0.08)	(-0.01)
6	0.80	0.80	1.18	0.80	1.02	1.20
	(0.32)	(0.20)	(0.00)	(0.15)	(0.00)	(-0.15)
7	0.80	1.20	0.86	1.20	1.20	1.20
	(1.25)	(-0.15)	(0.00)	(-0.01)	(-0.08)	(-0.72)
8	0.80	0.80	0.80	1.20	0.98	0.80
	(0.50)	(0.04)	(0.65)	(-0.17)	(0.00)	(1.44)
9	0.80	1.20	0.80	1.20	0.80	0.80
	(0.04)	(-0.02)	(0.10)	(-0.01)	(0.13)	(0.04)
10	0.89	1.20	0.80	0.80	0.80	0.80
	(0.00)	(-0.07)	(0.26)	(0.03)	(0.01)	(0.61)
August 86						
1	0.80	0.80	0.80	1.00	0.80	0.80
	(0.02)	(0.00)	(0.08)	(0.00)	(0.00)	(0.01)
2	1.08	1.20	0.95	0.80	0.80	0.80
	(0.00)	(0.00)	(0.00)	(0.00)	(0.07)	(0.01)
3	0.80	0.98	0.80	0.80	1.20	1.20
	(0.01)	(0.00)	(0.01)	(0.00)	(-0.00)	(-0.01)
4	1.20	0.80	0.80	1.20	1.20	1.20
	(-0.11)	(0.11)	(0.38)	(0.00)	(-0.06)	(-0.09)
5	0.80	1.20	1.20	0.80	0.80	0.80
	(0.07)	(-0.07)	(-0.12)	(0.01)	(0.23)	(0.20)
6	0.81	1.20	1.20	1.20	0.80	0.80
	(0.00)	(-0.10)	(0.00)	(-0.03)	(0.30)	(0.30)
7	1.13	0.96	0.87	0.80	0.80	0.80
	(0.00)	(0.00)	(0.00)	(0.14)	(0.27)	(1.19)
8	1.20	0.80	0.80	1.20	0.80	0.80
	(-0.09)	(0.02)	(2.60)	(-0.30)	(4.56)	(0.47)
9	0.80	0.80	1.20	0.80	1.10	0.80
	(5.75)	(2.04)	(-2.80)	(0.28)	(0.00)	(0.72)
10	0.80	1.20	0.97	1.20	0.80	1.20
	(5.14)	(-0.81)	(0.00)	(-0.67)	(7.36)	(-1.20)

Table B.12 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
October 86						
1	1.20	0.80	1.20	1.00	0.80	0.80
	(-5.17)	(0.00)	(-4.63)	(0.00)	(0.40)	(7.42)
2	1.20	1.20	1.20	0.80	1.20	0.80
	(-0.68)	(0.00)	(-3.79)	(0.00)	(-0.24)	(9.42)
3	0.80	1.20	0.80	0.80	0.80	1.09
	(0.81)	(-1.61)	(1.88)	(0.00)	(6.35)	(0.00)
4	1.10	0.80	0.94	1.20	1.20	0.80
	(0.00)	(0.80)	(0.00)	(-0.23)	(-1.38)	(6.07)
5	0.91	1.20	1.20	0.80	0.80	1.20
	(0.00)	(-0.56)	(-0.50)	(0.01)	(3.35)	(-0.86)
6	1.19	1.20	0.80	0.80	1.20	0.80
	(0.00)	(-0.05)	(4.06)	(0.28)	(-0.13)	(3.95)
7	1.20	0.80	0.80	1.20	0.80	1.20
	(-0.13)	(2.15)	(2.17)	(-0.46)	(5.19)	(-3.87)
8	0.80	1.20	1.20	0.80	1.20	0.93
	(1.70)	(-0.67)	(-1.87)	(2.28)	(-0.93)	(0.00)
9	0.98	0.80	1.20	0.80	0.80	1.09
	(0.00)	(1.64)	(-0.66)	(0.73)	(3.37)	(0.00)
10	0.80	1.20	1.20	0.80	0.80	1.15
	(6.42)	(-0.56)	(-0.31)	(0.65)	(0.61)	(0.00)
December 86						
1	0.80	1.20	0.80	1.00	0.80	0.97
	(3.83)	(-0.55)	(2.20)	(0.00)	(0.96)	(0.00)
2	0.80	1.05	1.20	0.80	1.20	0.80
	(3.20)	(0.00)	(-2.92)	(0.48)	(-1.93)	(3.64)
3	1.20	0.80	0.80	1.20	0.80	1.20
	(-0.42)	(0.84)	(0.93)	(-0.04)	(0.34)	(-0.89)
4	0.88	1.20	0.80	1.20	0.80	0.80
	(0.00)	(-0.11)	(0.18)	(-0.03)	(0.06)	(0.07)
5	0.99	0.80	0.80	0.80	0.80	0.80
	(0.00)	(0.17)	(0.34)	(0.02)	(0.01)	(0.26)
6	0.80	0.80	0.80	1.20	1.20	0.92
	(0.03)	(0.03)	(0.05)	(-0.01)	(-0.01)	(0.00)
7	1.08	1.07	1.02	0.80	0.80	0.80
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.02)
8	1.20	1.20	0.80	1.20	0.80	1.20
	(-0.00)	(-0.04)	(0.21)	(-0.00)	(0.27)	(-0.13)
9	0.80	0.80	0.80	1.20	1.20	0.80
	(0.69)	(0.08)	(0.32)	(-0.16)	(-0.17)	(0.39)
10	0.80	1.20	1.11	0.80	1.20	1.20
	(0.05)	(-0.01)	(0.00)	(0.04)	(-0.04)	(-0.00)

Table B.12 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
February 87						
1	1.20	1.20	0.80	1.00	0.80	0.80
	(-8.40)	(0.00)	(0.43)	(0.00)	(0.95)	(12.99)
2	0.80	1.20	1.20	0.80	0.80	1.07
	(16.22)	(-0.56)	(-5.53)	(0.00)	(2.06)	(0.00)
3	0.80	1.20	0.80	1.20	0.80	1.20
	(2.77)	(-1.54)	(1.55)	(0.00)	(1.24)	(-9.87)
4	0.80	1.20	1.20	0.80	0.80	1.20
	(0.05)	(-0.10)	(-1.02)	(0.58)	(1.09)	(-1.33)
5	1.20	1.20	0.80	0.80	0.80	1.20
	(-0.68)	(-0.19)	(1.39)	(0.47)	(0.66)	(-0.20)
6	1.20	0.80	0.99	1.20	0.80	1.20
	(-0.24)	(0.14)	(0.00)	(-0.05)	(1.08)	(-0.31)
7	1.20	1.20	1.20	0.80	0.80	0.80
	(-0.13)	(-0.01)	(-0.12)	(0.07)	(0.84)	(0.06)
8	1.20	0.80	0.80	1.20	1.20	0.80
	(-0.69)	(1.11)	(0.08)	(-0.18)	(-2.19)	(0.84)
9	0.80	0.80	0.80	0.80	0.80	1.20
	(4.16)	(0.54)	(0.03)	(0.04)	(3.42)	(-4.52)
10	0.80	0.80	1.20	1.20	0.80	0.80
	(1.03)	(1.65)	(-3.96)	(-0.15)	(2.79)	(9.73)
April 87						
1	0.80	1.20	1.20	1.00	0.80	0.80
	(28.92)	(0.00)	(-43.59)	(0.00)	(0.00)	(1.74)
2	0.80	0.80	0.80	0.80	1.20	1.20
	(2.03)	(0.93)	(5.96)	(0.00)	(-0.29)	(-12.57)
3	1.20	0.80	0.80	0.80	0.80	0.80
	(-4.02)	(2.96)	(2.61)	(1.41)	(0.56)	(2.52)
4	1.20	0.80	0.80	0.80	1.11	1.20
	(-0.81)	(1.54)	(4.85)	(0.00)	(0.00)	(-0.54)
5	0.80	1.20	0.80	1.20	1.20	1.20
	(0.06)	(-0.27)	(0.60)	(-0.12)	(-0.65)	(-0.31)
6	0.80	1.20	0.80	1.20	0.90	1.20
	(0.59)	(-0.33)	(0.77)	(-0.34)	(0.00)	(-1.31)
7	0.80	0.80	0.80	0.80	0.80	0.80
	(1.01)	(2.36)	(1.87)	(0.27)	(0.31)	(1.49)
8	1.20	1.20	0.80	0.80	0.80	1.20
	(-1.57)	(-0.88)	(17.31)	(1.98)	(1.83)	(-2.28)
9	0.80	0.80	0.80	1.20	0.80	1.20
	(8.61)	(3.16)	(1.83)	(-0.90)	(2.43)	(-7.05)
10	1.20	0.80	1.20	1.20	1.20	0.80
	(-2.27)	(3.79)	(-0.65)	(-0.75)	(-0.23)	(11.64)

Table B.12 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
June 87						
1	0.80	1.20	0.80	1.00	0.80	1.20
	(24.97)	(-3.62)	(22.39)	(0.00)	(4.60)	(-20.13)
2	1.20	0.80	0.80	0.80	0.80	1.20
	(-10.54)	(1.88)	(2.43)	(0.00)	(2.78)	(-4.85)
3	0.80	1.20	0.80	0.80	0.80	1.20
	(7.67)	(-0.36)	(0.91)	(0.00)	(1.60)	(-11.10)
4	0.80	1.20	0.80	0.80	1.20	1.20
	(2.74)	(-1.23)	(5.24)	(0.00)	(-0.03)	(-1.36)
5	0.80	1.20	0.80	1.20	1.20	1.19
	(0.58)	(-0.13)	(0.28)	(-0.27)	(-2.25)	(0.00)
6	1.20	1.20	1.13	0.80	0.80	0.85
	(-0.38)	(-0.03)	(0.00)	(0.01)	(0.52)	(0.00)
7	1.13	1.20	0.80	0.80	0.91	0.80
	(0.00)	(-0.01)	(2.23)	(0.82)	(0.00)	(1.31)
8	0.80	1.20	1.20	0.80	0.80	0.80
	(0.62)	(-0.08)	(-1.19)	(0.56)	(1.82)	(1.48)
9	0.80	0.80	0.80	1.20	1.20	1.02
	(3.90)	(1.34)	(0.64)	(-2.23)	(-1.62)	(0.00)
10	0.80	0.80	1.20	1.20	0.80	1.20
	(7.36)	(0.20)	(-1.72)	(-0.22)	(1.85)	(-0.83)
August 87						
1	0.80	1.20	1.20	0.80	0.80	1.20
	(2.10)	(0.00)	(-2.10)	(0.20)	(3.06)	(-1.26)
2	0.80	1.20	1.20	1.20	1.20	0.80
	(2.11)	(-1.32)	(-3.39)	(-0.07)	(-0.45)	(4.74)
3	1.20	1.20	1.08	0.80	1.20	1.20
	(-0.64)	(-0.36)	(0.00)	(0.00)	(-1.13)	(-1.01)
4	0.80	1.20	1.20	1.20	0.95	0.80
	(3.00)	(-0.06)	(-1.63)	(-0.08)	(0.00)	(0.39)
5	0.80	1.20	0.80	1.20	1.20	1.20
	(0.80)	(-0.05)	(0.59)	(-0.14)	(-0.48)	(-0.18)
6	1.20	0.80	0.80	0.80	0.80	1.17
	(-0.04)	(0.02)	(0.01)	(0.00)	(0.01)	(0.00)
7	0.80	1.20	0.80	0.80	0.81	0.80
	(0.03)	(-0.05)	(0.16)	(0.05)	(0.00)	(0.07)
8	1.20	1.20	0.80	0.80	0.80	1.20
	(-0.00)	(-0.00)	(0.04)	(0.04)	(0.10)	(-0.06)
9	1.20	1.20	0.81	0.80	0.80	1.20
	(-0.00)	(-0.01)	(0.00)	(0.01)	(0.03)	(-0.01)
10	0.80	1.20	0.80	1.20	0.80	1.20
	(0.87)	(-0.04)	(0.09)	(-0.02)	(0.34)	(-0.45)

Table B.12 continued	---------- Trader Group ----------					
Contract Subperiod	LC	MC	LN	MN	OTH	ST
October 87						
1	1.20	1.20	1.20	1.20	0.80	1.20
	(-2.81)	(-2.79)	(-5.39)	(-0.67)	(0.73)	(-10.37)
2	0.80	0.83	1.20	1.20	0.80	1.20
	(7.47)	(0.00)	(-4.57)	(-2.48)	(7.63)	(-2.86)
3	1.20	0.80	0.80	0.80	1.20	1.20
	(-2.02)	(0.34)	(0.80)	(0.08)	(-0.43)	(-2.07)
4	0.80	1.20	1.20	1.20	0.80	1.20
	(0.09)	(-0.24)	(-1.01)	(-0.25)	(1.00)	(-1.48)
5	0.80	0.80	1.20	1.20	1.20	1.20
	(1.00)	(0.14)	(-0.22)	(-0.13)	(-0.10)	(-0.36)
6	1.04	0.80	1.20	0.80	1.20	0.80
	(0.00)	(0.04)	(-0.08)	(0.00)	(-0.10)	(0.02)
7	0.80	1.20	1.07	0.80	0.80	1.20
	(0.02)	(-0.11)	(0.00)	(0.20)	(1.05)	(-0.54)
8	1.20	0.80	0.80	1.20	0.80	0.80
	(-0.07)	(1.29)	(1.93)	(-0.10)	(0.43)	(0.41)
9	0.80	0.80	1.20	0.80	0.80	1.20
	(0.18)	(0.72)	(-0.81)	(1.54)	(1.63)	(-0.14)
10	0.80	1.20	1.20	1.20	1.20	1.20
	(1.47)	(-0.36)	(-0.45)	(-0.60)	(-0.45)	(-0.08)

Table B.13. Optimal Change in Trader Group Price Pressure and Shadow Prices (in parenthesis) by Contract Subperiod for Models 5-10 Omitting Intergroup Response Effects.

	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
December 83						
1	0.80	1.00	1.20	1.00	1.00	0.80
	(2.02)	(0.00)	(-2.81)	(0.00)	(0.00)	(1.79)
2	0.80	1.20	1.20	0.80	0.80	0.80
	(0.13)	(-1.87)	(-2.68)	(2.34)	(6.96)	(1.94)
3	1.20	0.80	0.80	1.20	0.80	0.80
	(-1.35)	(2.00)	(1.21)	(-0.78)	(2.45)	(1.47)
4	1.20	1.00	0.80	0.80	1.20	0.80
	(-1.42)	(0.00)	(1.09)	(1.72)	(-0.02)	(8.37)
5	0.98	1.20	0.91	0.80	1.20	1.20
	(0.00)	(-0.25)	(0.00)	(1.66)	(-3.75)	(-9.49)
6	1.00	0.98	1.20	0.80	1.00	1.00
	(0.00)	(0.00)	(-2.89)	(3.08)	(0.00)	(0.00)
7	1.08	1.20	1.20	1.20	0.81	1.04
	(0.00)	(-0.08)	(-2.47)	(-0.10)	(0.00)	(0.00)
8	1.20	1.20	0.80	1.06	0.80	0.95
	(-0.94)	(-2.07)	(2.38)	(0.00)	(0.66)	(0.00)
9	0.80	0.80	1.20	0.80	0.80	1.20
	(9.86)	(2.95)	(-1.99)	(0.80)	(0.34)	(-1.00)
10	1.20	1.00	0.80	1.20	1.20	0.80
	(-5.20)	(0.00)	(6.49)	(-0.36)	(-0.51)	(16.43)

Table B.13 cont'd	--------- Trader Group ---------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
February 84						
1	1.20	1.20	0.80	1.00	1.00	1.20
	(-0.78)	(0.00)	(6.40)	(0.00)	(0.00)	(-9.93)
2	0.80	1.20	0.80	0.80	0.80	0.80
	(3.54)	(-0.21)	(0.99)	(0.00)	(0.00)	(1.45)
3	1.20	0.80	1.03	1.20	1.20	1.20
	(-0.55)	(0.00)	(0.00)	(0.00)	(-4.21)	(-2.31)
4	0.80	1.20	1.20	0.80	1.20	1.20
	(2.87)	(-2.14)	(-0.05)	(0.00)	(-2.88)	(-0.34)
5	0.98	0.91	0.92	1.20	0.80	0.97
	(0.00)	(0.00)	(0.00)	(-0.82)	(0.22)	(0.00)
6	0.80	0.80	1.20	1.20	0.80	1.20
	(0.39)	(1.01)	(-6.02)	(-0.16)	(1.77)	(-3.09)
7	0.80	0.80	0.80	0.80	0.99	1.20
	(3.26)	(-0.06)	(12.25)	(0.46)	(0.00)	(-2.68)
8	0.80	0.94	1.00	1.00	1.00	1.20
	(2.93)	(0.00)	(0.00)	(0.00)	(0.00)	(-4.22)
9	1.00	0.80	0.80	0.94	1.20	1.00
	(0.00)	(0.39)	(0.43)	(0.00)	(-0.17)	(0.00)
10	0.80	1.20	1.20	1.20	1.20	0.80
	(10.78)	(-0.08)	(-2.26)	(-0.01)	(-2.62)	(0.24)
April 84						
1	0.80	1.20	0.80	1.00	0.80	1.20
	(11.41)	(-6.34)	(2.28)	(0.00)	(0.30)	(-4.61)
2	0.80	1.20	0.80	0.80	1.20	1.20
	(8.42)	(-1.79)	(1.43)	(1.50)	(-1.05)	(-2.73)
3	0.91	0.80	0.80	1.20	1.20	1.02
	(0.00)	(2.02)	(3.21)	(-2.98)	(-0.82)	(0.00)
4	0.80	0.80	1.07	0.80	0.88	1.20
	(2.63)	(0.54)	(0.00)	(0.41)	(0.00)	(-3.47)
5	0.84	0.80	1.20	0.99	0.80	0.80
	(0.00)	(0.78)	(-0.09)	(0.00)	(2.20)	(0.08)
6	0.80	1.20	0.80	0.80	1.20	0.97
	(1.90)	(-0.21)	(1.06)	(0.18)	(-2.10)	(0.00)
7	1.00	0.94	1.00	1.00	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
8	1.20	1.20	0.80	0.80	0.80	1.20
	(-0.07)	(-0.21)	(6.40)	(1.35)	(1.35)	(-0.74)
9	0.80	0.80	1.20	1.00	1.00	1.20
	(3.06)	(1.07)	(-0.18)	(0.00)	(0.00)	(-1.04)
10	1.20	1.20	0.80	0.80	0.80	0.80
	(-3.69)	(-0.07)	(0.87)	(0.00)	(0.80)	(2.29)

Table B.13 cont'd	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
June 84						
1	0.90	0.80	1.01	1.00	0.80	0.93
	(0.00)	(0.17)	(0.00)	(0.00)	(0.01)	(0.00)
2	1.20	0.80	0.80	0.80	0.80	0.90
	(-0.02)	(0.04)	(0.08)	(0.00)	(0.02)	(0.00)
3	1.20	0.80	1.20	0.80	0.80	0.80
	(-0.02)	(0.01)	(-0.64)	(0.01)	(0.22)	(0.72)
4	0.80	0.80	0.80	1.20	1.20	1.20
	(0.36)	(0.22)	(0.23)	(-0.06)	(-0.03)	(-0.04)
5	0.80	0.80	0.80	1.20	1.20	0.80
	(0.61)	(0.02)	(0.06)	(-0.12)	(-1.08)	(0.35)
6	1.20	0.90	0.80	0.80	0.80	1.20
	(-0.04)	(0.00)	(0.99)	(0.22)	(0.55)	(-0.61)
7	0.98	0.80	0.80	1.20	1.20	1.10
	(0.00)	(0.03)	(0.07)	(-0.04)	(-0.02)	(0.00)
8	1.20	0.80	0.80	1.09	0.80	0.80
	(-0.19)	(0.10)	(0.09)	(0.00)	(0.24)	(0.06)
9	0.80	1.20	1.20	1.20	0.80	0.80
	(0.07)	(-0.58)	(-0.03)	(-0.09)	(0.06)	(0.28)
10	1.20	0.80	0.82	0.80	1.16	0.80
	(-0.02)	(0.13)	(0.00)	(0.01)	(0.00)	(0.12)
August 84						
1	1.20	0.80	0.80	0.80	1.20	0.80
	(-0.09)	(0.00)	(0.01)	(0.50)	(-0.79)	(0.43)
2	0.80	1.20	1.20	1.20	0.80	0.80
	(0.04)	(0.00)	(-0.15)	(-0.86)	(0.04)	(0.47)
3	1.20	0.80	1.20	0.80	0.80	0.80
	(-0.29)	(0.30)	(-0.39)	(0.17)	(0.23)	(0.03)
4	1.20	0.80	0.80	1.20	1.20	0.99
	(-0.10)	(0.01)	(0.32)	(-0.03)	(-0.35)	(0.00)
5	1.09	0.99	0.89	1.15	1.20	1.20
	(0.00)	(0.00)	(0.00)	(0.00)	(-0.06)	(-0.42)
6	1.20	0.80	0.80	0.80	0.81	0.80
	(-0.01)	(0.12)	(0.01)	(0.23)	(0.00)	(0.20)
7	1.20	1.20	1.20	0.80	1.20	1.20
	(-0.06)	(0.00)	(-0.03)	(0.07)	(-0.00)	(-0.06)
8	1.20	0.80	0.80	1.20	0.83	1.20
	(-0.01)	(0.02)	(0.03)	(-0.00)	(0.00)	(-0.18)
9	1.20	0.80	0.80	1.17	0.80	0.80
	(-0.16)	(0.01)	(0.06)	(0.00)	(0.13)	(0.12)
10	1.13	0.80	1.20	1.20	1.20	0.80
	(0.00)	(0.46)	(-0.06)	(-0.04)	(-0.07)	(0.36)

Table B.13 cont'd	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
October 84						
1	1.20	0.80	0.80	0.80	1.20	0.80
	(-1.19)	(0.00)	(0.58)	(0.00)	(0.00)	(0.45)
2	0.80	1.20	1.20	1.20	1.20	0.80
	(0.49)	(0.00)	(-0.71)	(0.00)	(-0.38)	(1.05)
3	1.20	0.80	0.80	0.80	0.80	1.20
	(-0.07)	(0.09)	(0.10)	(0.20)	(0.32)	(-0.09)
4	1.20	0.80	0.92	0.80	1.20	0.80
	(-0.11)	(0.07)	(0.00)	(0.04)	(-0.25)	(0.06)
5	1.20	1.20	0.80	0.80	0.80	0.80
	(-0.01)	(-0.05)	(0.03)	(0.09)	(0.29)	(0.05)
6	0.86	1.20	1.20	0.80	1.20	1.01
	(0.00)	(-0.39)	(-0.00)	(0.17)	(-0.29)	(0.00)
7	0.80	0.80	0.80	0.87	1.03	1.20
	(0.03)	(0.01)	(0.51)	(0.00)	(0.00)	(-0.31)
8	1.20	1.09	0.80	0.80	0.80	0.80
	(-0.51)	(0.00)	(0.35)	(0.07)	(0.05)	(0.05)
9	1.20	1.20	1.20	0.80	0.96	0.80
	(-0.11)	(-0.04)	(-0.18)	(0.18)	(0.00)	(1.06)
10	0.80	1.20	0.80	1.20	1.20	0.80
	(1.05)	(-0.13)	(0.81)	(-0.01)	(-0.21)	(0.31)
December 84						
1	0.80	1.00	0.80	1.00	0.80	1.20
	(0.07)	(0.00)	(0.19)	(0.00)	(0.83)	(-1.32)
2	0.80	1.00	0.80	1.00	0.80	1.20
	(0.66)	(0.00)	(2.40)	(0.00)	(0.07)	(-1.19)
3	0.80	1.20	0.80	1.00	1.20	1.20
	(0.60)	(-0.30)	(1.73)	(0.00)	(-1.94)	(-1.59)
4	0.88	1.20	0.81	1.20	1.20	1.20
	(0.00)	(-0.13)	(0.00)	(-1.16)	(-0.44)	(-1.21)
5	1.00	0.80	1.00	1.20	0.80	0.95
	(0.00)	(0.71)	(0.00)	(-0.07)	(1.29)	(0.00)
6	0.80	0.92	0.80	1.20	0.98	0.83
	(0.48)	(0.00)	(0.27)	(-0.31)	(0.00)	(0.00)
7	0.80	0.80	0.81	1.20	1.20	1.20
	(1.10)	(0.00)	(0.00)	(-0.02)	(-0.41)	(-0.30)
8	1.00	1.00	0.99	0.96	1.00	0.80
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.61)
9	0.80	0.80	0.80	0.80	0.80	1.20
	(0.87)	(1.03)	(1.48)	(0.22)	(1.50)	(-0.08)
10	0.80	1.20	1.20	1.20	0.80	1.20
	(1.08)	(-0.43)	(-1.22)	(-0.02)	(0.77)	(-0.99)

Table B.13 cont'd	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
February 85						
1	1.20	1.00	0.80	1.00	1.20	1.20
	(-0.24)	(-1.53)	(0.12)	(0.00)	(-0.03)	(-0.15)
2	1.20	1.00	0.80	1.00	0.80	1.20
	(-0.06)	(0.00)	(0.15)	(0.00)	(0.09)	(-0.10)
3	1.06	0.80	0.80	1.20	0.80	1.12
	(0.00)	(-1.78)	(0.01)	(-0.04)	(0.07)	(0.00)
4	1.20	1.20	0.80	0.80	0.80	0.80
	(-0.02)	(-0.06)	(0.04)	(0.04)	(0.03)	(0.10)
5	1.20	0.80	0.80	0.80	1.15	0.80
	(-0.00)	(-0.05)	(0.00)	(0.02)	(0.00)	(0.08)
6	1.20	1.00	0.80	0.80	0.80	1.00
	(-0.02)	(0.00)	(0.03)	(0.09)	(0.05)	(0.00)
7	0.92	0.80	0.80	0.80	0.80	1.18
	(0.00)	(0.28)	(0.00)	(0.02)	(0.01)	(0.00)
8	1.20	0.80	0.80	1.09	1.20	0.80
	(-0.06)	(0.00)	(0.23)	(0.00)	(-0.27)	(0.00)
9	1.20	1.06	0.80	0.80	0.80	1.20
	(-0.50)	(0.00)	(1.09)	(0.10)	(0.81)	(-0.02)
10	1.20	0.80	0.80	0.80	0.80	0.80
	(-1.39)	(0.00)	(0.87)	(0.05)	(0.07)	(0.18)
April 85						
1	1.20	1.20	1.11	1.00	0.80	0.80
	(-0.54)	(-0.91)	(0.00)	(0.00)	(4.39)	(14.48)
2	0.80	1.00	1.20	1.00	0.80	0.80
	(5.98)	(0.00)	(-1.41)	(0.00)	(3.17)	(5.68)
3	1.20	0.80	1.20	1.20	1.20	0.80
	(-1.78)	(0.20)	(-0.82)	(0.00)	(-1.86)	(2.19)
4	0.80	0.80	0.85	0.80	1.20	1.20
	(2.40)	(1.20)	(0.00)	(0.00)	(-0.48)	(-1.99)
5	0.80	1.20	1.20	0.80	0.80	1.20
	(0.24)	(-0.50)	(-1.25)	(1.49)	(2.72)	(-1.81)
6	1.20	0.80	1.20	0.80	1.20	0.80
	(-3.21)	(0.12)	(-0.28)	(1.24)	(-1.07)	(1.63)
7	0.80	1.03	1.20	1.20	0.87	1.20
	(2.49)	(0.00)	(-2.10)	(-0.42)	(0.00)	(0.00)
8	1.20	1.20	1.20	0.80	0.80	1.20
	(-0.40)	(-0.07)	(-0.94)	(0.22)	(1.56)	(-0.06)
9	1.13	1.20	0.80	0.98	0.80	0.80
	(0.00)	(-0.75)	(2.42)	(0.00)	(0.59)	(6.91)
10	0.80	0.80	0.80	0.80	1.20	1.20
	(1.82)	(4.36)	(12.46)	(0.71)	(-3.31)	(-7.45)

Table B.13 cont'd	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
June 85						
1	1.20	1.20	0.80	1.00	0.80	1.20
	(-2.71)	(0.00)	(1.84)	(0.00)	(2.76)	(-8.24)
2	1.20	1.00	0.80	0.80	0.80	1.20
	(-12.91)	(0.00)	(15.94)	(0.76)	(1.51)	(-1.03)
3	0.80	1.20	0.80	1.20	1.20	0.80
	(5.51)	(-1.18)	(0.59)	(-2.76)	(-4.96)	(3.66)
4	0.80	1.20	0.80	0.80	0.80	1.20
	(0.74)	(-2.40)	(0.94)	(0.93)	(8.03)	(-3.44)
5	1.20	0.80	1.20	0.80	1.20	0.99
	(-1.85)	(1.01)	(-1.56)	(1.20)	(-1.96)	(0.00)
6	0.80	0.80	0.80	1.20	1.20	1.20
	(0.00)	(0.02)	(0.24)	(-0.43)	(-5.42)	(-4.04)
7	0.80	0.80	0.92	1.20	0.80	0.80
	(0.47)	(1.52)	(0.00)	(-0.97)	(2.51)	(3.63)
8	1.20	1.02	1.20	0.91	1.04	0.80
	(-1.83)	(0.00)	(-0.67)	(0.00)	(0.00)	(2.47)
9	0.80	0.80	0.80	1.20	1.19	1.00
	(3.79)	(0.69)	(3.40)	(-0.58)	(0.00)	(0.00)
10	1.20	0.80	0.80	1.20	0.80	1.00
	(-3.16)	(1.74)	(3.02)	(-0.39)	(7.16)	(0.00)
August 85						
1	0.80	1.20	1.20	0.80	1.20	0.80
	(0.82)	(0.00)	(-3.32)	(0.59)	(-0.43)	(6.63)
2	0.80	0.80	0.80	0.80	0.80	1.20
	(2.53)	(0.41)	(9.83)	(0.00)	(0.00)	(-2.47)
3	1.20	1.20	1.20	1.20	0.80	0.80
	(-12.45)	(0.00)	(-0.20)	(-4.13)	(1.63)	(4.83)
4	1.20	0.80	1.20	0.80	0.80	1.01
	(-5.12)	(2.35)	(-1.38)	(0.36)	(0.40)	(0.00)
5	1.20	1.20	1.19	0.80	0.80	0.80
	(-2.26)	(0.00)	(0.00)	(0.63)	(0.49)	(0.59)
6	0.99	1.04	1.20	0.80	0.89	1.20
	(0.00)	(0.00)	(-1.31)	(1.30)	(0.00)	(-2.71)
7	1.20	0.80	1.20	1.20	1.01	0.80
	(-6.15)	(0.42)	(-0.73)	(-0.06)	(0.00)	(11.14)
8	1.00	0.99	1.00	0.99	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
9	1.00	0.80	0.80	0.81	1.00	1.00
	(0.00)	(1.09)	(2.52)	(0.00)	(0.00)	(0.00)
10	1.20	0.98	1.00	1.00	1.00	0.99
	(-4.17)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Table B.13 cont'd	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
October 85						
1	0.80	1.20	0.80	0.80	0.80	1.20
	(0.69)	(0.00)	(0.89)	(0.00)	(0.77)	(-0.81)
2	1.20	1.20	1.19	0.80	0.80	1.18
	(-0.35)	(-0.23)	(0.00)	(0.03)	(0.45)	(0.00)
3	0.80	1.20	0.82	1.20	0.80	0.80
	(0.23)	(-0.09)	(0.00)	(-0.00)	(0.33)	(0.13)
4	0.80	0.80	1.20	0.80	1.20	0.80
	(0.01)	(0.06)	(-0.15)	(0.00)	(-0.08)	(0.25)
5	1.00	1.00	1.20	0.80	1.20	0.80
	(0.00)	(0.00)	(-0.07)	(0.02)	(-0.02)	(0.25)
6	0.89	0.84	0.80	1.17	0.87	1.20
	(0.00)	(0.00)	(0.42)	(0.00)	(0.00)	(-2.57)
7	0.98	0.80	1.00	0.95	0.80	1.20
	(0.00)	(0.06)	(0.00)	(0.00)	(0.05)	(-0.20)
8	0.99	0.80	1.00	0.80	1.00	1.00
	(0.00)	(0.87)	(0.00)	(0.03)	(0.00)	(0.00)
9	1.00	0.99	0.80	1.00	1.00	1.03
	(0.00)	(0.00)	(2.00)	(0.00)	(0.00)	(0.00)
10	1.00	1.00	1.00	1.20	1.00	0.80
	(0.00)	(0.00)	(0.00)	(-0.01)	(0.00)	(7.44)
December 85						
1	0.81	0.80	1.20	1.00	1.20	0.80
	(0.00)	(0.08)	(-0.10)	(0.00)	(-0.04)	(0.87)
2	0.80	1.20	1.20	0.80	1.20	0.86
	(0.19)	(-1.45)	(-0.01)	(0.37)	(-0.03)	(0.00)
3	1.20	0.80	0.80	1.00	0.80	1.20
	(-0.12)	(2.67)	(0.32)	(0.00)	(0.03)	(-0.76)
4	1.11	0.80	1.15	0.80	0.80	1.20
	(0.00)	(0.74)	(0.00)	(0.70)	(0.00)	(-0.39)
5	1.20	0.80	1.00	0.98	0.80	0.82
	(-1.42)	(0.17)	(0.00)	(0.00)	(1.01)	(0.00)
6	1.00	0.97	1.00	0.80	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.07)	(0.00)	(0.00)
7	0.99	1.00	1.00	0.80	0.99	1.00
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
8	0.80	0.80	0.80	0.80	1.20	0.80
	(6.06)	(0.66)	(3.94)	(0.22)	(-5.18)	(6.17)
9	1.00	0.80	0.98	0.80	0.80	1.20
	(0.00)	(0.77)	(0.00)	(0.46)	(6.99)	(-6.63)
10	1.20	0.93	1.00	0.84	1.00	1.00
	(-2.03)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Table B.13 cont'd	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
February 86						
1	1.20	0.80	0.80	1.00	1.20	0.80
	(-3.31)	(-0.00)	(4.44)	(0.00)	(-0.72)	(1.65)
2	1.20	1.15	1.14	0.80	0.80	0.80
	(-2.34)	(0.00)	(0.00)	(0.20)	(4.86)	(0.79)
3	1.00	0.80	0.86	1.20	1.20	1.20
	(0.00)	(0.01)	(0.00)	(-0.04)	(-0.39)	(-0.81)
4	1.20	0.80	1.14	0.80	0.80	1.19
	(-0.10)	(0.00)	(0.00)	(0.02)	(1.62)	(0.00)
5	0.80	1.00	0.98	0.80	0.99	1.00
	(0.36)	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)
6	0.86	1.20	0.91	1.12	1.20	1.14
	(0.00)	(0.00)	(0.00)	(0.00)	(-1.84)	(0.00)
7	1.00	0.80	1.00	1.00	1.20	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(-1.06)	(0.00)
8	0.81	1.00	1.20	0.98	1.00	1.00
	(0.00)	(0.00)	(-0.60)	(0.00)	(0.00)	(0.00)
9	1.00	0.99	1.00	0.99	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
10	1.20	1.20	0.80	0.80	1.17	0.80
	(-3.46)	(0.00)	(10.70)	(0.49)	(0.00)	(5.85)
April 86						
1	1.00	0.80	1.00	1.00	0.80	1.20
	(0.00)	(0.00)	(0.00)	(0.00)	(0.46)	(-3.35)
2	0.80	0.80	1.20	0.80	0.80	1.10
	(1.65)	(1.03)	(-2.16)	(0.00)	(0.21)	(0.00)
3	1.01	0.80	0.80	0.80	0.80	0.96
	(0.00)	(0.36)	(0.84)	(1.18)	(0.86)	(0.00)
4	0.80	1.20	1.20	0.80	0.80	1.20
	(4.70)	(-0.33)	(-1.51)	(0.01)	(1.09)	(-0.16)
5	1.20	1.00	0.80	1.01	0.86	0.93
	(-1.84)	(0.00)	(0.45)	(0.00)	(0.00)	(0.00)
6	0.80	0.91	0.84	0.80	1.20	1.20
	(1.08)	(0.00)	(0.00)	(0.37)	(-0.56)	(-1.36)
7	0.99	1.09	1.00	1.10	1.19	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
8	0.80	1.02	1.00	0.80	0.99	1.20
	(3.19)	(0.00)	(0.00)	(2.12)	(0.00)	(-7.08)
9	1.00	1.00	1.00	1.01	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
10	1.20	0.92	0.99	0.99	1.00	1.00
	(-2.39)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Table B.13 cont'd	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
June 86						
1	1.00	1.00	0.80	1.00	0.80	1.00
	(0.00)	(0.00)	(1.35)	(0.00)	(0.38)	(0.00)
2	1.20	1.20	0.96	0.80	0.80	1.20
	(-2.56)	(-5.39)	(0.00)	(0.00)	(0.00)	(-0.22)
3	0.80	0.80	1.20	0.80	1.20	0.80
	(1.38)	(0.54)	(-0.31)	(0.00)	(-0.14)	(0.47)
4	1.20	1.20	0.99	0.80	0.80	0.81
	(-0.17)	(-0.53)	(0.00)	(0.00)	(0.09)	(0.00)
5	0.80	0.80	0.80	1.20	1.00	1.20
	(1.29)	(0.10)	(0.80)	(-0.27)	(0.00)	(-0.16)
6	1.00	0.99	1.00	1.00	1.00	1.20
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(-0.64)
7	0.80	1.20	1.20	1.20	1.20	1.20
	(2.22)	(-0.33)	(-0.08)	(-0.04)	(-0.53)	(-4.13)
8	1.00	1.00	1.00	1.01	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
9	1.02	1.00	1.00	0.99	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
10	1.07	0.81	0.80	0.94	0.80	1.09
	(0.00)	(0.00)	(3.12)	(0.00)	(0.27)	(0.00)
August 86						
1	0.80	1.20	0.99	1.00	0.80	0.80
	(0.15)	(0.00)	(0.00)	(0.00)	(0.00)	(0.10)
2	1.20	1.20	1.20	0.80	0.82	1.13
	(-0.12)	(0.00)	(-0.11)	(0.00)	(0.00)	(0.00)
3	0.94	0.80	0.80	0.80	1.20	1.05
	(0.00)	(0.04)	(0.09)	(0.00)	(-0.01)	(0.00)
4	0.91	0.94	1.05	0.80	0.80	0.80
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.58)
5	1.20	0.80	1.00	0.80	1.00	1.00
	(-0.34)	(0.39)	(0.00)	(0.11)	(0.00)	(0.00)
6	1.00	1.00	1.00	0.94	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
7	1.00	1.00	1.05	1.00	0.93	0.99
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
8	1.20	1.00	0.85	1.20	0.80	1.00
	(-0.54)	(0.00)	(0.00)	(-0.04)	(14.78)	(0.00)
9	1.00	0.99	1.00	1.01	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
10	0.80	1.00	1.00	1.00	1.00	1.00
	(10.85)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Table B.13 cont'd	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
October 86						
1	1.20	1.20	1.20	1.00	0.80	0.80
	(-12.04)	(0.00)	(-2.36)	(0.00)	(0.51)	(3.69)
2	1.20	1.20	1.20	0.80	1.20	0.80
	(-1.91)	(0.00)	(-0.71)	(0.00)	(-0.29)	(2.79)
3	1.00	1.20	0.94	0.80	0.80	1.15
	(0.00)	(-1.88)	(0.00)	(0.00)	(7.87)	(0.00)
4	1.08	0.80	1.00	1.20	1.00	0.95
	(0.00)	(0.81)	(0.00)	(-0.79)	(0.00)	(0.00)
5	0.80	1.17	0.80	0.98	0.91	1.00
	(4.21)	(0.00)	(1.35)	(0.00)	(0.00)	(0.00)
6	1.00	1.20	0.95	1.20	1.16	0.84
	(0.00)	(-0.11)	(0.00)	(-1.29)	(0.00)	(0.00)
7	1.20	0.80	0.99	0.97	0.80	1.20
	(-0.12)	(5.32)	(0.00)	(0.00)	(11.41)	(-14.93)
8	1.00	1.20	1.20	0.98	1.02	1.00
	(0.00)	(-1.44)	(-7.56)	(0.00)	(0.00)	(0.00)
9	0.98	1.00	1.20	0.80	0.80	1.00
	(0.00)	(0.00)	(-1.72)	(0.14)	(6.27)	(0.00)
10	0.80	1.20	1.20	0.80	0.80	1.17
	(0.46)	(-1.37)	(-0.96)	(0.26)	(1.45)	(0.00)
December 86						
1	0.80	1.20	1.00	1.00	0.80	1.00
	(8.29)	(-1.36)	(0.00)	(0.00)	(2.42)	(0.00)
2	1.00	1.00	1.20	0.80	1.20	0.80
	(0.00)	(0.00)	(-7.58)	(1.51)	(-3.72)	(8.41)
3	1.20	0.80	0.80	1.20	0.80	1.16
	(-1.44)	(3.91)	(3.22)	(-0.23)	(1.60)	(0.00)
4	1.00	1.20	1.00	1.20	0.99	1.00
	(0.00)	(-0.00)	(0.00)	(-0.43)	(0.00)	(0.00)
5	1.00	0.97	1.09	0.97	1.08	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
6	0.80	0.80	0.80	0.81	1.06	0.89
	(0.01)	(0.12)	(0.23)	(0.00)	(0.00)	(0.00)
7	1.00	1.20	1.00	1.01	1.00	1.00
	(0.00)	(-0.13)	(0.00)	(0.00)	(0.00)	(0.00)
8	0.84	1.17	0.80	1.14	0.80	1.20
	(0.00)	(0.00)	(0.52)	(0.00)	(0.69)	(-0.30)
9	0.80	0.85	0.80	1.20	1.20	0.80
	(2.62)	(0.00)	(1.05)	(-0.59)	(-0.70)	(1.18)
10	0.80	1.20	1.20	1.20	0.80	0.80
	(0.21)	(-0.50)	(-1.21)	(-0.31)	(0.18)	(0.65)

Table B.13 cont'd	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
February 87						
1	1.20	1.20	0.80	1.00	0.80	1.00
	(-5.15)	(0.00)	(1.49)	(0.00)	(1.97)	(0.00)
2	0.80	1.20	1.00	0.80	0.80	1.00
	(6.33)	(-1.78)	(0.00)	(0.00)	(5.63)	(0.00)
3	0.96	1.20	0.81	1.20	0.80	1.12
	(0.00)	(-0.64)	(0.00)	(0.00)	(4.51)	(0.00)
4	1.20	1.20	1.20	0.80	0.80	1.20
	(-1.19)	(-0.14)	(-2.73)	(0.71)	(3.91)	(-7.97)
5	0.80	1.20	0.80	0.89	0.80	1.20
	(2.35)	(-0.14)	(3.55)	(0.00)	(3.13)	(-2.25)
6	1.00	0.99	0.94	0.80	0.99	1.20
	(0.00)	(-0.52)	(0.00)	(0.04)	(0.00)	(-1.79)
7	1.20	0.80	1.20	0.80	1.20	1.20
	(-2.51)	(0.00)	(-0.42)	(0.70)	(-1.79)	(-1.27)
8	1.20	1.00	0.80	1.20	1.11	1.20
	(-6.82)	(-0.04)	(0.04)	(-1.14)	(0.00)	(-2.19)
9	0.80	0.80	0.80	0.80	0.80	1.09
	(24.05)	(0.51)	(0.09)	(0.28)	(3.77)	(0.00)
10	0.86	0.80	1.20	1.20	0.91	0.80
	(0.00)	(-0.51)	(-9.75)	(-0.59)	(0.00)	(3.67)
April 87						
1	0.80	1.20	1.20	1.00	0.80	0.80
	(17.77)	(0.00)	(-31.65)	(0.00)	(0.00)	(1.97)
2	0.80	0.80	0.80	0.80	1.20	1.20
	(1.24)	(1.45)	(3.96)	(0.00)	(-0.36)	(-23.30)
3	0.91	0.80	0.80	0.80	0.80	0.80
	(0.00)	(5.10)	(1.16)	(1.61)	(0.61)	(4.55)
4	0.80	0.80	0.91	0.80	0.80	1.20
	(3.68)	(3.54)	(0.00)	(0.00)	(0.85)	(-7.91)
5	0.80	1.20	1.20	1.14	1.20	1.20
	(0.16)	(-0.80)	(-0.95)	(0.00)	(-0.22)	(-1.12)
6	0.80	0.99	0.80	1.20	1.20	1.01
	(4.80)	(0.00)	(3.34)	(-0.96)	(-2.48)	(0.00)
7	0.80	0.80	0.80	0.80	0.89	1.20
	(4.13)	(2.85)	(6.08)	(0.58)	(0.00)	(-0.07)
8	1.00	1.20	0.80	0.99	0.98	1.20
	(0.00)	(-1.25)	(45.42)	(0.00)	(0.00)	(-1.76)
9	0.97	0.99	0.80	1.00	0.99	1.20
	(0.00)	(0.00)	(4.53)	(0.00)	(0.00)	(-5.71)
10	1.20	0.80	1.20	1.20	1.20	0.80
	(-6.42)	(5.26)	(-1.57)	(-1.44)	(-0.55)	(10.01)

Table B.13 cont'd	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
June 87						
1	0.80	1.20	0.80	1.00	0.80	1.20
	(31.19)	(-4.68)	(27.53)	(0.00)	(5.76)	(-22.13)
2	1.20	0.80	0.80	0.80	0.80	1.20
	(-14.05	(2.60)	(3.09)	(0.00)	(3.56)	(-5.36)
3	0.80	1.20	0.80	0.80	0.80	1.20
	(10.71)	(-0.51)	(1.21)	(0.00)	(2.15)	(-11.93)
4	0.80	1.20	0.80	0.80	1.20	1.20
	(4.29)	(-1.81)	(6.97)	(0.00)	(-0.03)	(-1.03)
5	1.00	1.20	1.00	0.99	1.20	0.81
	(0.00)	(-0.22)	(0.00)	(0.00)	(-2.21)	(0.00)
6	0.99	0.95	0.89	1.20	0.80	1.00
	(0.00)	(0.00)	(0.00)	(-0.69)	(0.73)	(0.00)
7	1.10	0.80	0.80	0.80	1.03	0.82
	(0.00)	(0.33)	(4.91)	(0.15)	(0.00)	(0.00)
8	0.80	1.20	1.20	1.13	0.80	0.80
	(0.88)	(-0.16)	(-2.40)	(0.00)	(3.86)	(4.04)
9	0.80	0.80	0.80	1.00	1.20	1.12
	(5.74)	(2.84)	(0.60)	(0.00)	(-2.73)	(0.00)
10	0.80	0.80	1.20	1.20	0.80	1.20
	(10.59)	(0.49)	(-3.58)	(-0.12)	(3.88)	(-2.25)
August 87						
1	0.80	1.20	1.20	0.80	0.80	1.20
	(2.76)	(0.00)	(-2.45)	(0.26)	(4.10)	(-1.45)
2	0.80	1.20	1.20	1.20	1.20	0.80
	(3.10)	(0.00)	(-4.33)	(-0.09)	(-0.70)	(5.84)
3	0.80	1.20	1.15	0.80	1.20	1.15
	(3.88)	(0.00)	(0.00)	(0.00)	(-2.14)	(0.00)
4	0.96	1.20	1.20	1.20	1.01	0.90
	(0.00)	(0.00)	(-2.32)	(-0.16)	(0.00)	(0.00)
5	0.80	1.20	0.80	1.20	1.20	1.20
	(2.80)	(0.00)	(1.11)	(-0.26)	(-2.41)	(-0.40)
6	0.80	1.20	1.14	1.14	0.80	1.08
	(1.35)	(0.00)	(0.00)	(0.00)	(0.64)	(0.00)
7	0.82	1.11	0.80	1.01	0.86	1.00
	(0.00)	(0.00)	(0.76)	(0.00)	(0.00)	(0.00)
8	0.80	1.20	0.80	0.80	0.80	1.20
	(0.03)	(0.00)	(0.45)	(0.54)	(0.55)	(-0.85)
9	0.80	0.80	1.20	1.20	1.20	1.18
	(0.07)	(0.15)	(-2.54)	(-0.15)	(-0.41)	(0.00)
10	0.80	1.20	0.80	1.20	0.80	1.20
	(1.91)	(0.00)	(1.15)	(-0.34)	(1.82)	(-3.98)

Table B.13 cont'd	---------- Trader Group ----------					
Contract Subperiod	Model 5 LC	Model 6 MC	Model 7 LN	Model 8 MN	Model 9 OTH	Model 10 ST
October 87						
1	1.20	1.20	1.20	1.20	0.80	1.20
	(-3.45)	(-5.76)	(-7.32)	(-1.69)	(1.27)	(-10.27)
2	0.80	1.05	1.20	1.05	0.80	1.20
	(9.33)	(0.00)	(-7.42)	(0.00)	(12.24)	(-2.66)
3	1.20	0.80	0.80	0.80	1.20	1.20
	(-2.40)	(1.06)	(1.15)	(0.31)	(-1.35)	(-1.96)
4	0.80	1.20	1.20	1.20	0.80	1.03
	(0.11)	(-1.09)	(-2.25)	(-2.18)	(2.95)	(0.00)
5	0.95	0.80	1.17	1.20	1.20	0.80
	(0.00)	(1.83)	(0.00)	(-1.96)	(-0.46)	(0.20)
6	1.20	1.20	1.00	0.80	0.81	0.80
	(-2.12)	(-0.27)	(0.00)	(0.56)	(0.00)	(3.97)
7	0.98	0.99	1.00	1.00	0.80	1.20
	(0.00)	(0.00)	(0.00)	(0.00)	(1.99)	(-1.76)
8	1.20	0.98	0.80	1.20	0.80	0.80
	(-0.26)	(0.00)	(5.25)	(-0.06)	(0.74)	(2.02)
9	1.00	0.80	1.20	0.80	0.80	1.20
	(0.00)	(0.36)	(-3.65)	(0.12)	(4.31)	(-0.93)
10	0.80	1.20	1.20	0.96	1.20	1.20
	(10.94)	(-0.18)	(-2.74)	(0.00)	(-2.10)	(-0.10)

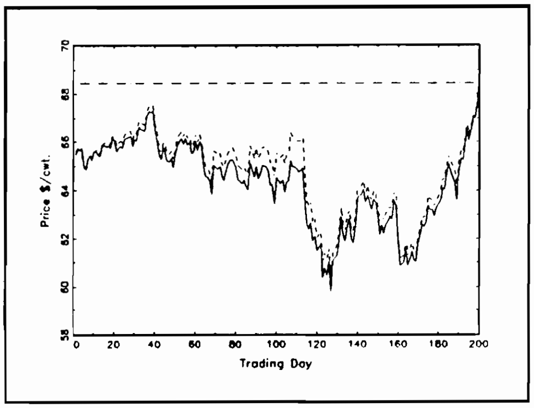

Figure B.1. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Dec. 1983 Live Cattle Contract.

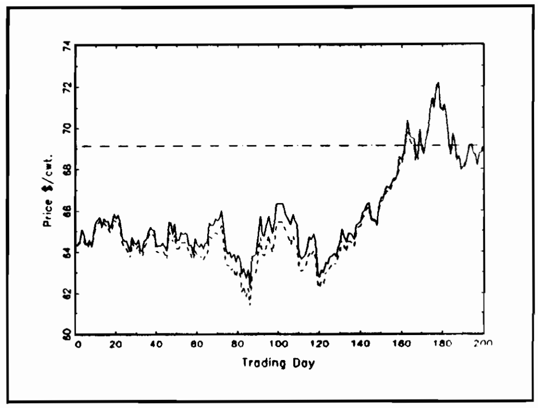

Figure B.2. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Feb. 1984 Live Cattle Contract.

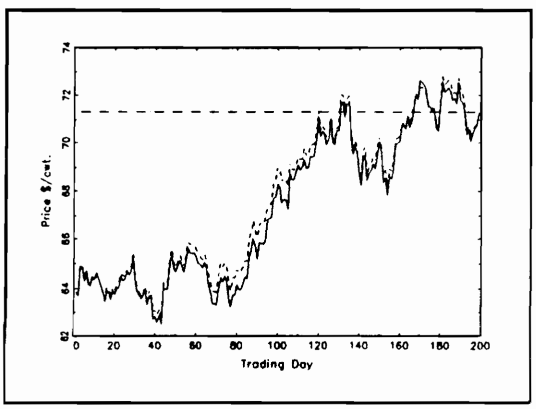

Figure B.3. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Apr. 1984 Live Cattle Contract.

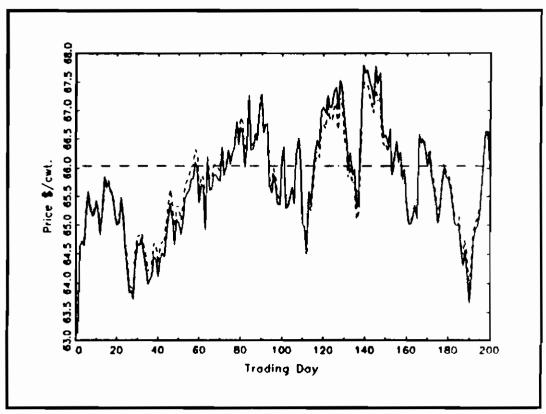

Figure B.4. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Jun. 1984 Live Cattle Contract.

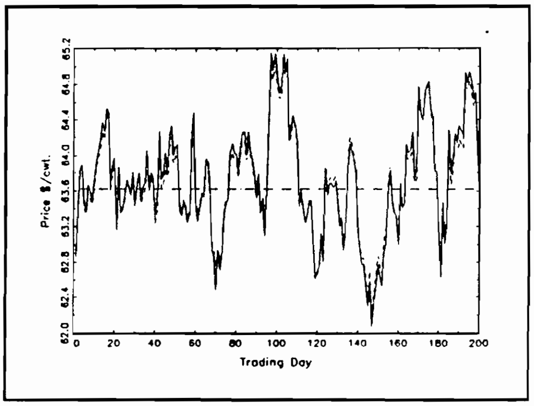

Figure B.5. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Aug. 1984 Live Cattle Contract.

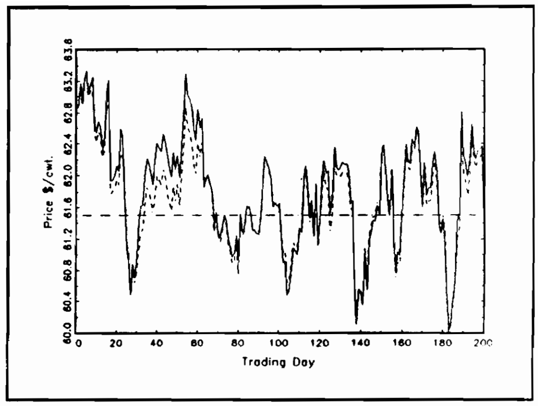

Figure B.6. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Oct. 1984 Live Cattle Contract.

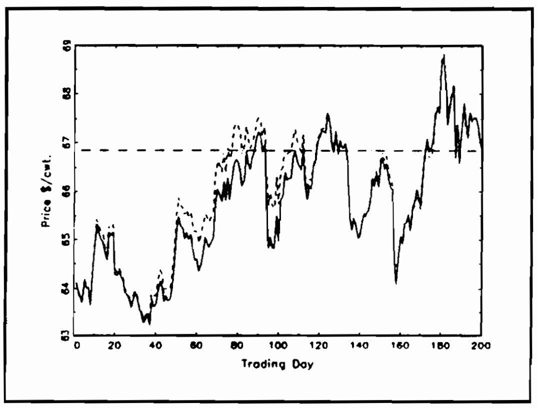

Figure B.7. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Dec. 1984 Live Cattle Contract.

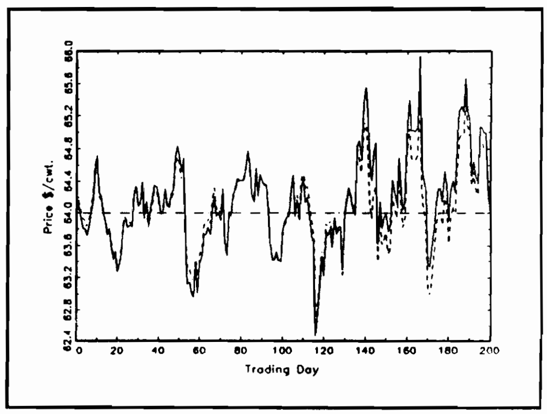

Figure B.8. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Feb. 1985 Live Cattle Contract.

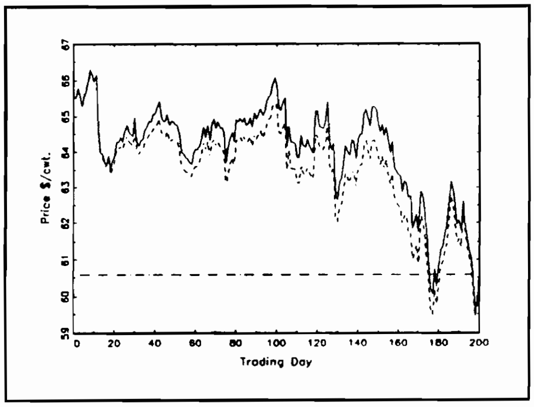

Figure B.9. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Apr. 1985 Live Cattle Contract.

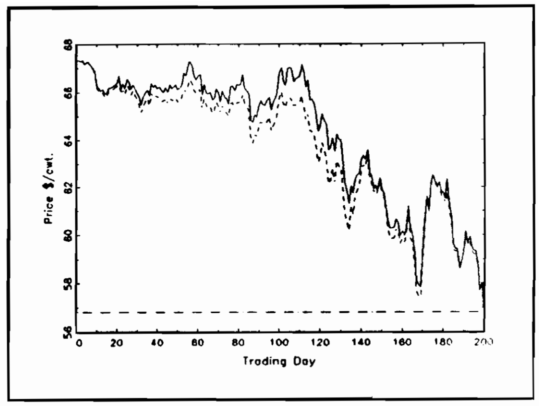

Figure B.10. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Jun. 1985 Live Cattle Contract.

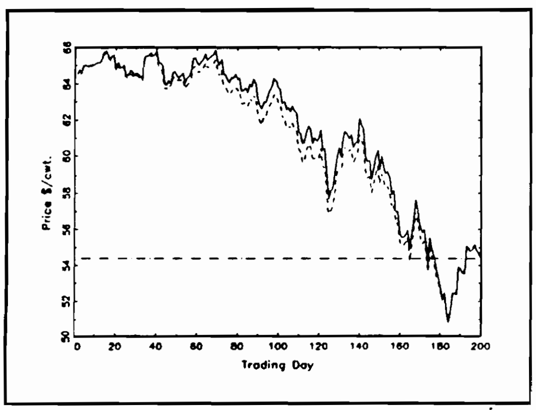

Figure B.11. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Aug. 1985 Live Cattle Contract.

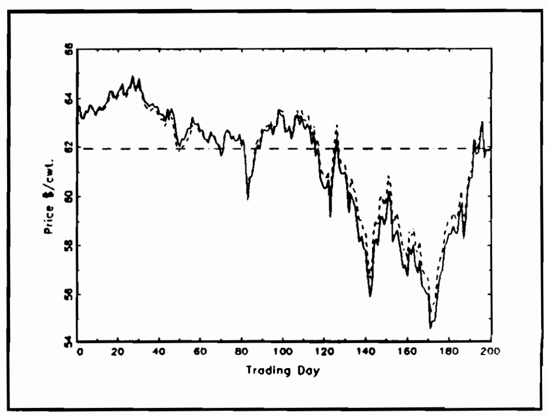

Figure B.12. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Oct. 1985 Live Cattle Contract.

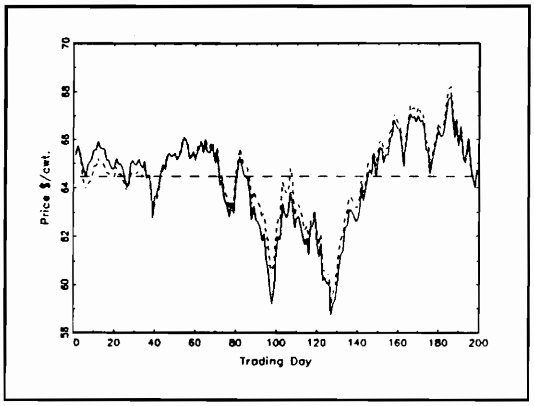

Figure B.13. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Dec. 1985 Live Cattle Contract.

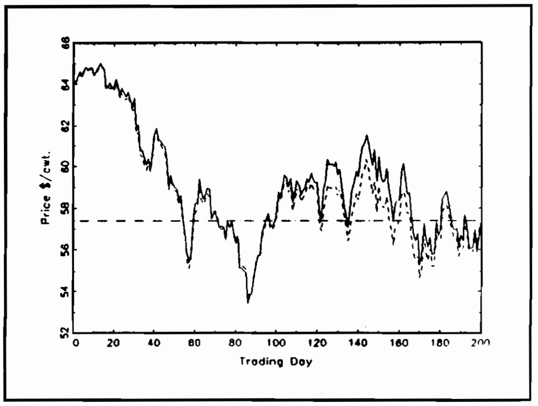

Figure B.14. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Feb. 1986 Live Cattle Contract.

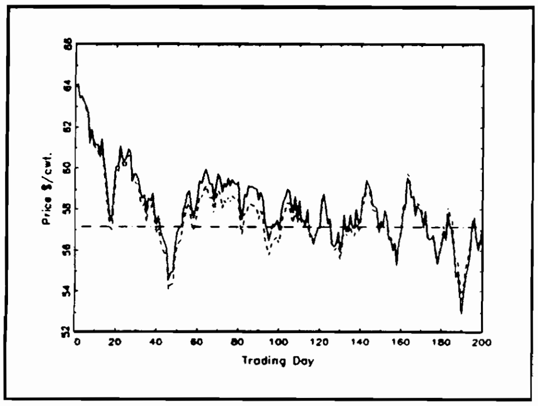

Figure B.15. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Apr. 1986 Live Cattle Contract.

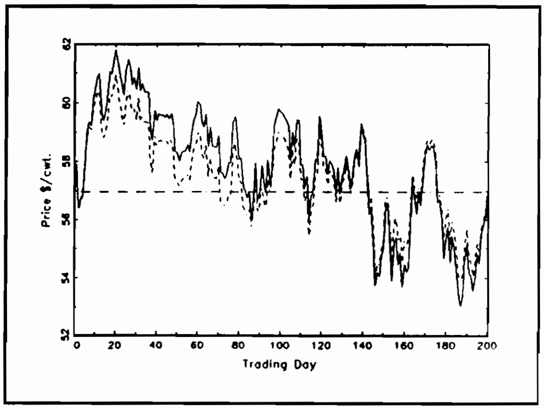

Figure B.16. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Jun. 1986 Live Cattle Contract.

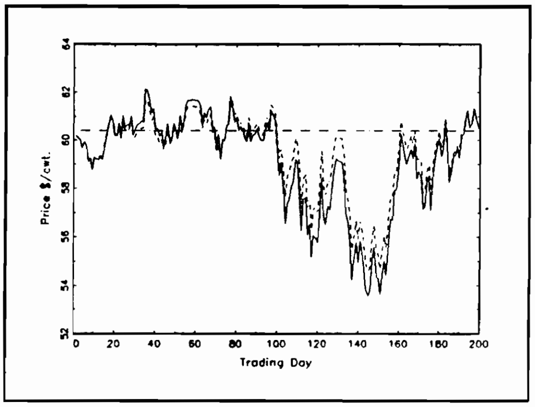

Figure B.17. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Aug. 1986 Live Cattle Contract.

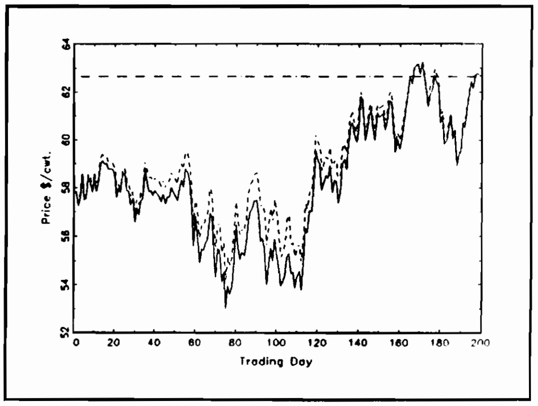

Figure B.18. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Oct. 1986 Live Cattle Contract.

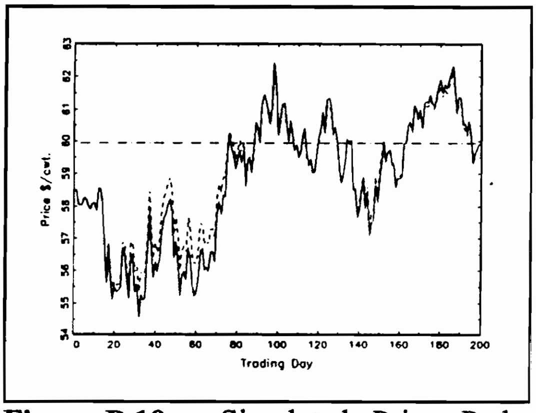

Figure B.19. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Dec. 1986 Live Cattle Contract.

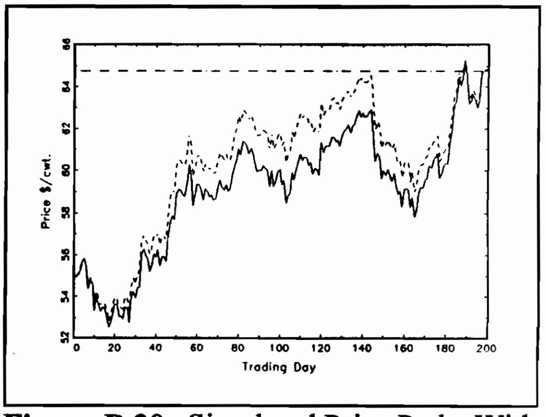

Figure B.20. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Feb. 1987 Live Cattle Contract.

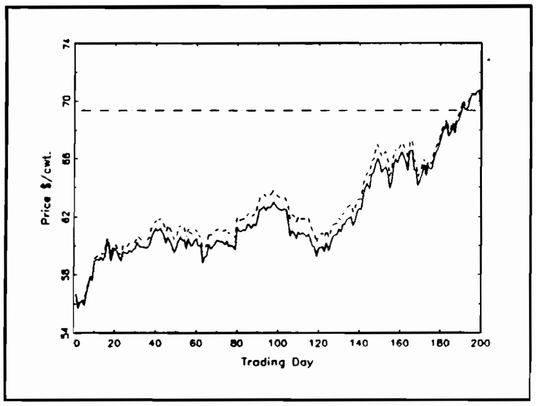

Figure B.21. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Apr. 1987 Live Cattle Contract.

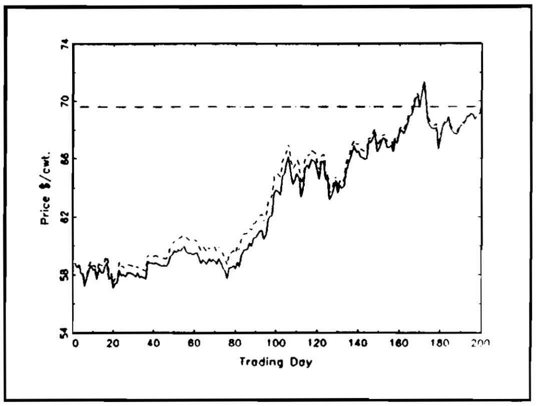

Figure B.22. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Jun. 1987 Live Cattle Contract.

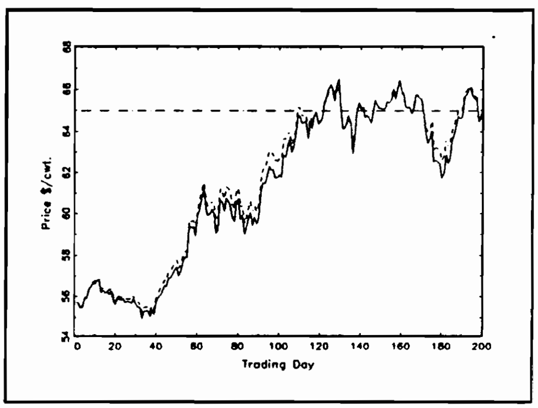

Figure B.23. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Aug. 1987 Live Cattle Contract.

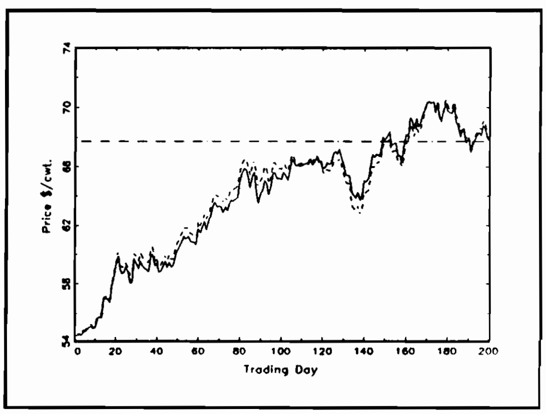

Figure B.24. Simulated Price Paths With Intergroup Response Effects (solid line) and Without (dashed line), Model 4, Oct. 1987 Live Cattle Contract.

VITA

Robert David Murphy, son of Robert and Edna (Edmiston) Murphy, was born on August 19, 1960 in Baton Rouge, Louisiana.

He graduated from Broadmoor High School in Baton Rouge in May, 1978. Robert entered Louisiana State University in 1981 and graduated with a Bachelor of Science degree in Animal Science in December, 1987. In June, 1988 Robert accepted a graduate research assistantship in the Department of Agricultural Economics and Agribusiness at Louisiana State University. He received the Master of Science degree in Agricultural Economics in May, 1991.

Robert was awarded a USDA National Needs Fellowship in August, 1991 and began studies toward the Ph.D. degree at Virginia Polytechnic Institute and State University in Blacksburg, Virginia. He fulfilled the requirements for the Doctor of Philosophy in Agricultural and Applied Economics in January, 1995. Upon completion of his graduate education, Robert was employed as an economist in the Commodity Research Department at the Chicago Mercantile Exchange.

Robert married Jenny Ann Radelat of Baton Rouge in April, 1991 and a son, Matthew Douglas Murphy, was born to them in May, 1993 in Salem, Virginia.

Robert David Murphy