Basis Variability in the Feeder Cattle Contract

Before and After Cash Settlement

by

Lisa Carol Currin

Thesis submitted to the Faculty of the

Virginia Polytechnic Institute and State University

In partial fulfillment of the requirements for the degree of

Master of Science

in

Agricultural Economics

APPROVED:

Wayne D. Purcell, Co-Chairman

David E. Kenyon, Co-Chairman

Everett B. Peterson

June 1993

Blacksburg, VA

Basis Variability in the Feeder Cattle Contract

Before and After Cash Settlement

by

Lisa Carol Currin

Agricultural Economics

(ABSTRACT)

Relationships between the futures price, cash price, and U.S. Feeder Steer Price in the final eight weeks of trading on the feeder cattle futures contract were analyzed. Models were developed to examine continued problems with basis variability in the feeder cattle futures contract. The results of these models indicated that the change from physical delivery to cash settlement and the use of the U.S. Feeder Steer Price as a settlement index for the contract did not improve problems associated with basis variability.

## Acknowledgements

Many people deserve credit for their contributions to the completion of this thesis. My committee was very understanding and encouraging through the entire research process. My committee co-chairs, Wayne Purcell and Dave Kenyon, were especially patient and served not only as professional mentors, but as role models as well.

Brian Dietz and Rodney Jones were also particularly helpful in completion of this research. Their patience and knowledge were much appreciated.

Finally, none of this work would have been possible without the support of my parents, Rector and Linda Currin. I will be forever grateful for their unquestioning support and encouragement throughout my studies.

# Table of Contents

# List of Tables

# List of Figures

# Chapter 1

# Introduction

In September of 1986, the Chicago Mercantile Exchange (CME) changed the feeder cattle futures contract from physical delivery to cash settlement. The change resulted from the Exchange's concerns about decreased contract usage. Average total end-of-month open interest in the feeder cattle futures contracts, which started trading in 1972, peaked at over 20,000 in 1979 and then dropped to around 7,000 in 1984. Deliveries actually made on the contract exceeded 31% of the contracts in 1984 (Paul). These deliveries could be made at any one of 11 delivery point locations stretching from Billings, Montana to Mobile, Alabama, creating great uncertainty to the long trader considering standing for delivery. In an attempt to encourage use of this market and eliminate the difficulties associated with physical delivery, the CME established cash settlement as the mandatory method of settlement. Under cash settlement, futures positions which are not offset prior to contract expiration are settled in cash based on the United States Feeder Steer Price (USFSP). The USFSP is a cash index reported by Cattle-Fax and consists of a 7-day moving average based on auction and direct trade prices of 600-800 pound Large and Medium feeder steers in 27 states.

The CME had several reasons to believe that cash settlement would be preferable to physical delivery. Cash settlement eliminated the difficulties involved with physical delivery including dissatisfaction with grading, existence of incremental costs associated with delivery, discounts for non-par cattle which were out of line with market differentials, and volatile basis relationships (CME). The major changes in the contract specifications concentrated on the weight, grade, and delivery point provisions. The specific changes in each of these areas as reported by CME releases were:

> **Weight:** The cash settlement price was to be based on sales of feeder steers weighing between 600 and 800 pounds rather than the former 575-700 pound par weight range. The weight range was expanded to include a broader group of feeders produced

throughout the U. S.

**Grade:** The cash settlement price was to be based on sales of feeder steers which will grade 60 to 80 percent Choice when fed to slaughter weight rather than the somewhat tighter grade specifications of the physical delivery contract.

**Delivery Points:** Prices of cattle included in the USFSP would be from 27 states, whereas cattle delivered on the physical delivery contract had to be presented at one of 11 delivery points in only 10 states.

## 1.1 Problem Statement

Preliminary analysis of market usage subsequent to cash settlement seemed to justify the CME's decision to institute cash settlement. Open interest increased to almost 20,000 contracts in 1988. Since that time, however, open interest on the contract has declined and open interest was under 10,000 contracts in 1992. Although one of the CME 's intentions for cash settlement was to decrease basis variability, industry groups are again raising concerns over basis risk under the new contract. The National Cattleman's Association (NCA) devoted time in its January 1992 convention, to the development of recommended changes in both the live cattle and feeder cattle contracts to improve what it considered "flaky"

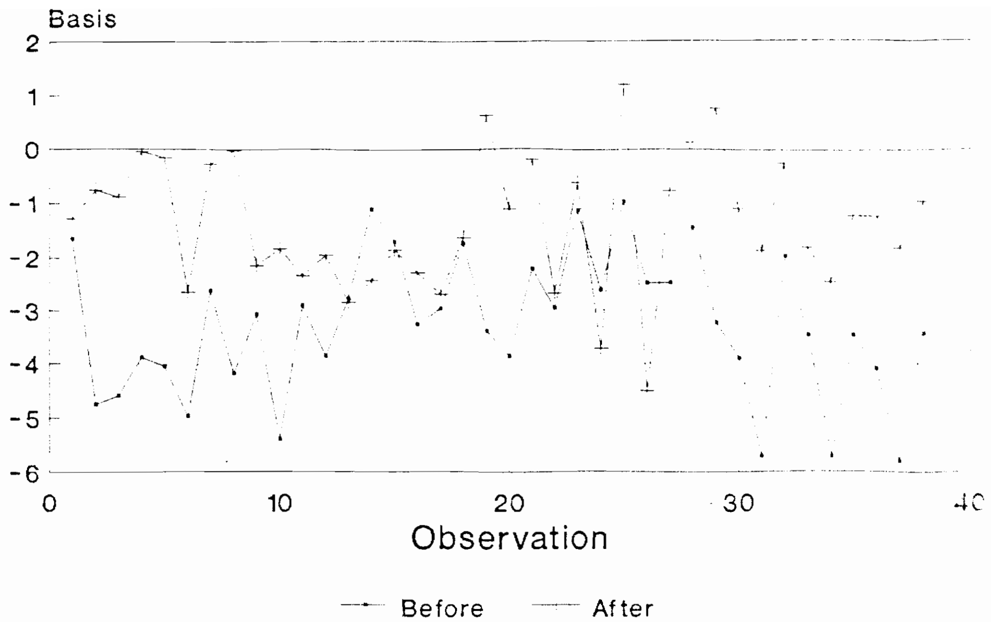


Figure 1.1 Amarillo Basis Two Weeks Prior to Contract Delivery

Before and After Cash Settlement.

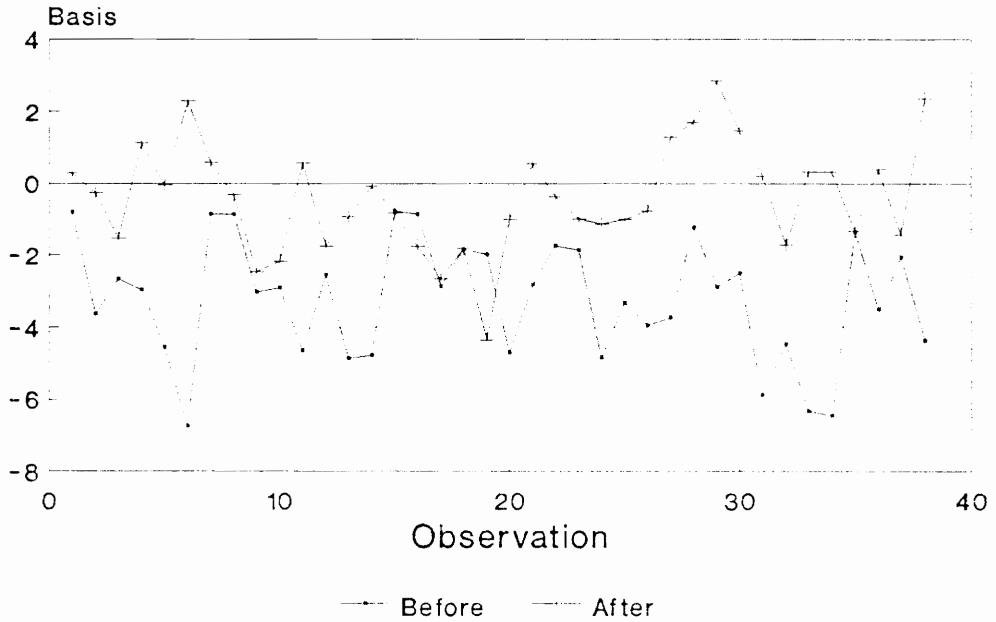


Figure 1.2 Amarillo Basis Five Weeks prior to Contract Expiration

Before and After Cash Settlement.

basis. Figures 1.1 and 1.2 are graphs of Amarillo basis (cash-futures) across time periods before (April 1981-August 1986) and after (September 1986-November 1991) the move to cash settlement. Figure 1.1 includes basis two weeks prior to contract maturity of the nearby futures contract. Figure 1.2 contains basis for five weeks prior to contract maturity for the first nearby contract outside the delivery month. Figure 1.1 shows almost no decrease in the basis standard deviation within the delivery month (standard deviation = 1.3 before and 1.2 after cash settlement). Figure 1.2 indicates that while the basis variability may have decreased slightly outside of the delivery month after cash settlement was instituted, (standard deviation = 1.66 before cash settlement and 1.49 after cash settlement), the reduction has been far less than the CME expected.

Why is basis variability still a problem under cash settlement? While it is true that futures are forced to converge with a cash price index at expiration, if that index is not representative of cattle actually sold on the cash market, the hedging risk associated with basis variability is not reduced. Potential hedgers in the feeder cattle contract cite "...lack of predictability in the relationship of the settlement index and their own cattle" as the major reason for their reluctance to use the market (Beef). The changes proposed at the NCA convention were aimed at changing the settlement price to more accurately reflect the variability in cash market prices.

Much of the problem associated with the lack of correlation between the

USFSP and cash prices could be attributed to the 7-day averaging built into the index's construction. Because the USFSP for any given day is actually an average of the past 7 days's prices, much of the variability of the cash markets is taken out. An index based on averaging of this magnitude is much smoother and less responsive to actual price movements. Table 1.1 contains the means and standard deviations of the threes cash series and the USFSP since the institution of cash settlement. As Table 1.1 indicates, the standard deviation of the USFSP is much lower than those of the cash series.

Table 1.1 Means and Standard Deviations of Cash Series and USFSP, 1986-1991

| Price Series* | Mean | Standard Deviation |
|---|---|---|
| USFSP | -.028 | .913 |
| Amarillo | -.081 | 1.26 |
| Dodge City | -.040 | 1.47 |
| Oklahoma City | -.019 | 1.37 |

* Weekly prices from September 1986 to November 1991.

The example in Table 1.2 uses actual Amarillo cash feeder cattle and futures prices to illustrate the magnitude of the basis problems that can occur when the USFSP fails to respond to price changes as quickly as the cash price. Assume a backgrounder hedged feeders on April 14, 1989. The hedger sold one September feeder cattle contract at $76.02 with an expected basis of $ -1.02 and an expected net price (ENP) of $75.00. If the producer lifted the hedge on September 2, 1989, at $82.45 while cash price was at $82.50 the actual net price (ANP) would have been $76.02. The actual basis was $0.05, a difference of $1.07 from the expected basis estimated on April 14. As a result of the basis error, the ANP is $1.07 more than the ENP.

Table 1.2 Hedging Example Showing the Impact of Basis Error

| Date | Cash | Futures | Basis |
|---|---|---|---|
| April 14, 1989 | ENP=$75.00 | $76.02 | -$1.02 (expected) |
| Sept. 2, 1989 | $82.50 ANP=$76.07 | $82.45 | $0.05 (actual) |
| Sept. 16, 1989 | $78.50 ANP=$71.35 | $83.17 | $-4.67 (actual) |

If the producer lifted the hedge two weeks later on September 16, 1989, the futures price would have reached $83.17 while cash fell to $78.50. The actual basis is now -$4.67, or $3.65/cwt less than expected. The ANP in this situation would be $71.35. Waiting two weeks to lift the hedge cost the producer $4.72 per hundredweight or $35.40 per head on cattle weighing 750 pounds. For many producers, a loss of this magnitude eliminates any margin for profit. This loss is the result of a situation where the futures market failed to accurately reflect cash price movements, hence causing large basis changes across a 2 week period. It is these large basis changes near contract expiration that cattleman refer to as "flaky" basis performance that discourages them from hedging with feeder cattle futures contracts.

## 1.2 Objectives

The general objective of this research is to analyze the impact of cash settlement of the feeder cattle contract on feeder cattle basis behavior. More specifically, the research objectives are to:

1. determine how cash settlement has affected the basis behavior of futures contracts near maturity due to changing relationships between futures, cash, and the USFSP price series, and

2. explore possible alternative forms of settlement which might improve basis performance on the feeder cattle futures contract.

## 1.3 Procedure

To analyze the affect of cash settlement on ending basis behavior the relationships between cash, futures and the USFSP will be analyzed. This study will focus on the behavior of these three price series across the final eight weeks of trading on the contract. First differences will be taken across these individual weeks. The use of first differences removes trends from the data and forces attention on the week-to- week changes, an important determinant of whether the markets move together. If analyzed using absolute levels, all the price series will tend to move together and statistical measures may be artificially high relative to the true ability of one series to move and change with another series. For example, the cash price in week 1 for the September contract-cash price for week 2 = difference one for the September contract; cash price in week two-cash price in week three = difference two for the September contract, etc. All differences between weeks one and two were placed together, all the differences between week two and three were placed together, etc. Explanatory models were estimated using the following general forms:

CF = f{CC}

CF = f{CU}

CU = f{CC} where,

CF = change in the futures price,

CC = change in the cash price and,

CU = change in the USFSP.

To facilitate statistical comparisons across weeks, the same general form was used in models where the data were combined such that all differences across all weeks were aggregated in a model with intercept shifters and slope shifters for each set of weekly differences. The explicit models for this analysis are outlined in Chapter four.

# Chapter 2

# Literature Review

## 2.1 Cash Settlement

In 1983, when the futures exchanges began considering cash settlement as a method of delivery for several contracts, Garbade and Silber performed an economic analysis of the new settlement method. Although the authors were primarily involved in financial futures, their article provides an in-depth look at the mechanics behind cash settlement. The principles they discussed are equally applicable to agricultural futures contracts. The authors defined two reasons why cash settlement should be instituted:

"(1.)...the need to promote convergence of cash and futures prices because delivery costs are large; and

(2.) the need to reduce the incidence of squeezes and corners..."

## 2.2 Settlement Index Construction

Garbade and Silber emphasize the importance of an accurate settlement index on the success of a cash settled futures market. Any settlement index must be reflective of the true cash price in order for the contract to attract participation, especially participation from hedgers.

Garbade and Silber suggest several sources of price data for construction of the index including transaction bids, bid and offer quotations, and price indications. Of these three, transaction prices are generally the best estimate of the commercial value of the product. For this method of index calculation to work, the transactions must be frequent enough to facilitate averaging. Bid and offer quotations tend to be easier to obtain in larger quantities, but are subject to manipulation, a serious problem for a proposed settlement index. Price indications, unlike the two previous sources of price data, are "expert opinions" and are least likely to be representative of the cash commodity's actual price movements.

When constructing a settlement index, Garbade and Silber suggest averaging several price observations in a cross-sectional manner, unless lack of observations is a problem. In the latter case, the index could be calculated based on prices aggregated across time. The authors point out that these aggregated prices need not be given equal weight, but serious consideration must be given when assigning weights based on elapsed time. The weight assigned to the observation should be based on the volatility of the commodity's value across time. In other words, the more volatile the commodity the shorter the aggregated time period should be in order to accurately reflect price movement.

## 2.3 Basis Variability

Cohen and Gorham explored the potential use of a cash settled contract for feeder cattle from both a speculator's and a hedger's point of view. Their study concentrates on expected price performance at the contract's expiration given a change to cash settlement. The authors argued that the incremental cost of delivery was a major cause of the basis variability which plagued the feeder cattle contract under physical delivery. They suggested that there existed a band around zero basis which includes all incremental costs of delivery faced by the long and the short. Normally, the basis on a futures contract is kept in line by arbitrage or the threat of arbitrage. Within this band of incremental costs, however, control of basis via arbitrage is not profitable and will not occur. It is therefore obvious, the authors assert, that the larger the incremental costs of delivery, the larger the basis variability. Cohen and Gorham found these delivery costs to range from $2-$3/cwt. for a short who must deliver and as much as

$1.50/cwt for a long standing for delivery. The cost incurred by the short included grading fees, sorting costs, and grading uncertainty while those faced by the long included uncertainties concerning quality, location, and actual date of delivery.

Under cash settlement delivery costs are zero; therefore, the large band of basis indeterminacy should be eliminated. The authors contend, however, that cash settlement does not eliminate basis risk, but rather reduces it. Because the cash index is an average across space and time, the producer is still subject to basis risk equal to the difference between his local cash price and the cash index price. Cohen and Gorham predicted that the reduction in basis risk with a change from physical delivery to cash settlement would be at least one-third. Conceptually, the authors predicted that the futures price under cash settlement should be lower because the new contract specifications contained less strict grade specifications and delivery requirements. The new cash index would also include a large 27 state area which encompasses more low-price markets than the 11 delivery points established under physical delivery. Given these factors, the authors concluded that the futures price would be much lower and the mean basis much higher in algebraic terms under cash settlement when compared to physical delivery. In one example the authors found that an Oklahoma City hedger that typically received a basis of -$1.85 under physical delivery could expect a cash price $2.35 above futures under cash settlement, a basis of +$2.35.

Kenyon et al. conducted an analysis comparing basis performance before and after cash settlement using weekly average cash and futures prices and individual lot prices for 16 Virginia markets between 1983 and 1988. Based on the premise that hedging effectiveness is a product of the ability to predict ending basis, the authors analyzed data sets containing Virginia ending basis data before and after cash settlement. They found that the variance of the futures market decreased relative to cash variance following the institution of cash settlement, a factor attributed to tying the futures market to a slow-moving average. The authors indicated that uncertain cash-futures relationships have serious implications for hedging in that a successful hedge is based on the ability of the cash and futures markets to move together. If the futures price does not accurately reflect the movement of the cash price of the commodity, hedging effectiveness is greatly diminished. In order to quantify the effect of cash settlement on the ability to forecast termination or closing basis, the authors used basis models for breed, weight, muscle score, and frame size to predict ending basis. Using these models, basis for spring steers and heifers and fall steers and heifers were estimated and compared with actual basis outcomes before and after cash settlement. In general, basis forecast error was not reduced by the adoption of cash settlement. The authors concluded that although cash settlement did not reduce variability of the basis, the new delivery method was still an improvement over physical delivery since it eliminated the difficulties of physical delivery for both longs and shorts,

Schroeder and Minert also conducted a study of the impact of cash settlement on hedging effectiveness. Their research, however, focused on the changes in hedge ratios for feeder steers and heifers, based on the premise that if cash settlement fulfilled expectations and decreased basis variability, optimal hedge ratios would increase. Using data from June 1977 to December 1987, hedge ratios were calculated using generalized least squares for 400-500 pound and 700-800 pound steers and heifers. Their results were based on simulated futures prices using the historical USFSP as a proxy for futures prices. They estimated hedge ratios separately for market locations in Amarillo, Dodge City, Kansas, and Illinois Direct, by contract month, and different weight categories and sex. For most contracts, the authors found that hedging risk had been reduced, and the models resulted in hedge ratios 10-15% greater under cash settlement, therefore necessitating producers to reconsider their hedge ratios under the new contract provisions. These results must be interpreted with some caution, however, since the authors were forced to simulate futures price under cash settlement. If the relationship between futures and the USFSP has been altered since cash settlement, their results may not be valid.

Although a 1989 study by Bastian centered mainly on price discovery as opposed to basis variability, much of his work is relevant to this study. Bastian examined the causal relationships between feeder cattle cash prices, futures prices and the USFSP. His objective was to determine how well the USFSP correlates to local auction prices for feeder cattle. He analyzed the USFSP series from January 1987 through October 1989 and weekly auction prices from Torrington, Wyoming; Greeley, Colorado; Billings, Montana; and Oklahoma City Oklahoma. The data were divided into three subperiods consisting of nearby, middle and distant data.

In general, Bastian found that Granger causality tests indicated that the feeder cattle futures market was not the center of price discovery. The author arrived at this conclusion when the causality tests revealed significant unidirectional causality from the USFSP to futures in the middle subperiods and a significant bidirectional relationship in the nearby subperiod. The results led the author to question the ability of the futures market to react quickly to supply and demand information.

When analyzing the correlation between the USFSP and auction prices, Bastian found positive and highly significant relationships between the settlement index and futures price for the October and September contracts. The August contract, however, exhibited some negative correlation, especially in the Billings market, raising questions concerning the adequacy of the settlement index to accurately reflect market information. These results would indicate the need for continued research into the adequacy of the settlement index to accurately reflect market price.

# Chapter 3

# Theory of Price Behavior in the Feeder Cattle Futures Market

## 3.1 Price Behavior of a Non-Storable Commodity

The futures price for a non-storable commodity such as livestock behaves quite differently from a storable commodity such as grains. For storable commodities, the futures price generally does not exceed the cash price of the commodity by more than transportation and storage costs (Ernst). When distant grain futures are greater than current cash price plus storage costs, grain handlers increase the amount stored and, hence futures for storable commodities serve an allocative role. Feeder cattle, on the other hand, are non-storable and tend to be heterogenous in type. Ernst identified several factors which affect feeder cattle basis including weight, frame size, muscle score, producer expectations, sex, and time of year. The purpose of the feeder cattle futures market is generally viewed as that of a forward pricing mechanism. In other words, the price quotation for a particular contract is the market's best estimate of the price for that particular point in time. The difference in prices across contracts is a reflection of changing supply and demand expectations rather than storage costs (Hughes et al.).

In order for the futures market to fulfill its function as a risk management tool, the producer must be able to predict basis with a certain degree of accuracy. After considering certain characteristics such as those identified by Ernst, producers should be able to lock in a price for an expected level of basis. The change in expected basis should be less than the change in the price to which a producer is exposed in the cash market, otherwise hedging does not reduce producer risk.

In a cash-settled contract such as feeder cattle, convergence is forced between futures and the cash index at contract maturity. Cash settlement changes the relationship between cash and futures prices, and therefore affects basis. Cohen and Gorham predicted that basis under cash settlement would be reduced by the nature of the USFSP's calculation. Under physical delivery, the cattle delivered on a contract were generally of the lowest deliverable grade. Futures prices, therefore, were discounted to a level based on this lowest grade. With cash settlement, the settlement price is based on an average across grades and because this average price would be expected to move less than the price for the lowest grade, basis variability should be reduced. This hypothesis, however, is based on the assumption that the settlement index for a cash-settled contract is truly reflective of cash prices.

## 3.2 Index Construction

In order to analyze an index and determine if it is functioning properly, it is important to understand the logic behind an index's design. Paul describes a good index as one that is "accurate, relevant, widely accepted, fairly continuous, and difficult to manipulate." If the index on which settlement is based does not possess these qualities to some degree, the contract is not a good candidate for cash settlement.

**Difficulty in defining an index.** Defining an index for a heterogenous commodity such as feeder cattle is much more difficult than defining an index for a market such as financial futures. Feeder cattle vary greatly in grade, weight, and breed. The current feeder cattle grading system includes three frame sizes and three muscle scores. This yields nine possible grading combinations with widely varying prices across grades and even within the same grades. Defining a settlement index for feeder cattle is further complicated by the fact that the cattle are quite geographically dispersed. If the index were to be truly reflective of every producer's cattle the index would have to include data from all feeder cattle sales in the U.S. Because this is impractical the challenge then becomes choosing the markets that are most representative of cash price movements on which to base the index.

**Potential for manipulation.** One of the main concerns in defining an index centers on defining an index which is not easily manipulated. Manipulation can occur in conventional physical delivery contracts, but designers of these contracts use large volume and multiple delivery points as protection from corners and squeezes in a market. Paul illustrates the logic of this in economic terms. He states that the short run supply curve for a potential manipulator is much more positive for one delivery location than is the aggregate supply curve for several delivery locations. In other words, the potential manipulator would have to invest much more capital into buying cattle at various locations in a multiple delivery situation in order to affect prices as opposed to influencing the market in only one location under a single delivery situation. The same principle holds under cash settlement. To avoid the possibility of manipulation, the index must incorporate a substantial number of markets. Kahl et al. agree with this hypothesis and further suggest that the cash settlement price series be averaged over several days to reduce manipulative potential. Based on this concern over the potential for manipulation, the CME included both spatial (27 states) and temporal (7 days) averaging in the construction of the USFSP.

## 3.3 Models

Since the feeder cattle contract forces convergence between the USFSP and futures, ending basis between these two prices approaches zero. Producers, however, are not actually trading their animals based on the USFSP price, but on their local cash price. The question then becomes: How well does the USFSP reflect cash market price movements? The USFSP is an average across time and space and therefore cannot be perfectly correlated with any one market. Because the USFSP is an average across many markets in 27 states and also across a period of seven days, it is much smoother and slower-moving than individual cash markets. As Figure 3.1 suggests, the futures market may track the specific cash market fairly closely up to the month of expiration, but at some point the futures market must diverge, if necessary, from that cash market and converge with the USFSP. If the USFSP is a poor reflection of the variability of cash market prices, the relationship between the cash market and the converging futures will be unpredictable. Fluctuations in the cash price will not be reflected in the futures

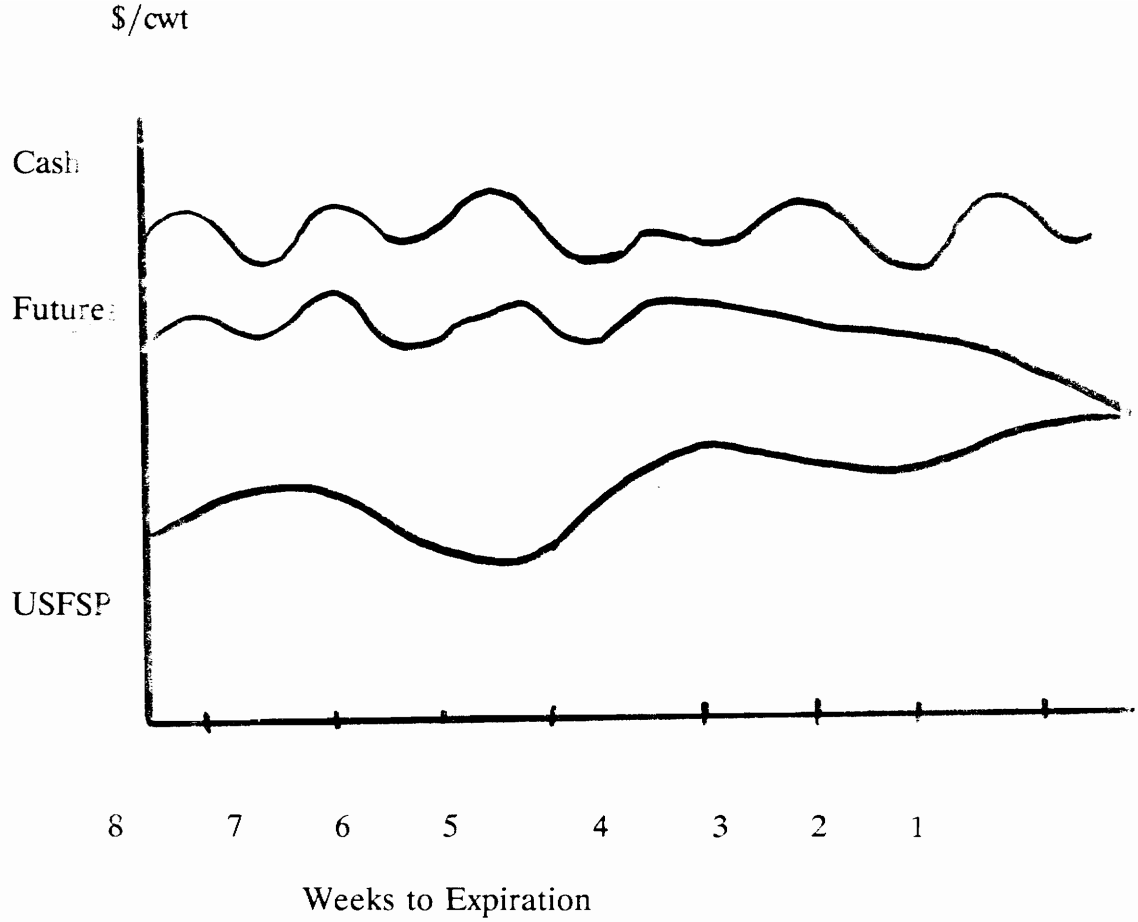


Figure 3.1. Theoretical Movements of the Futures, Cash and U.S. Feeder Steer Price During the Last Eight Weeks Prior to Expiration of the Feeder Cattle Futures Contract After Cash Settlement.

market and basis "wrecks" much like the example in Table 1.2 are likely to occur. Such unreliable basis relationships discourage producers from use of the contract for price risk management.

This study will quantify the relationships between USFSP, futures, and cash during the last 8 weeks before and during the delivery month. The hypothesis on which the following models were based is that basis variability will increase in the expiration month because:

1. As expiration approaches, the USFSP and futures markets must become more highly correlated;
2. In the process of converging with the USFSP price, futures will become less correlated to the more variable cash price; because
3. The USFSP is not highly correlated to cash prices.

The models to test these hypothesis will regress the weekly changes in the futures prices (CF) on the weekly changes in cash prices (CC) from 8 weeks up to 1 week prior to contract maturity.

(1) $CF = f\{CC\}$

The second set of models is similar except it regresses weekly changes in futures (CF) on weekly changes in the USFSP (CU) across the same time periods.

(2) $CF = f\{CU\}$

If the relationship between the price series in either of the two models is perfect, the slope of the regression line should be one with an intercept of zero. In other words, each change in one market is equally matched in magnitude and direction by changes in the other market. Regressions will be performed for Equation 1 on data before cash settlement (April 1981-August 1986). These regressions would be expected to show fairly constant relationship between futures and the cash price across the eight weeks since futures prior to September 1986 were not forced to converge with a settlement index. Although this relationship would be expected to be somewhat poor given industry criticism, statistically the fit of the model should remain fairly constant across the eight-week period. If the hypothesis presented above is correct, however, the regression based on Equation 1 with data after cash settlement (September 1986- November 1991) should result in similar $R^2$ across the eight weeks, slope coefficients close to one, and intercept coefficients close to zero in the weeks furtherest from expiration. As expiration, and hence convergence of futures and USFSP approaches, changes in the cash market would be expected to explain less of the changes in the futures market and the regressions will tend to have a lower $R^2$ and significant changes in the slope and intercept coefficients should occur. Equation 2 should yield results opposite to equation 1 for data after cash settlement. The model would be expected to provide a poorer fit further from expiration while improving as expiration, and forced convergence, approaches.

The validity of these two models and the first two hypotheses stated above depend on the results of the relationship between local cash market prices and the USFSP (CU). These relationships will be evaluated using the following regression model.

(3) $CF = f\{CU\}$

This model regresses weekly changes in the USFSP (CU) on weekly changes in the cash market (CC). If the third hypothesis holds, the correlation between these two price series should be low. As stated earlier, because the USFSP is an average across such a large period of time and space, it is unlikely to be able to accurately reflect the changes in the cash market. As demonstrated earlier in Table 1.1, the standard deviation of the USFSP is 25-30% less than the standard deviations of the three cash price series used in this analysis. Because of these differences in variability, the $R^2$'s between the USFSP and the individual cash markets would be expected to be low across the entire eight weeks.

The results of these models are important for two reasons. First, they identify at what point hedging effectiveness breaks down during a contract's trading period and therefore provide producers with an idea of when they need to eliminate their positions in the market before basis predictability deteriorates.

Second, the results will add to the knowledge base from which hopefully a new and improved index can be developed.

# Chapter 4

# Data and Model Results

## 4.1 Data

The data were collected across 10 years from 1981-1991, 5 years before and 5 years after cash settlement. The three price series used in this analysis were cash, futures, and the U. S. Feeder Steer Price (USFSP).

The cash price series selected for this analysis is based on 700-800 pound large and medium frame steers from three midwest markets-- Amarillo, TX; Dodge City, KS; and Oklahoma City, OK. These markets were chosen because they are high volume markets which reflect current U.S. cash markets prices. The Amarillo and Oklahoma City sales take place only on Tuesdays, so the prices for each of the two cash series as well as the futures and USFSP are Tuesday quotes. Dodge City sales take place on Wednesday and the corresponding futures and USFSP quotes are for Wednesday.

The futures prices are the Chicago Mercantile Exchange's closing quotes for its feeder cattle contract. Although feeder cattle contracts expire in the months of January, March, April, May, August, September, October, and November, the January data were excluded from the analysis because trading volume in this contract tends to be light and because data for this contract encompass the Christmas and New Year's holidays when there is little or no trading. The price series for each individual contract includes the price on Tuesdays and Wednesdays across the final eight weeks of trade for each specific contract. The last Tuesday or Wednesday may not be the last trading day hence, convergence of the USFSP and the futures price cannot always be expected to be complete.

The USFSP series is the 27 state 7-day moving average reported by Cattle-Fax to the CME. The Tuesday and Wednesday quotes for this series were selected to match corresponding futures and cash prices.

The price series were differenced in order to more accurately capture the influences of small changes in the data that occur in the last eight weeks of trade on a particular contract. For example, the Tuesday quotes for the last eight weeks of trade on the October contract were collected and differences were taken across those eight weeks. The data were then aggregated so that the differenced values for each week prior to contract maturity were placed together for a total of 38 observations for each of the respective weeks (3 contracts in 1986 after cash settlement plus 7 contracts per year for five years after 1986). The week one differenced data is the change from week two prior to maturity to week one prior to maturity for each contract. Likewise, week two is the change in price from week three to week two, etc.

## 4.2 Regression Models

### 4.21 Futures and Cash

From the risk management standpoint of a hedger, the critical relationship is that between the futures market and the producer's cash price. If the relationship between these two is predictable, basis will be predictable and hedging can be used to effectively manage exposure to price risk and to establish a particular forward price. The first equation is devised to reveal how much of the changes in the futures market' s prices from week to week can be explained by changes in the cash market:

(1) $CF_i = B_1 + B_2 CC_i$ where $i = 1\text{-}7$ and refers to the number of weeks prior to maturity,

For example, $CF_1 = B_1 + B_2CC_1$ would include all the differences in the futures price between weeks one and two across each contract month included in the time period and regressed on the all the differences in the cash price between weeks one and two across the same time period. The hypothesis outlined in Chapter 3 indicated that as expiration approaches and futures is forced to converge with the USFSP, it becomes less correlated with the cash market. As outlined in the Chapter 3, in a perfect market the two series would move together, in a one to one relationship giving a regression equation with a zero intercept and a slope of one. In other words, each move in one market should be reflected by a move of equal magnitude and direction in the other market. The models for each of the three price series contained 38 observations and were tested at a 5% significance level. The critical values for the Durbin Watson statistic for all weekly regressions in this study are 1.535 and 2.465. The critical F value for these weekly models is 4.17 at the 5% level of significance. All future references to statistical significance are at the 5% level unless stated otherwise.

Table 4.1 contains the results of Equation 1 for time periods before and after cash settlement using Amarillo cash data. The results in Table 4.1 show a deterioration in the correlation between the futures and cash markets across the last eight weeks of trading on a contract since the implementation of cash settlement. With the exception of week four, the $R^2$ s were much higher before

Table 4.1 Estimated Regression Coefficients of Amarillo Cash and Nearby Futures Before and After Cash Settlement.[1]

| Before Cash Settlement[2] | | | | | After Cash Settlement | | | |
|---|---|---|---|---|---|---|---|---|
| Week | Constant | Slope | $R^2$ | D.W. | Constant | Slope | $R^2$ | D.W. |
| 1 | .138<br>(.232)[3] | .805<br>(.177) | .36 | 1.64 | .096<br>(.115) | .330<br>(.083) | .31 | 2.21 |
| 2 | .231<br>(.215) | .550<br>(.155) | .26 | 1.66 | .137<br>(.156) | .325<br>(.131) | .15 | 2.00 |
| 3 | -.230<br>(.184) | .853<br>(.106) | .64 | 1.58 | .452<br>(.164) | .398<br>(.142) | .18 | 1.99 |
| 4 | .087<br>(.179) | .800<br>(.142) | .47 | 1.84 | -.098<br>(.166) | .708<br>(.117) | .51 | 1.80 |
| 5 | -.017<br>(.229) | .780<br>(.144) | .45 | 1.67 | .072<br>(.150) | .488<br>(.118) | .32 | 1.56 |
| 6 | .053<br>(.204) | .604<br>(.145) | .32 | 2.04 | .131<br>(.156) | .347<br>(.131) | .16 | 2.41 |
| 7 | -.113<br>(.161) | .627<br>(.095) | .55 | 1.15 | .059<br>(.168) | .535<br>(.140) | .29 | 2.12 |

1. Dependent variable is futures price change.
2. Before period is April 1981-August 1986. After period is September 1986-November 1991.
3. Standard errors are in parenthesis.

cash settlement. The Durbin Watson statistics for each week indicated no serial correlation with the exception of week seven before cash settlement. Generally the slopes were closer to one and the intercepts closer to zero under physical delivery. Before cash settlement, none of the intercepts were statistically different from zero and only three of the weeks had slope coefficients statistically different from one. After cash settlement, however, two intercepts are significantly different from zero and all the slope coefficients are statistically different from one.

The slope coefficient on the variable CC is a reflection of the magnitude of change that takes place in the futures market for a given change in the cash market. For example, in week one before cash settlement, a $1 change in the cash market was reflected by a $.81 change in the futures market. After cash settlement, however, a $1 change in the cash market during week one results in only a $.33 move in the futures market. The implications of this to hedging are tremendous. Because a producer that hedges is using the futures market for protection against unexpected changes in the cash market, it is vital that the two markets move together in magnitude and in direction. The results in Table 4.1 indicate that since the implementation of cash settlement, the relationship between the futures market and the Amarillo cash market has deteriorated substantially.

The results of the regression model employing the Oklahoma City series, contained in Table 4.2, were very similar to the results for Amarillo. Before cash settlement, one intercept was statistically different from zero, while two slope coefficient were statistically different from one. After cash settlement, only the intercept for week three was statistically different from zero while six of the seven slope coefficients were statistically different from one. The Durbin Watson statistics for this model were acceptable with the exception of week seven before cash settlement.

The results from the model using Dodge City cash price data, Table 4.3, differed from the other two markets. While only one intercept was statistically different from zero both before and after cash settlement, six of the slope coefficient before and seven of the slope coefficients after cash settlement were statistically different from one. The low magnitude of the slope coefficients as well as relatively low $R^2$s would indicate that Dodge City prices were not highly correlated with the futures relative to the other two markets either before or after cash settlement.

These weekly models show general support for the hypothesis that the futures and cash markets will become less correlated in the final weeks of trading. The $R^2$s across these final weeks decreased, especially across the last two weeks of the contract. These models also indicate that the relationship between the futures and cash markets across all eight weeks has deteriorated with the implementation of cash settlement.

Table 4.2 Estimated Regression Coefficients of Oklahoma City Cash and Nearby Futures Before and After Cash Settlement.[1]

| | Before Cash Settlement[2] | | | | After Cash Settlement | | | |
|---|---|---|---|---|---|---|---|---|
| Week | Constant | Slope | $R^2$ | D.W. | Constant | Slope | $R^2$ | D.W. |
| 1 | .163<br>(.207)[3] | 1.17<br>(.196) | .50 | 1.91 | -.064<br>(.116) | .284<br>(.077) | .28 | 2.12 |
| 2 | .398<br>(.177) | .909<br>(.158) | .48 | 2.05 | .160<br>(.103) | .649<br>(.085) | .62 | 1.59 |
| 3 | -.201<br>(.232) | .949<br>(.182) | .43 | 1.97 | .339<br>(.157) | .522<br>(.139) | .28 | 1.44 |
| 4 | -.098<br>(.197) | .806<br>(.181) | .35 | 1.76 | -.010<br>(.157) | .952<br>(.140) | .56 | 2.20 |
| 5 | .007<br>(.211) | .950<br>(.149) | .53 | 1.25 | .036<br>(.143) | .540<br>(.118) | .37 | 1.47 |
| 6 | .085<br>(.208) | .693<br>(.172) | .31 | 2.40 | .106<br>(.161) | .179<br>(.088) | .10 | 2.45 |
| 7 | -.023<br>(.176) | .752<br>(.137) | .46 | 2.30 | -.084<br>(.155) | .522<br>(.111) | .38 | 2.56 |

1. Dependent variable is futures price change.
2. Before period is April 1981-August 1986. After period is September 1986-November 1991.
3. Standard errors are in parenthesis.

Table 4.3 Estimated Regression Coefficients of Dodge City Cash and Nearby Futures Before and After Cash Settlement.[1]

| | Before Cash Settlement[2] | | | | After Cash Settlement | | | |
|---|---|---|---|---|---|---|---|---|
| Week | Constant | Slope | $R^2$ | D.W. | Constant | Slope | $R^2$ | D.W. |
| 1 | .653<br>(.217)[3] | .517<br>(.165) | .21 | 1.76 | .012<br>(.248) | .474<br>(.173) | .17 | 1.93 |
| 2 | .186<br>(.161) | .441<br>(.101) | .35 | 1.75 | .071<br>(.137) | .236<br>(.095) | .14 | 1.89 |
| 3 | -.102<br>(.234) | .364<br>(.161) | .12 | 2.34 | .448<br>(.169) | .338<br>(.097) | .25 | 1.88 |
| 4 | -.437<br>(.241) | .383<br>(.180) | .10 | 2.24 | .099<br>(.153) | .568<br>(.096) | .49 | 2.13 |
| 5 | .116<br>(.243) | .828<br>(.159) | .43 | 1.86 | -.078<br>(.197) | .408<br>(.138) | .19 | 1.92 |
| 6 | .069<br>(.206) | .296<br>(.145) | .10 | 2.17 | .293<br>(.274) | .104<br>(.204) | .01 | 2.05 |
| 7 | .025<br>(.155) | .745<br>(.103) | .59 | 1.40 | -.122<br>(.285) | .312<br>(.232) | .05 | 2.11 |

1. Dependent variable is futures price change.
2. Before period is April 1981-August 1986. After period is September 1986-November 1991.
3. Standard errors are in parenthesis.

Because of the statistical difficulty in comparing individual weekly regressions across time, the data were aggregated such that CC contains the data for all weeks 1 to 7 and dummy variables for intercepts and slope shifters for each week were created to facilitate statistical testing. The new model follows:

(2) $$CF_{1-7} = B_1 + B_2CC_{1-7} + B_3D2 + B_4D3 + B_5D4 + B_6D5 + B_7D6 + B_8D7 + B_9D2C + B_{10}D3C + B_{11}D4C + B_{12}D5C + B_{13}D6C + B_{14}D7C .$$

where: $CF_{1-7}$ = aggregated differences in futures across all 8 weeks prior to expiration;

$CC_{1-7}$ = aggregated differences in cash for all eight weeks prior to expiration;

D2-D7 = intercept dummy variables for weeks 2-7,

D2 = 1 in week= 2, 0 otherwise

D3 = 1 in week= 3, 0 otherwise, etc.; and

D2C-D7C = slope shifters for CC for weeks 2-7,

D2C = D2*CC,

D3C = D3*CC, etc.

The intercept shifters and slope shifters were added to the model in order to facilitate more accurate comparisons across weeks. Because the base for the dummy variables is week one, the model is set up to test whether the behavior of the price series are different in weeks 2-8 than in week one. The critical values for the Durbin Watson statistics for these aggregate models are 1.632 and 1.908. The critical F value is 1.75 at the 5% level of significance.

The results of equation 2 using the Amarillo price data are found in Table 4.4. The variables which were found to be significant were CC and the D4C. The significant slope shifter in week four indicates a significant improvement in the relationship between Amarillo cash and futures in week four compared to week one, the base. During week four, each $1.00 change in cash leads to a $0.78 change in futures (.407+.301). During the remaining weeks, a $1.00 change in cash only results in a $0.407 change in futures, leading to a $0.60 change in basis. The improved correlation in week four between cash and futures may be related to producers liquidating futures positions to avoid having positions during the delivery month.

The results using the Oklahoma City data are in Table 4.5. For this equation, the significant variables were CC, D2C and D4C. As with the Amarillo data, week four appears to represent some significant changes in the relationship between the nearby futures and the Oklahoma City cash series. For the Oklahoma City market during week four, each $1.00 change in cash leads to a $.952 change in futures (.284 +.668). Unlike the Amarillo model, the slope shifter in week two is also significant although its coefficient is of a smaller magnitude. In week two a $1.00 change in the cash market results in a $.649

Table 4.4 Estimated Regression Coefficients of Amarillo Cash and Nearby Futures After Cash Settlement.[1]

| Variable | Parameter | Standard Error |
|---|---|---|
| Constant | .112 | .154 |
| CC | .407[2] | .094 |
| D2 | .015 | .216 |
| D3 | .340 | .216 |
| D4 | -.210 | .216 |
| D5 | -.056 | .216 |
| D6 | .019 | .216 |
| D7 | -.053 | .219 |
| D2C | -.152 | .123 |
| D3C | -.009 | .161 |
| D4C | .301[2] | .142 |
| D5C | .047 | .122 |
| D6C | -.060 | .159 |
| D7C | .128 | .160 |
| $R^2$ | .32 | |
| Durbin Watson | 2.03 | |
| F-Statistic | 9.11 | |
| Observations | 266 | |

[1]Dependent variable is futures price change.
[2]Statistically significant at the 5% level.

Table 4.5 Estimated Regression Coefficients of Oklahoma City and Nearby Futures After Cash Settlement.[1]

| Variable | Parameter | Standard Error |
|---|---|---|
| Constant | .064 | .142 |
| CC | .284[2] | .093 |
| D2 | .096 | .202 |
| D3 | .275 | .203 |
| D4 | -.074 | .201 |
| D5 | -.280 | .203 |
| D6 | .042 | .201 |
| D7 | .020 | .202 |
| D2C | .365[2] | .151 |
| D3C | .238 | .159 |
| D4C | .668[2] | .158 |
| D5C | .256 | .151 |
| D6C | -.105 | .121 |
| D7C | .238 | .139 |
| $R^2$ | .41 | |
| Durbin Watson | 2.04 | |
| F-Statistic | 13.42 | |
| Observations | 266 | |

[1]Dependent variable is futures price change.
[2] Statistically significant at the 5% level.

(.284 + .365) change in the futures price. During the remaining weeks, a $1.00 change in cash only results in a $.284 change in futures, leading to a $.72 change in basis.

The results for Dodge City are found in Table 4.6. The significant variables for this equation were CC and the dummy intercept variable for week two. There were no significant slope shifters in this model, and therefore the slope across weeks two through eight were no different than that of week one. The $R^2$ of this model was .23 indicating that 77% of the change in basis for the Dodge City market was unexplained.

Because week one is the base for comparison across the weeks, the variable CC reflects the magnitude of the expected futures price change in this week. A comparison across the three markets indicates that in week one, Amarillo cash with a slope coefficient of .407 is more highly correlated to the futures market then either Oklahoma City with a slope coefficient of .284 or Dodge City with a coefficient of .353. During week four, however, Oklahoma City with a slope coefficient of .952 (.284 + .668) is more highly correlated with the futures market than Amarillo at .708 (.407 + .301) or Dodge City at .353. These results are consistent with the individual week analysis-- they both indicate that cash and futures are less correlated in the delivery month than outside the delivery month. The remaining weeks are basically all the same.

Table 4.6 Estimated Regression Coefficients of Dodge City and Nearby Futures After Cash Settlement.[1]

| Variable | Parameter | Standard Error |
|---|---|---|
| Constant | .096 | .211 |
| CASH | .353[2] | .111 |
| D2 | .261[2] | .063 |
| D3 | .006 | .297 |
| D4 | .228 | .302 |
| D5 | .046 | .298 |
| D6 | .021 | .297 |
| D7 | .169 | .298 |
| D2C | -.228 | .297 |
| D3C | -.113 | .184 |
| D4C | -.006 | .165 |
| D5C | .159 | .172 |
| D6C | -.023 | .184 |
| D7C | -.305 | .191 |
| $R^2$ | .23 | |
| Durbin Watson | 1.99 | |
| F-Statistic | 5.67 | |
| Observations | 266 | |

[1] Dependent variable is futures price change.
[2] Statistically significant at the 5% level

## 4.22 Futures and USFSP

The second regression model, CF= f(CU), measures the relationship between futures and the USFSP.

(3) $CF_i = B_1 + B_2CU_i$ where i=1-7 and refers to the number of weeks prior to maturity.

The hypothesis outlined earlier indicated that futures and the USFSP must become more highly correlated as the contract nears expiration due to mandatory convergence at expiration. Five of the seven slope coefficients for these weeks are statistically different from one even in the last two weeks (Table 4.7). This result is not entirely unexpected, however,because while the futures price may be converging with the USFSP, it may have to move in the opposite direction of the USFSP as it leaves cash and becomes tied to the index. The $R^2$ s resulting from this model would seem to support this possibility concept because the largest $R^2$ for the model (.62) is in the last week of trading. Table 4.7 indicates that, in general, the USFSP and feeder cattle futures price changes are somewhat more highly correlated near expiration.

A model similar to equation two was developed including dummy variables for intercept and slope shifters was developed using aggregated USFSP data. The resulting model follows:

Table 4.7 Estimated Regression Coefficients of U.S. Feeder Steer Price and Nearby Futures.[1]

| Week | Constant | Slope | $R^2$ | D.W. |
|---|---|---|---|---|
| 1 | .077<br>(.084)[2] | .675<br>(.088) | .62 | 1.88 |
| 2 | .042<br>(.156) | .444<br>(.218) | .10 | 2.22 |
| 3 | .549<br>(.148) | .575<br>(.131) | .35 | 1.31 |
| 4 | -.001<br>(.200) | .866<br>(.224) | .29 | 2.00 |
| 5 | -.111<br>(.165) | .542<br>(.230) | .13 | 1.64 |
| 6 | .148<br>(.159) | .462<br>(.198) | .13 | 2.26 |
| 7 | .095<br>(.151) | .697<br>(.140) | .41 | 2.05 |

1. Dependent variable is futures price change.
2. Standard errors are in parenthesis.

$$(4) \quad CF_{1\text{-}7} = B_1 + B_2CU_{1\text{-}7} + B_3D2 + B_4D3 + B_5D4 + B_6D5 + B_7D6 + B_8D7 + B_9D2U + B_{10}D3U + B_{11}D4U + B_{12}D5U + B_{13}D6U + B_{14}D7U$$

where: $CF_{1\text{-}7}$ = aggregated differences in futures across all 8 weeks prior to expiration;

$CU_{1\text{-}7}$ = aggregated differences in cash for all eight weeks prior to expiration;

D2-D7 = Intercept dummy variables for weeks 2-7,

D2 = 1 in week 2, 0 otherwise,

D3 = 1 in week 3, 0 otherwise, etc.; and

D2U-D7U = Slope dummy variables for USFSP for weeks 2-7,

D2C = D2*CU,

D3C = D3*CU, etc.

The results of estimating equation 4 are found in Table 4.8. The model resulted in a $R^2$ of .30, a value similar to those of the corresponding cash models. The intercept shifter for week three and the slope coefficient for week one are the only statistically significant variables in this model. Because there are no statistically significant slope shifters, the relationship between the futures and the USFSP would be no different across weeks 2-8 than in week one. The statistically significant slope coefficient on the base week one (USFSP) indicates that a $1 change in USFSP results in a $ 0.673 change in the futures.

Table 4.8 Estimated Regression Coefficients of U.S. Feeder Steer Price and Nearby Futures After Cash Settlement.[1]

| Variable | Parameter | Standard Error |
|---|---|---|
| Constant | .077 | .155 |
| USFSP | .673[2] | .162 |
| D2 | -.035 | .219 |
| D3 | .472[2] | .220 |
| D4 | -.078 | .219 |
| D5 | -.188 | .219 |
| D6 | .071 | .219 |
| D7 | .017 | .220 |
| D2U | -.299 | .269 |
| D3U | -.098 | .213 |
| D4U | .193 | .238 |
| D5U | -.131 | .270 |
| D6U | -.211 | .252 |
| D7U | .022 | .217 |
| $R^2$ | .30 | |
| Durbin Watson | 1.94 | |
| F statistic | 8.31 | |

[1] Dependent variable is futures price change.
[2] Statistically significant at the 5% level.

The slope estimate in equation 4 is very similar to the slope of week one in the weekly regressions--.675 for the weekly regressions and .673 for the combined regressions. The weekly model supports the second hypothesis in that the $R^2$'s in week one was considerably higher than in the preceding weeks (.41 was the next highest with the $R^2$ for three of the weeks falling below .15). These results indicate that futures and USFSP are more closely correlated near contract expiration.[1]

### 4.23 USFSP and Cash

The futures and cash market regression indicates that cash and futures become less correlated as contract maturity approaches, whereas USFSP and futures become more closely correlated as contract maturity approaches. The next logical question is how closely correlated are the USFSP and the cash market? Although each of the markets used in this analysis are included in the calculation of the USFSP, many other markets are also included. As a result of averaging across such a large number of markets, it becomes questionable how well the average can be correlated with any one market. As indicated in the theory chapter, the USFSP would be expected to be much less variable than the individual cash markets of which the index is comprised. If the USFSP is truly reflective of cash price fluctuations this regression should result in high $R^2$ s with

---

[1]A correlation matrix for futures and the USFSP with time lags up to seven weeks revealed no lagged effects in the weekly differences of the two price series.

slope coefficients close to one. If the USFSP were a perfect reflection of cash price movements, they would have a one-to-one relationship much as was discussed concerning the relationship between the futures and cash markets. The following model was developed to quantify this relationship:

(5) $CU_i = B_1 + B_2CC_i$ where i=1-7 and refers to the number of week prior to contract maturity.

Tables 4.9-4.11 summarize the results of estimating equation 5, CU=f(CC), for the Amarillo, Oklahoma City, and Dodge City markets. In Table 4.9, the resulting coefficients for Amarillo indicate that while none of the intercepts were statistically different from zero, all of the slope coefficients were statistically different from one. In addition, the F values indicate that in weeks two, three, and four the models are not statistically significant and therefore the two price series have no significant relationship during these weeks. Four of the seven weeks have $R^2$s less than .15 leaving over 85% of the variation of the change in the USFSP across weeks unexplained by one of the markets on which the index is based.

The results from the model using Oklahoma City data can be found in Table 4.10. While all the F values for these equations were statistically significant, none of the intercepts were statistically different from zero, and all the slope coefficients were statistically different from one. Three of the weeks yielded $R^2$s less than .15.

Table 4.9 Estimated Regression Coefficients of Amarillo and USFSP After Cash Settlement.[1]

| Week | Constant | Slope | $R^2$ | F[3] | D.W. |
|---|---|---|---|---|---|
| 1 | -.001<br>(.138)[2] | .358<br>(.100) | .26 | 12.84 | 2.35 |
| 2 | .050<br>(.122) | .123<br>(.101) | .04 | 1.50 | 2.10 |
| 3 | -.158<br>(.177) | .286<br>(.123) | .09 | 3.49 | 2.17 |
| 4 | -.116<br>(.128) | .302<br>(.091) | .24 | 11.20 | 2.00 |
| 5 | .092<br>(.121) | .096<br>(.095) | .03 | 1.02 | 2.29 |
| 6 | -.065<br>(.124) | .248<br>(.015) | .13 | 5.61 | 2.11 |
| 7 | .018<br>(.151) | .510<br>(.126) | .31 | 16.52 | 1.85 |

1. Dependent variable is U.S. Feeder Steer Price.
2. Standard errors are in parenthesis.
3. Critical F= 4.17 at 5% significance.

Table 4.10 Estimated Regression Coefficients of Oklahoma City and USFSP After Cash Settlement.[1]

| Week | Constant | Slope | $R^2$ | $F^3$ | D.W. |
|---|---|---|---|---|---|
| 1 | -.029 (.132)[2] | .352 (.086) | .32 | 16.64 | 2.52 |
| 2 | .060 (.109) | .247 (.091) | .17 | 7.46 | 2.10 |
| 3 | -.293 (.152) | .604 (.135) | .36 | 20.03 | 2.07 |
| 4 | -.094 (.140) | .255 (.125) | .10 | 4.18 | 1.79 |
| 5 | .131 (.101) | .331 (.083) | .30 | 15.71 | 2.32 |
| 6 | -.084 (.123) | .173 (.067) | .15 | 6.58 | 2.23 |
| 7 | .049 (.144) | .467 (.103) | .36 | 20.47 | 2.19 |

1. Dependent variable is U.S. Feeder Steer Price.
2. Standard errors are in parenthesis.
3. Critical F= 4.17 at 5% significance level.

Table 4.11 Estimated Regression Coefficients of Dodge City and USFSP After Cash Settlement.[1]

| Week | Constant | Slope | $R^2$ | $F^3$ | D.W. |
|---|---|---|---|---|---|
| 1 | -.070 | .199 | .09 | 3.57 | 2.48 |
| | (.151)[2] | (.105) | | | |
| 2 | .009 | -.056 | .01 | .460 | 2.08 |
| | (.119) | (.083) | | | |
| 3 | -.189 | .245 | .14 | 6.10 | 2.04 |
| | (.172) | (.123) | | | |
| 4 | -.086 | .172 | .10 | 3.82 | 1.61 |
| | (.141) | (.088) | | | |
| 5 | .069 | .134 | .07 | 2.76 | 2.17 |
| | (.114) | (.081) | | | |
| 6 | -.078 | .023 | .001 | .051 | 2.12 |
| | (.134) | (.199) | | | |
| 7 | .150 | .101 | .01 | .493 | 2.03 |
| | (.178) | (.144) | | | |

1. Dependent variable is U.S. Feeder Steer Price.
2. Standard errors are in parenthesis.
3. Critical F value = 4.17 at 5% significance level.

Dodge City appears to be the least correlated with the USFSP. The F values for five of the seven weeks indicate that there is no significant relationship between the USFSP and Dodge City cash prices across these weeks. The $R^2$'s for each of the weeks in this model were under .15. Because Dodge City cash prices also seemed to be less correlated with the futures market in the weekly regressions, serious basis problems would seem imminent in this market.

An aggregate model similar to those developed in the first two sections were developed for this model.

(6) $$CU_{1-7} = B_1 + B_2CC_{1-7} + B_3D2 + B_4D3 + B_5D4 + B_6D5 + B_7D6 + B_8D7 + B_9D2C + B_{10}D3C + B_{11}D4C + B_{12}D5C + B_{13}D6C + B_{14}D7C$$

where: $CU_{1-7}$ = aggregated differences in USFSP across all 8 weeks prior to expiration;

$CU_{1-7}$ = aggregated differences in CASH across all 8 weeks prior to expiration;

D2-D7 = intercept dummy variables for weeks 2-7,

D2 = 1 in week 2, 0 otherwise,

D3 = 1 in week 3, 0 otherwise, etc.; and

D2C-D7C = slope dummy variables for CC for weeks 2-7,

D2C = D2*CC,

D3C = D3*CC, etc.

Table 4.12 Estimated Regression Coefficients of Amarillo Cash and U.S. Feeder Steer Price After Cash Settlement.[1]

| Variable | Parameter | Standard Error |
|---|---|---|
| Constant | -.001 | .139 |
| CC | .358[2] | .100 |
| D2 | .051 | .197 |
| D3 | -.472 | .195 |
| D4 | -.115 | .195 |
| D5 | .093 | .198 |
| D6 | -.064 | .195 |
| D7 | .019 | .197 |
| D2C | -.234 | .154 |
| D3C | -.072 | .155 |
| D4C | -.054 | .139 |
| D5C | -.262 | .150 |
| D6C | -.110 | .153 |
| D7C | .153 | .154 |
| $R^2$ | .17 | |
| Durbin Watson | 2.13 | |
| F statistic[3] | 4.46 | |
| Observations | 266 | |

[1] Dependent variable is U.S. Feeder Steer Price change.
[2] Statistically significant at the 5% level.
[3] Critical F value at 5% significance level and 266 observations is 1.75.

Table 4.13 Estimated Regression Coefficients of Oklahoma City Cash and U.S. Feeder Steer Price After Cash Settlement.[1]

| Variable | Parameter | Standard Error |
|---|---|---|
| Constant | -.029 | .129 |
| CC | .351[2] | .085 |
| D2 | .089 | .183 |
| D3 | -.264 | .184 |
| D4 | -.065 | .183 |
| D5 | .161 | .184 |
| D6 | -.055 | .182 |
| D7 | .078 | .183 |
| D2C | -.104 | .136 |
| D3C | .251 | .144 |
| D4C | -.096 | .142 |
| D5C | -.021 | .137 |
| D6C | -.179 | .110 |
| D7C | -.115 | .126 |
| $R^2$ | .28 | |
| Durbin Watson | 2.17 | |
| F statistic[3] | 7.62 | |
| Observations | 266 | |

[1] Dependent variable is U.S.Feeder Steer Price change.
[2] Statistically significant at the 5% level.
[3] Critical F value at 5% significance level with 266 observations is 1.75.

The results of the Amarillo model are found in Table 4.12. The F value for the model was significant at the 5% level and the Durbin Watson statistic was acceptable. According to the results of this aggregate model, the changes in the Amarillo cash market from week to week explains only 19% of the changes in the USFSP across weeks. The cash variable CC was the only significant variable in the model; none of the slope shifters indicated any improvement over week one. The slope coefficient for week one is .358 indicating that a $1.00 change in cash leads to only a $.36 change in the USFSP.

The results from the Oklahoma City cash data are found in Table 4.13. Again, the F value for the equation was significant and the Durbin Watson statistic indicated no serial autocorrelation. The $R^2$ of .28 was slightly larger than that of the Amarillo model. As in the Amarillo model, only the slope coefficient for week one (CC) was significant with a value of .351. This value is similar to that of the Amarillo market and again results in a $.64 change in basis across weeks.

The results for Dodge City were again quite different from Amarillo or Oklahoma City. The F value for the equation indicates that there is no significant relationship between the changes in the USFSP and the Dodge City cash price.

As Table 4.14 indicates, none of the parameters are significant and the $R^2$ for the equation is only .08. As mentioned earlier, the fact that Dodge City is a fairly large cash market which is included in the calculation of the USFSP, yet has

Table 4.14 Estimated Regression Coefficients of Dodge City Cash and U.S. Feeder Steer Price After Cash Settlement.[1]

| Variable | Parameter | Standard Error |
|---|---|---|
| Constant | -.070 | .146 |
| CC | .199 | .101 |
| D2 | .080 | .206 |
| D3 | -.119 | .206 |
| D4 | -.015 | .207 |
| D5 | .139 | .206 |
| D6 | -.008 | .206 |
| D7 | .220 | .206 |
| D2C | -.256 | .144 |
| D3C | .045 | .132 |
| D4C | -.027 | .137 |
| D5C | -.065 | .144 |
| D6C | -.177 | .149 |
| D7C | -.099 | .156 |
| $R^2$ | .08 | |
| Durbin Watson | 2.09 | |
| F statistic | 1.699 | |
| Observations | 266 | |

[1] Dependent variable is U.S.Feeder Steer Price change.
[2] Statistically significant at the 5% level.
[3] Critical F value at 5% level with 266 observations is 1.75.

no statistically significant relationship with the USFSP, demonstrates why producers across the country are reluctant to utilize the feeder cattle contract.

The results of the equation 3 models indicate that Oklahoma City is more closely tied to the USFSP than the other two series. However, none of the cash markets are well correlated with the index. Given the fact that the USFSP seems to have little relationship to these three large, high volume markets, the USFSP appears to not be reflective of cash price fluctuations and is therefore a major source of hedging difficulties.

## 4.3 Summary of Results

The first hypothesis of this research postulated that since the implementation of cash settlement as a delivery mechanism for the feeder cattle contract, the futures market and the cash market have become less correlated across the final weeks of trading on the contract. Based on the model CF=f(CC), where CF= the change in futures and CC= the change in cash prices, the individual weekly equations indicate that since cash settlement the $R^2$s of the equations have decreased dramatically, especially in the final weeks of trading. The aggregate models for Amarillo, Oklahoma City, and Dodge City resulted in $R^2$s of .32, .41, and .23 , respectively indicating that anywhere from 59% to 77% of the variation of basis from week to week is unexplained by the cash market.

The second hypothesis was that the relationship between the futures market and the USFSP improves as expiration approaches. The individual weekly equations for the model CF=f(CU) confirmed this hypothesis with considerably higher $R^2$s the last week before expiration. The aggregate equation for this model yielded an $R^2$ of only .30 indicating that the USFSP explained only 30% of the change in futures across the final eight weeks of trading on the contract.

The third hypothesis indicated that the USFSP and the cash markets were not highly correlated. The results of the weekly regressions from the model CU=f(CC) supported this hypothesis. Many of the equations were not statistically significant and the $R^2$ of the equations were quite low across all weeks. The aggregate equations also confirmed this hypothesis with a low $R^2$ and no statistically significant intercept or slope shifters across any of the eight weeks.

The results presented in this chapter indicate that the changes in the USFSP are not well correlated with the changes in the cash market. Since the changes in the futures market are well correlated with changes in the USFSP only in the last week, changes in cash and changes in the futures market are not well correlated, hence basis error from week to week is large. The resulting basis variability problem stems from the fact that the USFSP is not well correlated with cash market prices. As Garbade and Silber advised, a settlement index must be an accurate reflection of the cash market for cash settlement to be successful. Based on the results of this study, a 7-day moving average of cash price in 27 states does not appear to fulfill this requirement.

# Chapter 5

# Conclusions and Implications

## 5.1 Summary and Conclusions

From a hedging standpoint, the goal of the futures market is to reduce risk from cash price fluctuations. For hedging to be effective, the difference in the cash and futures price, or basis, must be predictable with some amount of certainty. The more variable the basis of a contract, the less effective a hedging strategy will be in a producer's risk management program. The feeder cattle futures contract has been plagued with basis problems almost since its conception.

A change in the contract's specification from physical delivery to cash settlement beginning with the September 1986 contract was aimed at decreasing basis variability in the contract by eliminating delivery problems and tying the futures market to an index based on average cash prices across several markets and days.

Studies performed prior to cash settlement were encouraging. Cohen and Gorham, and Silber and Garbade indicated the feeder cattle contract was a good candidate for cash settlement because of its high cost of delivery. Cohen and Gorham predicted basis variability would be decreased by one-third. However, five years after the implementation of cash settlement, the National Cattleman's Association still viewed the basis as "flaky," and the settlement index, the USFSP, as unreflective of cash market prices. Several studies using data after cash settlement reinforced what producers and industry leaders had already discovered. Kenyon et. al found that cash settlement did not decrease basis variability for Virginia markets, while Bastian's study supported the belief that the USFSP was poorly correlated with cash markets.

The objective of this study was to analyze the changes in the relationships between the cash, futures, and the USFSP since the implementation of cash settlement. A better understanding of these relationships should help in the design of a cash settlement index that is more representative of cash market prices.

The models used in this study were based on three interrelated hypotheses.

The first hypothesis stated that outside the delivery month, futures prices may track cash fairly well but that the correlation between these two prices would decline during the expiration month and as the contract reached maturity. The expected results of this hypothesis are directly related to hypothesis two. If the futures and USFSP are forced to converge, at some point the futures must diverge from the cash price and begin converging with the USFSP. The USFSP and futures must then become more correlated as expiration approaches. The validity of this hypothesis in turn hinges on the third and final hypothesis. This hypothesis postulates that because the USFSP is an average of many markets and a slow-moving average, the USFSP and cash in individual markets cannot be well correlated. If this hypothesis holds, there is no reason to believe cash settlement will decrease basis variability in the feeder cattle contract because the futures price will not be an accurate reflection of fluctuations in the cash price.

There were two types of models developed for the analysis of these hypotheses. The first type of model was an individual weekly regression set up to yield regression results on individual weekly differences in the three series. The second type of model was based on data aggregated across the entire eight weeks and included dummy intercept and slope shifters to facilitate comparison across weeks. The results of the models generally supported the three hypotheses although the correlation between futures and USFSP near expiration was not as large as expected. As mentioned earlier, this occurrence can be attributed to the fact that the data is based on differences and the futures market may be forced to move in an opposite direction from the USFSP across the last few weeks in order to converge with the index. The correlation between cash and futures has diminished since cash settlement and, as expected, the correlation between the USFSP and the cash markets was quite poor.

## 5.2 Implications and Further Research

The results of this study were based on the use of the USFSP as a settlement index for the feeder cattle contract. Starting with the January 1993 contract, the settlement of the feeder cattle contract has been based on the CME's Composite Weighted Average. The incorporation of this new index involved the following changes in the feeder cattle contract and the cash settlement index:

1. Increase the size of the contract from 44,000 pounds to 50,000 pounds of feeder steers;
2. Narrow the weight range from 600-800 pounds to 700-800 pounds;
3. Update the description of the cattle from those that are expected to grade 60-80% Choice at slaughter, to those in the medium and lower half of the large frame score, all #1 thickness (muscling) score;

4. Include auction sales, direct trade, and video sales;

5. Reduce the size of the region from 27 states to 12 states in the central U.S.; and

6. Adopt a new cash settlement index based on USDA reported data on number of head, average weight per head, and average price per cwt., to calculate a true weighted average price--total dollars of cattle sold divided by total pounds of cattle sold-- for the pool of feeder cattle sold within the previous 7 calendar days (CME).

This change in the contract resulted from industry pressure on the exchange to create an index which more accurately reflects cash prices. When enough data can be collected to analyze this new index, inferences similar to those investigated here can be made concerning how well this new index works. If this study is any indication, however, the changes made above will not result in a profound improvement in the contract because the new index is still an average across a 7-day period. Averaging across this amount of time will "average out" and smooth the cash price variability much the same as the USFSP. Hedging problems such as the example in Chapter 3 are likely to continue.

Future research in this area should center on the development of a settlement index that decreases the amount of averaging used in the calculation of the index. As mentioned earlier, the exchange uses spatial and temporal averaging to decrease the possibility of price manipulation. There would be no reason for this concern, however, if the contract is terminated due to lack of trader interest. Some compromise must be reached between the need for an index which accurately reflects cash prices and the desire to reduce the potential for manipulation. Future studies should center on decreasing the period of time across which the new CME composite weighted average is calculated. Perhaps a two or three day average can be used instead of seven days. Although great consideration was given to the choices of markets for the new CME composite weighted average, unless the number of days in the averaging process is reduced, the index will most likely not be representative of cash prices. The new index needs to be analyzed in terms of the tradeoff between potential manipulation versus ability to accurately represent cash market prices. Since the new CME composite index uses actual quantities and weight sold, these volumes could be compared to total daily volume estimates to determine how many days need to be in the index.

# References

Bastian C. "An Analysis of the Interrelationships Between Cash and Futures prices in the Discovery of Price in Feeder Cattle." Unpublished M. S. Thesis,Department of Agricultural Economics, University of Wyoming, 1989.

Chicago Mercantile Exchange. "Cash Settlement for Feeder Cattle Futures." Chicago, 1986.

Chicago Mercantile Exchange. *Chicago Mercantile Exchange Yearbooks 1981-1991.* Chicago: Chicago Mercantile Exchange, 1982-1992.

Chicago Mercantile Exchange. Daily Information Bulletin: Agricultural Futures, Chicago: Chicago Mercantile Exchange 1993.

Cohen, L. and M. Gorham. "The Projected Impact of Cash Settled Commodity Contracts on Cash/ Futures Price Relationships." *Proceedings of Applied Commodity Price Analysis, Forecasting, and Market Risk Management, NCR--134 Conference,* Chicago, IL, 1985, pp. 313-335.

Cornett, S. "Changes Urged in CME Contracts to Improve Basis." *Beef.* March 1992.

Ernst, R. "Virginia Feeder Cattle Basis by Season, Location, Sex, Breed, Weight, and USDA Grade Differentials." Unpublished M. S. Thesis Department of Agricultural Economics, Virginia Polytechnic Institute and State University, 1989.

Garbade, K. and Silber, W. "Cash Settlement of Futures Contracts: An Economic Analysis." *Journal of Futures Market* Vol.3, No. 4 (1983): 451-472.

Hughes, M. S. Koontz, M. Hudson. "Rational Price Formation in Live Cattle and Live Hog Futures Markets." Presented Paper NCR--134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management, Chicago, IL, 1988.

Kahl, K. M. Hudson, C. Ward. "Cash Settlement Issues for the Live Cattle Futures Contract." *Journal of Futures Market* Vol. 9 (1989) No. 3, 237-248.

Kenyon D., B. Bainbridge., R. Ernst. "Impact of Cash Settlement of Feeder Cattle Basis." *Western Journal of Agricultural Economics*, (1991) 16 (1): 93-105.

Paul, A. "Pricing Implications of Alternative Delivery Mechanisms for Futures Contracts." *Key Issues in Livestock Pricing: A Perspective for the 1990's."* Wayne D. Purcell and John Rowsell, Eds. Research Institute on Livestock Pricing. Blacksburg, VA. 1987, pp 55-94.

Paul, A. " The Role of Cash Settlement on Futures Contract Specification." *American Enterprise Institute Occasional Paper on the Economics and Regulations of The Futures Markets*, Americans Enterprise Institute (1984).

Schroeder, T. and J. Minert "Hedging Feeder Steers and Heifers in a Cash-Settled Feeder Cattle Futures Market." *Western Journal of Agricultural Economics*. 13 (2): 316-326.

U. S. Department of Agriculture. *Livestock, Meat, and Wool Market News.* Washington Livestock Division, American livestock Service, U. S. Department of Agriculture, 1981-1991.

# Vita

Lisa Carol Currin was born in Sugar Grove, Virginia. She is the daughter of Rector and Linda Currin of Sugar Grove. Lisa received her Bachelor of Science Degree in Animal Science from Virginia Polytechnic Institute and State University in 1991. She received her Master of Science degree in Agricultural Economics from Virginia Polytechnic Institute and State University in 1993.