AN ABSTRACT OF THE THESIS OF

Cynthia Ann Vanderpool for the degree of Master of Science in Agricultural and Resource Economics presented on March 10, 1981

Title: An Econometric Model of Pacific Northwest Feeder Cattle Basis

Abstract approved: Carl O'Connor

Fluctuating feeder cattle prices have a direct affect on the revenue variability of feeder cattle producers. Hedging in the commodity futures market is a marketing strategy which can, if properly used, reduce the financial risk of feeder cattle producers. If the closing basis value is known when a hedge is placed, a price can be established for the feeder cattle in advance. This fact prompted research in determining the factors which affect nearby feeder cattle basis in the Pacific Northwest.

This research is an attempt to identify factors which influence the feeder cattle basis through their influence on the prices which compose the basis--i.e., the cash and futures prices. The feeder cattle cash price has been established as a function of the factors affecting the profit of feedlot operations. Controversy exists on the factors which influence the futures price of livestock products; however, the use of technical indicators is well established in the literature.

For the purposes of this research feeder cattle basis is developed as a function of the profit factors and a lag-trend indicator along with dummy variables which influence feeder cattle futures contracts over

time. The profit factors include expected slaughter price, corn price, and interest rate values. These profit factors are expected to influence the cash price of feeder cattle. The lag-trend indicator is a calculated trend of the basis over the past two time periods and is expected to represent the analysis made by traders in both the futures and cash markets of past events or prices. This analysis by traders in the futures market will be similar to their use of technical indicators.

In specifying the model, two methods of analyzing the expected affects of the profit factors on the basis are acknowledged. In this research, the profit factors are assumed to influence only the cash price. Therefore, the effect of the factors on basis is hypothesized by making assumptions about the price movement of the feeder cattle futures price. The analyses produce various hypotheses about the expected effects of the profit factors on basis.

The empirical results produce evidence that the estimated equations explain a good proportion of the Pacific Northwest basis of feeder cattle for light and heavy weight categories. After a close analysis of the profit factors, corn price is concluded to have a positive influence on 500-600 pound feeder cattle basis and a negative influence on 700-800 pound feeder cattle basis. However, due to the inability of the methods to hypothesize the effect of slaughter price on basis and/or to hypothesize, with consistency, the correct signs of the estimated interest rate coefficient, conclusions are not made about their influences on the basis.

Feeder cattle producers can apply the information produced in this research in making hedging decisions. However, a thorough knowledge and analysis of hedging theory and market conditions should be undertaken first. Since a predicted closing basis is needed by feeder cattle producers to establish a "locked-in" cash price, further research in developing a forecasting model of feeder cattle basis is warranted.

An Econometric Model of
Pacific Northwest Feeder Cattle Basis

by

Cynthia Ann Vanderpool

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirement for the
degree of

Master of Science

Completed March 1981

Commencement June 1981

APPROVED:

Associate Professor of Agricultural and Resource Economics

Head of Agricultural and Resource Economics

Dean of Graduate School

Date Thesis is presented March 10, 1981

Typed by Dodi Snippen for Cynthia Ann Vanderpool

ACKNOWLEDGEMENTS

I am indebted to many persons for their contribution in the preparation of this thesis. In particular, debts of gratitude are the following.

Dr. Carl O'Connor, my major professor, for his guidance and supervision in conducting this research.

Dr. Jack Edwards for his perception and insight which sparked deep thought into both my research and life.

Drs. Gene Nelson and Ron Oliveira for their helpful suggestions and answers to empirical considerations.

Dodi Snippen for her time spent typing the final draft and her helpful suggestions in typing the rough draft of this thesis.

My sister, Kayci, and her family for their love and comfort during the completion of this research, especially during a critical period at the outset of this research.

My parents and bother for their love, help, and support in obtaining my educational goals.

Finally, Mark for his total support in the completion of my degree requirements and, especially, for his unending love, patience, and understanding during the lengthy period in which the completion of this thesis and the physical distance between us was a very trying time.

This thesis is dedicated to Mark and my family for their confidence and total support.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF TABLES

AN ECONOMETRIC MODEL OF PACIFIC NORTHWEST FEEDER CATTLE BASIS

CHAPTER I

INTRODUCTION

Since 1972 feeder cattle prices in the Pacific Northwest[1/] have been highly variable. Not only have these prices been variable over the long run but also over the short run planning period for feeder cattle producers. This variability of feeder cattle prices has a direct effect on the revenue variability of feeder cattle producers.

An analysis of the feeder prices received over the period 1972-1978, during the months in which most feeder cattle are sold,[2/] is one estimate of the variance in revenue of producers. Feeder cattle prices varied from a difference of $3 to a difference of $11 during the selling period of any particular year for 500-600 pound feeder cattle. For a herd size of 300 calves, the potential variation in average total revenue ranged from $3,000 to $16,500 in any year depending on when the calves were sold during the specified marketing period.

Feeder price variability for heavier feeders (700-800 pound feeders) was similar to the variability of 500-600 pound feeders. However, due to the additional pounds, average revenue for 300 calves ranged from $6,300 to $23,100 for any particular year depending on when the calves were sold during the marketing period. This analysis is one indication of

---

1/ The Pacific Northwest is referred to in this research as including the states of Oregon and Washington.

2/ October, November, and December are the months chosen to represent the marketing period in which most feeder cattle are sold.

the financial risk faced by Pacific Northwest (PNW) feeder cattle producers.

Hedging in the commodity futures market is one possible tool feeder cattle producers can use to reduce this financial risk. Various research studies have shown that a complete hedge, as compared to a no hedge,[3/] marketing strategy reduces income variability while also reducing mean income returns [15, 19, 7]. A tradeoff exists between mean income return and income variability which must be chosen by each individual feeder calf producer.

If hedging is chosen as a marketing strategy, an understanding and knowledge of the basis (futures price minus cash price) and market conditions is essential in hedging effectively. If the basis can be accurately predicted, a price can be "locked-in" for the feeder cattle; thereby reducing financial risk.

For example, in March, a feeder calf producer decides to hedge in the futures market by selling an October contract of feeder cattle at a futures price of $70. If, when the hedge is placed, the October basis can be accurately predicted, the expected price to be received in October can be established. Given the predicted basis is -$5, the expected cash price in October is $75 (i.e., futures price minus predicted basis equals the expected cash price).

Hedging is an effective risk management tool in reducing financial risk, if used in conjunction with other market forecasts. However, hedging requires a thorough understanding of the cash market, futures market, and basis.

3/ A "no hedge" marketing strategy is a strategy in which no hedge is placed; i.e., the commodity is marketed only in the cash market.

Problem

For hedging to be beneficial to Pacific Northwest feeder cattle producers in establishing a "locked-in" price for their feeder cattle, two conditions are important to consider:

1. the feeder cattle basis corresponding to the Pacific Northwest must be less variable than the feeder cattle cash price, and

2. the value of the feeder cattle basis during the maturity of the futures contract is needed.

Carpenter [4] concludes from his research that the first condition presented above exists in the Pacific Northwest. However, the second condition is unknown with any degree of certainty. The research presented in this thesis is an attempt to develop a model which identifies the factors expected to affect the PNW feeder cattle basis. This research will, hopefully, lead to a forecasting model of the basis which can be used to determine the expected value of the basis corresponding to the hedged futures contract at maturity.

To identify the factors expected to affect the basis, a knowledge of the components of basis is needed. The basis value in one location consists of both the futures price and the local cash price. Basis is peculiar to a specific market location because different cash markets represent various dimensions of the cash price such as location, time, and quality. The PNW feeder cattle basis is, therefore, the futures prices of feeder cattle quoted on the Chicago Merchantile Exchange minus the cash price of feeder cattle quoted at the local spot market.

However, several price series exist in the Pacific Northwest corresponding to various weights of feeder cattle marketed. Only one futures prices for each contract month is quoted on the commodity exchange. Since PNW feeder cattle producers market feeder cattle of various weights, a basis corresponding to each weight category is important for these producers to hedge effectively. The basis of a particular feeder cattle weight category is the futures price of feeder cattle minus the PNW cash price of feeder cattle representing this weight category.

Knowledge of the components which influence the futures and cash price is important in identifying factors which influence the basis. A study of basis theory and prior research will also assist in this endeavor. The following section presents the objectives of this research in developing models of the Pacific Northwest basis.

Objective

The major objective of this research is to develop and test a theoretical model to explain the Pacific Northwest feeder cattle nearby basis for two weight categories. Subobjectives in reaching the major objective are:

1. to describe the interactions of the significant markets of the Pacific Northwest cattle industry and their effect on feeder cattle prices,

2. to describe the interactions of the traders in the commodity futures market and their effects on the feeder cattle futures price,

3. to identify measureable variables expected to explain the Pacific Northwest nearby basis for two weight categories of feeder cattle, and

4. to empirically estimate and statistically test the specified models.

Conclusions about the effects of the expected factors on basis can then be exemplified to show how these conclusions can be used in making better hedging decisions.

CHAPTER II

INSTITUTIONAL FRAMEWORK

Basis is the difference between the futures and cash price of a commodity at a particular point in time. Therefore, in order to develop a theoretical model of the basis, the components which influence the futures and cash price are important to identify. This chapter presents information about the factors of the cash and futures markets which influence their respective prices.

Pacific Northwest Cattle Industry

The interaction of the markets composing the cattle industry is relevant in establishing how the cash price for feeder cattle is determined. Figure 1 is a schematic diagram of the relationships to be explained. The forage and feedlot production sectors are the primary components of the beef production system. The slaughter, feeder, and grain markets reflect the interaction of the two production sectors.

The forage sector is composed of two subsectors, backgrounding and cow-calf. The cow-calf subsector raises 400-600 pound feeder cattle; whereas, the backgrounding subsector raises 600-800 pound feeder cattle. Feeder cattle are usually sold in the feeder market; however, the heavier weight feeders can be fed on forage to slaughter weight and sold in the slaughter market as grass-fed slaughter animals.

The feedlot sector purchases feeder cattle of various weights in the feeder market. This sector also purchases grain in the grain market as their main input in fattening the feeder cattle. Feeder cattle are held and fed in the feedlot until they reach a specified slaughter weight

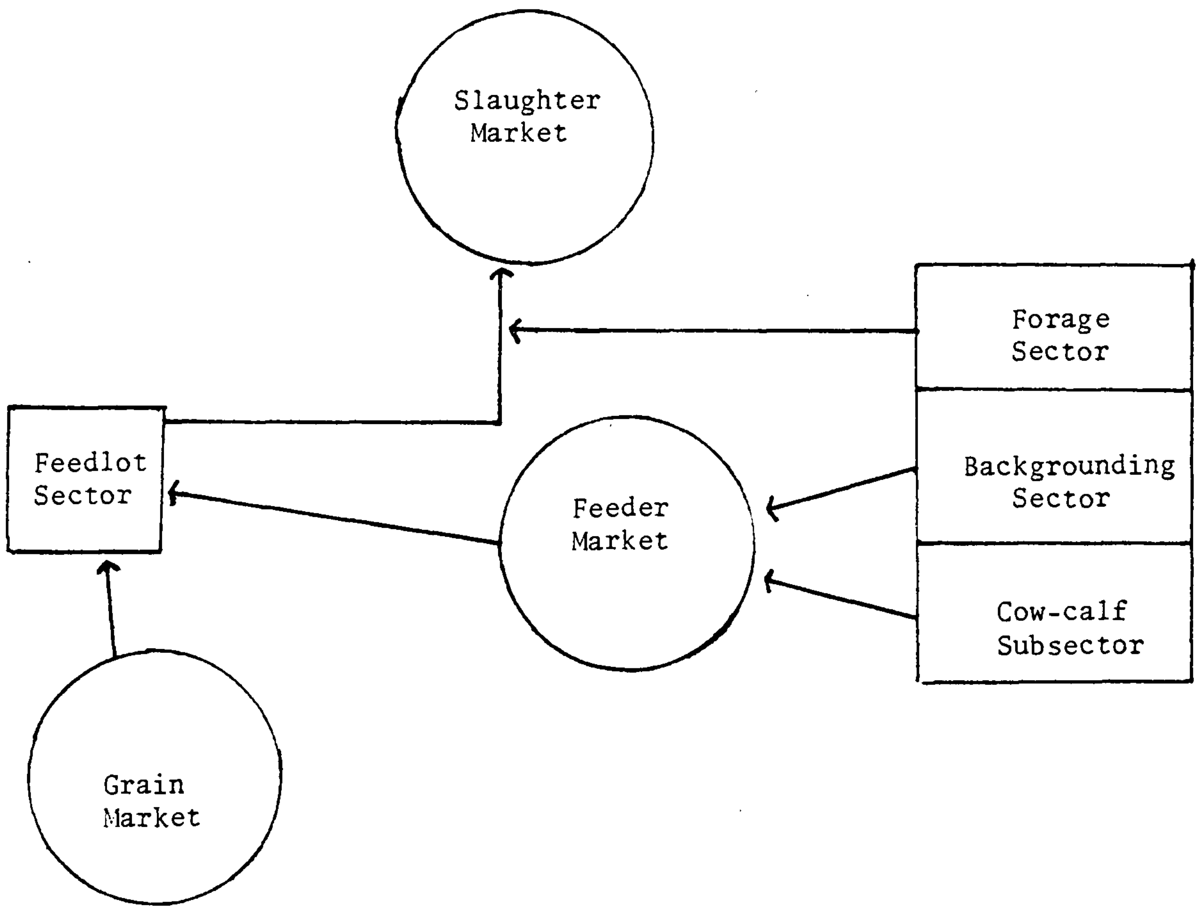

Figure 1. Schematic Diagram of the Pacific Northwest Cattle Industry.

at which time they are sold in the slaughter market as grain-fed slaughter animals.

There is a biological factor in the time requirement of feedeing a calf to slaughter weight. Feeder calves of lighter weights will take a longer time to feed to maturity than heavier weight feeder cattle since additional pounds must be added in the feedlot.

Table 1 summarizes the time requirement of feeding a particular weight category of feeder cattle to slaughter weight. These data are synonymous with a study presented by Brokken [3], but are adapted to weights corresponding to this research.

The total input costs of the feedlot will vary depending on the weight of the feeder purhcased, the feed utilized, and the feeding period required. The price received for the finished animal will also vary depending on the grade, weight, and time the animal is slaughtered. These varying expected revenues and costs will affect the price the feedlot is able to pay for the feeder cattle. Expected profit, which is based generally on past profits corresponding to past revenues and costs, will also influence the price the feedlot is able to bid for feeder cattle.

The effect of expected revenue, cost, and profit of the feedlot operation on the market price of feeder cattle is well established in the literature in which the estimating of the feeder cattle cash price is researched [2, 3, 5, 16]. The demand for farm products is derived from the consumer's demand for food products at the retail level. In the cattle industry, the demand for feeder cattle is derived from the demand for slaughter cattle and the demand for slaughter cattle is ultimately derived from the consumer's demand for beef products. Therefore, the profit function of the feedlot operation is generally used in determining

Table 1. Data Calculations to Obtain the Feeding Period Requirements of 500-600 and 700-800 Pound Feeder Cattle.

Descriptions	500-600 Pound		700-800 Pound	
	Pounds	Kilograms	Pounds	Kilograms
Purchase Weight	550	249.5	750	340.2
Initial Shrinkage[a/]	10	10	4	4
Beginning Weight	495	224.5	720	326.6
Average Gain/Day	2.31	1.05	3.08	1.40
Final Weight	1050	476.3	1050	476.3
Slaughter Weight	1008	457.2	1008	457.2
Days in Lot	217	217	217	217
Months in Lot	8	8	4	4

[a/] The initial shrinkage is in terms of percentages.

the cash price for feeder cattle. The feedlot's profit function can be expressed as:

$$\pi_h = W_p(P_s - P_f) + W_g(P_s - FC - C_o) \qquad (1)$$

where:

π_h = profit per finished animal

W_p = feeder purchase weight

P_s = price per unit weight of finished animal

P_f = price per unit weight of feeder animal

W_g = total weight gained in the feedlot

FC = feed cost per unit of W_g

C_o = cost of all other inputs per unit of W_g.

This function can then be solved for the purchase price of the feeder animal. This purchase price is calculated as:

$$P_f = P_s + \frac{W_g(P_s - FC - C_o) - \pi_h}{W_p} \qquad (2)$$

If the price parameters in the above equation are replaced with expected prices and the profit parameter is assumed to be zero, an expected break-even price for the feeder animal is expressed as:

$$BE = P_s^* + \frac{W_g(P_s^* - FC^* - C_o^*)}{W_p} \qquad (3)$$

where:

BE = expected break-even price per unit weight for the feeder animal, and * denotes expectation.

This break-even price is the price the feelot operator is able to pay for a feeder animal given his expected revenue and cost of gain. Assuming that the purchase weight and total weight gained is constant, the factors which affect the feeder cattle price are the expected price received for the finished animal in the future and the expected input costs to be accrued in adding the additional weight to the feeder.

Prior research has incorporated the concept of the feedlot's profit function in determining the factors which influence feeder cattle cash price. Beare [2] empirically developed a prediction model for Pacific Northwest feeder cattle cash prices of two weight categories. Two-stage least squares was used to estimate feeder cattle prices through a set of simultaneous equations. Light and heavy weight feeder cattle prices were regressed on the average price of feeder cattle and the corresponding feed-steer price ratio. The feed-steer price ratio corresponding to each weight category was hypothesized to adjust the average feeder cattle price to the price of the particular weight category. Beare's results suggested that feed prices have a negative impact on feeder calf prices. Light weight feeder cattle prices were found to be more responsive to changes in feed prices than heavy weight feeder cattle prices.

Brokken [3] also developed a model to predict feeder cattle prices for three weight categories. Brokken expressed the purhcased price of feeder cattle for each weight category as a function of the corresponding corn price, expected slaughter price, and profit per head.1/ However, instead of using an econometric model, Brokken determined the coefficients

---

1/ The profit per head was set at a specific level of return, given various feed and slaughter prices, so as to equalize profit per unit of time among the three weight categories of feeder cattle fed.

of the equations through a mathematical process based on specific costs, weights, rates of gain, shrinkage factors, and death rates applicable to the Pacific Northwest. From analyzing the resulting values of the coefficients, the results suggested that changes in the price of corn, the expected price of slaughter, and the profit per head affected the purchase price of lighter feeder cattle more than the heavier feeder cattle. These results with respect to corn prices were synonymous with Beare's results.

Beare and Brokken's models have had excellent results in predicting the feeder cattle cash price in the Pacific Northwest. Their research supports the belief that the feedlot profit function contains the major factors influencing the feeder cattle cash price. In the following section, the factors which influence the futures price of feeder cattle are discussed.

Commodity Futures Market

A commodity futures market is a market in which contracts are bought and/or sold for the future acceptance and/or delivery, respectively, of a particular commodity. There are two types of participants in the futures market, speculators and hedgers. Speculators do not have physical possession of the commodity and are in the market to make profits from price movements. Hedgers, however, do have actual possession of the commodity, or plan to, and are in the market to reduce their price risk. Yet, neither participant plans to accept or make delivery of the commodity.

The contracts bought and sold in the futures market have explicit specifications of each commodity so that a particular commodity can be delivered or accepted, if preferred by the trader. These specifications are designed to facilitate an orderly market through the threat of delivery. Contract specifications of various commodities include the commodity being traded, price, quantity, quality, place of delivery, and time of delivery.

Commodities comparable to those traded in the cash market of the cattle industry are traded on the futures market. These commodities are feeder cattle, live beef cattle, and corn.[2/] Table 2 lists the pertinent specifications of these contracts.

Various contract months of the year are traded for each commodity. These contract months correspond to the months of the year in which the commodity is most neavily traded in the cash market. Table 3 lists the contract months in which the feeder cattle, live beef cattle, and corn futures contracts are traded on their respective exchanges.

A futures price for each commodity contract exists when it is traded. The futures price of a commodity is a price for a particular quality and quantity of the traded commodity to be delivered at a specific location and time in the future. These characteristics of the price are based on the specifications and contract month of the commodity being traded. The active trading of speculators and hedgers on a commodity contract determines the futures price of the commodity.

Speculators play an active role in determining the futures price of a commodity. As defined earlier, speculators do not have possession of the commodity and are in the market to make profits as a result of price movements. To make profits, speculators must be able to identify the direction and magnitude of price movements. Therefore, speculators use various methods to determine the position and timing of their trans-

---

[2/] The corn futures contract is traded on the Chicago Board of Trade, whereas the feeder cattle and live beef cattle futures contracts are traded on the Chicago Merchantile Exchange.

Table 2. Contract Specifications of Feeder Cattle, Live Beef Cattle, and Corn Traded on Their Respective Exchange.[a/]

Specifications	Feeder Cattle	Live Beef[b/] Cattle	Corn
Quantity	42,000 lbs.	40,000 lbs.	5,000 bu.
Quality			
Grade	80% USDA Choice 20% USDA Good	USDA Yield Grades 1,2,3,4	Yellow Corn No. 2
Weight	550-650 lbs.	1050-1200 lbs.	
Sex	Steers	Steers	
Delivery[c/] Time	M,T,W,TH of the contract month	M,T,W,TH of the contract month	M,T,W,TH,F of the contract month
Par-delivery Location	Omaha, NB Sioux City, IO	Peoria, IL Joliet, IL Omaha, NB Sioux City, IO	Chicago, IL[d/]
Nonpar-Delivery Location[e/] (discounts)	Greely, CO 50¢ Billing, MO 75¢	Guymon, OK 50¢	Toledo, OH[d/] St. Louis, MO[d/]
Trading Termination	20th day of the contract month	20th day of the contract month	3rd Thursday of contract month

a/ Feeder and live beef cattle contracts are traded on the Chicago Mercantile Exchange, while corn contracts are traded on the Chicago Board of Trade.

b/ In February 1976 the live beef cattle contracts were revised incorporting those grading standards listed above due to government revised cattle grading standards.

c/ Each commodity can be delivered on the contract through the end of the contract month, even though trading ends in the third week of the month.

d/ These are district.

e/ Delivery points available only to the Pacific Northwest are listed for feeder cattle.

Table 3. Contract Months Traded for Feeder Cattle, Live Beef Cattle, and Corn.

Commodity \ Contract Month	Jan[a]	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Live Feeder Cattle	*		*	*	*			*	*	*	*	
Live Beef Cattle	*	*		*		*		*		*		*
Corn			*		*		*		*			*

a/ The January contract for feeder and live beef cattle began in 1978.

actions. Two basic approaches are fundamental and technical analysis of price movements [10, 21].

Fundamental analysis is a comprehensive study of the factors affecting the supply and demand of a commodity and, therefore, the price of a commodity. A thorough analysis of supply and demand is usually not undertaken by speculators due to its complexity and time consuming attributes. However, a knowledge of the current and expected supply and demand conditions is important since these factors determine the actual price.

Technical analysis, on the other hand, is used extensively by speculators. This analysis involves studying price patterns and movements to determine the appropriate timing to enter the market and position to hold the market. Techniques such as moving averages [1, 14], point and figure charts, and bar charts are used to study price patterns of commodities [21]. These techniques are well established and are used in conjunction with fundamental analysis.

The combined use of fundamental and technical analysis is for checking purposes. Charts and averages only show price movements and do not take into consideration factors in the market which can drastically affect price (such as war, disease, and drought) through their effect on supply and demand. Therefore, fundamental and technical analyses are used in conjunction with each other to get a total perceptive of price movements.

The futures price of feeders, as explained by Massarco, is being determined by speculators through the use of the feedlot operation's profit function [13]. Speculators in the market analyze the spread between the live beef cattle, feeder cattle, and corn futures prices to observe if the markets conform to a theoretical relationship. This spread is referred to as the feeder or reverse feeder spread depending on the actions taken by the traders. Given the expectations of a narrowing or widening spread, speculators enter the markets and take the appropriate actions. Through their actions, speculators are keeping the feeder futures price in line with live beef and corn futures prices through a profit function technique.

Hedgers, as compared to speculators, play a more passive role in determining futures prices. Hedgers, as defined earlier, have physical possession of the commodity, or plan to, and trade in the futures market to reduce their price risk rather than to make a profit as a result of price movements. Therefore, they do not use as extensively the established methods used by speculators to determine the timing and position of their transactions.

Instead, the position and time of the hedger's trading in the futures market is given by the position and transactions made in the cash market. The hedger reduces his price risk by making offsetting transactions in the cash and futures market. In the cow-calf operation, a feeder cattle futures contract can be sold when the calves are born, and subsequently a feeder cattle futures contract is bought back when the calves are sold in the cash market. The hedger trades on the futures market based on the actions made in the cash market and the realized price for the animal is the combined revenue from the cash and futures markets. Hedgers can affect the timing of their trading by waiting to place a hedge until the futures prices appears to be in their favor [17].[3/] But in

[3/] The actions of hedgers to affect the timing of placing and removing a hedge so that prices are in their favor is termed selective hedging.

doing so, the hedger becomes, in part, a speculator.

In summary, the cash price of feeder cattle is determined through the derived demand of the consumer for beef products and, therefore, through the profit function of the feedlot operation. Factors found to influence the cash price of feeder cattle in previous research are the expected slaughter price, input costs such as feed, and profit.

The futures price, in theory, is determined by traders' expectations of the supply and demand conditions at a future point in time. Speculators are more active than hedgers in determining futures prices due to their drive to make a profit from the price movements. There is some evidence that speculators in the feeder cattle futures market are adopting the use of the feedlot profit function in determining the feeder cattle futures price. Since speculators are expected to be more active than hedgers in determining futures prices, the feeder cattle futures price is expected to be determined primarily by speculative action.

CHAPTER III

THEORETICAL FRAMEWORK

Factors influencing the cash and futures prices of feeder cattle are discussed in the previous chapter. Since a basic framework of the two markets and the factors influencing their respective prices have been established, the theory of basis can be developed.

A theoretical framework of basis is presented in this chapter. The theory of hedging is presented to show the effect the closing basis has on the price received for cattle which have been hedged. This price effect is a major reason for developing a theoretical model to estimate the basis for feeder cattle. A review of literature is also presented to identify prior research studies on basis estimation and cash-futures price spreads dealing with the cattle industry.

Basis Theory

Basis is defined as the difference between the futures and cash price. At any point in time, the basis, like the prices on which it depends, is determined either by location, time, product quality, or some combination of these factors. If the quality, location, and time represented by the cash price are different from those represented by the futures price, the two prices can be expected to differ, yielding a basis value not equal to zero.

As the futures contract approaches maturity, the futures and cash prices tend to equate at the part-delivery points[1/] for the products

---

1/ Par-delivery points are designated cash markets at which the commodity can be delivered or accepted on a futures contract with no price discounts.

meeting standards specified in the contract. The reason for this equality is that on the delivery date, at the delivery location, and for product deliverable on the futures contract, the time, location, and quality characteristics of the futures and cash prices are identical. This convergence is assured by the fact that if prices were higher in either the futures or cash market, traders would buy or take delivery in the low-priced market and sell or make delivery in the high-priced market, thereby quickly minimizing, if not eliminating, any price difference through their bidding process.

This convergence is also true for nonpar-delivery points except that the closing basis is expected to be wider than zero due to the difference in location, quality, and market conditions at the local cash market of the commodity. The cash price at a nonpar-delivery point and in a market where the commodity is not readily deliverable to a delivery point is determined primarily by supply and demand conditions of the area. However, the cash price of a commodity which is deliverable to a delivery point can also be discounted for transportation and quality costs, such as shrinkage.

In the Pacific Northwest, feeder cattle are not readily deliverable because of extremely high transportation costs to established delivery points. A surplus of feeder cattle also exists in the Pacific Northwest which depresses feeder cattle prices relative to other regional markets. Empirically the PNW cash price is discounted, on the average, approximately two dollars per cwt. to the Omaha cash price [4]. (Omaha being a par-delivery point with no discounts.) Given the following formula of calculating basis, the PNW basis which is a nonpar-delivery point can be shown to be generally wider (larger) than a par-delivery point basis:

$$B = (FP - CP_d) + (CP_d - CP_l) \quad (4)$$

where:

B = basis

FP = futures price

CP_d = cash price at the delivery point

CP_l = cash price at the local cash market (nonpar-delivery point)

Theoretically, the futures and cash price at the delivery point will narrow to zero at the maturity of the contract (i.e., $FP - CP_d = 0$); i.e., the par-delivery basis will equal zero. Given the PNW cash price is two dollars less than the Omaha cash price, the PNW basis will be a positive two dollars and, therefore, greater than zero at the close of the contract. This equation is equivalent to the typical equation of basis (i.e., $B = FP - CP_l$) because the par-delivery cash prices cancel out.

As explained earlier, the basis is primarily composed of three dimensions--time, location, and product quality. Of these dimensions, the time element is probably the most researched area of inter-temporal price relationships. The time dimension refers to that portion of the basis due to the time interval between the present and the delivery date of the futures contract. If the cash price is assumed to reflect the same location and quality as specified in the futures contract, then theoretically the basis is composed of only the time dimension.

For storable commodities, this basis value is accepted as the cost of storing a unit of commodity from the present to the delivery date of the futures contract. This definition is well established in economic theory [22, 23].

The price of storage is determined from the demand for and supply of storage. The price of storage is, therefore, influenced by the marginal cost of storage through the firm's supply curve; this relationship is analogous to the usual supply function. Since the marginal costs of storing goods is directly influenced through the amount of inventory held, the price of storage is, simplicitly, a function of current inventories. The "time" basis for storable commodities is, therefore, the cost, or price, of storage and a function of inventories [22, 23].

Unlike storable commodities, there is no definitive connection between today's cash price and the futures price for deferred delivery of non-storable commodities. Two major reasons are:

1. supplies cannot be stored for long period of time, and

2. the form of the commodity changes over time.

The futures price is believed to represent the expected price of a commodity at a particular time in the future for non-storable commodities. If the futures price does represent expected price, it represents the expected supply and demand conditions for that time in the future, given current information. The cash price is the current market price and, therefore, represents the current supply and demand conditions. Given these relationships the basis should represent the difference between the current and expected market conditions.

A few studies have researched the basis corresponding to a change in the form of the commodity. This "form" basis, for example, is the difference between the expected price of slaughter cattle and the current price of feeder cattle. The cost involved is that of feeding cattle instead of carrying inventories. Empirical research on these inter-temporal price relationships will be discussed more thoroughly in the literature review section of this chapter.

Referring back to the convergence of basis, the theoretical narrowing of basis over time implies that there is a basis value for each time period. For each cash market and futures contract, a basis exists each day that trading occurs. Current basis refers to a futures contract price quoted on the commodity exchange minus the cash price quoted on the cash market for the current time period. On any given day, several current basis values exist which correspond to their respective futures contract. For example, in the feeder cattle contract, on a particular day, a current basis value exists for each of the feeder contract months being traded. That is, on March 1, a current basis value exists which corresponds to each of the March, April, May, August, September, October, and November feeder cattle futures contracts and the cash price on that day.

The nearby basis of a commodity refers to the current basis corresponding to the futures contract of the commodity nearest maturity (i.e., the nearby futures contract). For example, on March 1, the nearby basis is the difference between the futures price quoted on the March feeder cattle contract and the cash price quoted on the cash market that day. The March feeder cattle contract is chosen because it is the contract nearest maturity.

The closing basis, on the other hand, refers to the difference between the futures and cash price when a particular contract matures and the commodity is sold in the cash market. This basis can refer to the specific basis on the date on which the contract matures or to the general value of the basis during the last few weeks of maturity.

The current basis is synonymous to the nearby basis when the current basis corresponds to the nearby futures contract. The current and nearby basis values are equivalent to the closing basis on the day on which the contract matures or, in the general sense, the last few weeks of maturity. Therefore, these terms can be used interchangeably to identify a given time period and futures contract.

If the closing basis can be estimated with a high degree of certainty when the commodity is hedged, a price can be established by hedging. Therefore, the value of the closing basis is important in using hedging as a marketing strategy. The following section discusses the theory of hedging and the effect of the closing basis on the hedged price.

Hedging Theory

Placing a hedge involves the feeder cattle producer making offsetting transactions in the cash and futures market. For example, shortly after the calves are born, a futures contract is sold and subsequently when the calves are sold in the cash market, the futures contract is repurchased. The futures contract chosen should correspond to the month in which the cattle will be marketed in the cash market. Therefore, the price received for the feeder calves from a sell hedge transaction (i.e., the hedged price) can be expressed:

$$HP = FS - FB + CS - TC \tag{5}$$

where:

HP = hedged price or realized price

FS = selling price of the futures contract

FB = buying price of the futures contract

CS = market cash price of the commodity

TC = transaction cost of hedging.

Gum and Wildermuth [8], in studying the "efficiency of the hedge" and the "effective hedged price," define an ideal hedge in terms of the above equation. An ideal hedge is a hedge which results in the hedged price received being equal to the net sales price of the futures contract (i.e., HP = FS - TC). Therefore, the closing basis, which is equivalent to the difference between the buying price of the contract and the market cash price of the commodity are the only unknowns at the time the hedge is placed. Since these prices are not a factor in an ideal hedge, and the selling price of the futures contract and the transaction costs of the hedge are known at the time the hedge is placed, the price received for the cattle from hedging is known for certain. Under conditions of an ideal hedge, no uncertainty about price exists for the hedger.

In theory, an ideal hedge should always result due to the convergence of the closing basis to zero at the maturity of the futures contract. However, in reality, this phenomenon rarely occurs because of differences in the location, time, and quality of the commodity marketed in the cash versus the futures market.

Since the closing basis is equal to the buying prices of the futures contract minus the market cash price of the commodity, Equation (5) can be expressed as:

$$HP = FS - B - TC \tag{6}$$

where:

B = closing basis (FB - CS)

HP, FS, and TC are as previously defined.

In this equation, the closing basis is the only unknown when the hedge is placed. Therefore, if the closing basis can be predicted with some degree of accuracy, the hedged price can be estimated. This hedged price is equivalent to the expected "locked-in" cash price explained previously in Chapter I.[2/]

For hedging to be beneficial to feeder cattle producers, the closing basis must be less variable than the cash price. The hedged price or cash price is the realized price received by the cattle producer when the cattle are marketed depending on whether or not the cattle are hedged. Therefore, the realized price depends on the closing basis value or the market cash price received. If the closing basis is less variable than the cash price, less price risk exists in hedging. Carpenter [4] concluded that, for the Pacific Northwest, the basis is less variable than the cash price. Therefore, hedging can be beneficial in reducing the price risk of Pacific Northwest feeder cattle producers if used properly.

The purpose of this research is to identify factors which affect the closing basis for feeder cattle in the Pacific Northwest. With knowledge of these influencing factors, the feeder cattle producer can better estimate what the closing basis will be and, therefore, have a better idea of the hedged price to be received.

The following section discusses previous research on inter-temporal price relations, of which basis is a part. Although not all of the literature cited addresses basis estimation per se, these studies do

---

2/ The "locked-in" cash price explained in Chapter I does not include the cost of hedging which is included in the hedged price presented.

present valuable information on the price relationships between the feeder and fat cattle subsectors. Since the basis is, by definition, affected by these price relationships, the following literature review is pertinent to studying and developing a theoretical model to explain basis.

Literature Review

This section presents literature which has studied the inter-temporal price relationships of the cattle industry. Inter-temporal price relations are relationships at a given time, between prices applicable to different time periods. For example, this definition includes the relation on a given day between a cash and forward price (usually of the same commodity) or the relation between two forward prices. An example of the later relation is the spread between the December and May corn futures prices on a particular day. Basis is also an inter-temporal price relation since it is the value on a given day of the spread between the futures and cash price of a particular commodity.

Research on the inter-temporal price relationships of the cattle industry has been limited. A futures contract for live beef cattle has been in existence since 1964; whereas, a futures contract for feeder cattle has only been in existence since 1972.

A cornerstone study of inter-temporal price relationships of cattle was published in 1967 by Paul and Wesson [18]. They argued that the spot-forward spread between two forms of a commodity was the market price for converting one form of the product into another form. They defined the price of feedlot services for a given length of time as the value of the feeder calf and feed subtracted from the value of a fed animal deliverable therefrom and at the end of the feeding period. The spot-forward spread involving feeder cattle, feed, and fed cattle was established as a means of pricing feedlot services by comparing the activities of futures trading and custom feeding in the cattle industry. Paul and Wesson then analyzed whether feedlot operators were responding to the spread, also termed feeding margin, in the number of cattle they placed on feed. Quarterly feeding margins for the period 1965-1966 were calculated using the fed cattle futures price and current cash price to represent expected output prices. These two margins were then compared to the number of cattle placed on feed to find out if a supply response existed. A comparison of the feeding margins calculated using current cash prices to cattle placements revealed no supply response; whereas, a comparison of the feeding margins calculated using futures prices to cattle placements revealed a positive sloping supply response. From these results, Paul and Wesson emphasized that feedlot operators were responding to fed cattle futures prices, rather than cash prices, in their placement decisions.

Ehrich [6] expanded on Paul and Wesson's concept and developed a theory based on the break-even profit function of the feedlot operation to examine the difference between fed cattle futures prices and feeder cattle cash prices. Rearranging the profit function to obtain a spread between slaughter and feeder cattle prices on one side of the equation and substituting the futures price of slaughter for the current price of slaughter, the following equation was derived to represent the cash-futures spread:

$$P_s^* - P_f = (P_s^* - C)\ (1 - \frac{W_s}{W_f}) \qquad (7)$$

where:

P_s^* = futures price of fed steers

P_f = current price of feeder steers

C = total costs of feeding per cwt. of gain

W_s = finished weight of fed steers, and

W_f = beginning weight of feeder steers.

Ehrich hypothesized relationships between:

1. the cash-futures price spread and the cost of feed, and

2. the cash-futures price spread and the futures-cost spread

for a given beginning and finishing weight. An analysis of these hypotheses, through plotting their values against each other, confirmed that the above equation is the appropriate model of cash-futures prices relationships for beef cattle. Ehrich contended that feeder cattle cash prices adjust to expected fed cattle prices, while the number of feeders placed on feed is determined by short-run feedlot capacity rather than price changes. This later result was contradictory to Paul and Wesson's result that feedlot placement decisions were in response to changes in fed cattle futures prices.

In investigating the producers' utilization of the fed cattle futures market, Miller and Kenyon [16] also analyzed cattle placements and feeder cattle price adjustments in response to the fed cattle futures prices versus current cash prices. Miller and Kenyon attempted to verify Paul and Wesson's [18] results by updating the feeding margins through 1976. Feedlot placements were regressed on the feeding margins, corresponding to the futures price and current cash price as expected output prices, separately. The equations were run for two time periods: 1965-1966 and 1965-1976. The equations for both time periods were in accordance with Paul and Wesson's results. That is, only the feeding margin calculated using fed cattle futures prices was significant. However, identical equations were run adopting dummy variables to allow for seasonal feedlot placements. Neither feeding margin was significant in explaining feedlot placement variability for the 1965-1966 period. For the longer period, both feeding margins were significant, except the futures feeding margin had the wrong sign. Therefore, Miller and Kenyon suggested that, with the introduction of seasonal shifters in estimating placements, the use of fed cattle futures prices by fed cattle producers as expected output prices is doubtful. Miller and Kenyon argued that the direction of causality is mis-specified in the above equations. They argued that, due to an inelastic supply of feeder cattle over a quarter, feeder cattle prices should be estimated as a function of the quantity of feeder cattle.

Miller and Kenyon [16] estimated the derived demand equation for feeder cattle on a quarterly basis for the period 1967-1974. The average price of feeder cattle was regressed on the average cash price of fed cattle, average futures price of fed cattle corresponding to two quarters in the future, number of cattle placed on feed, and average prices of inputs. These input costs were corn, hay, protein, supplement, labor, and interest. A trend variable was also used in the model. The final model included fed cattle cash and futures prices, corn and labor prices, and the trend variable. From the results, Miller and Kenyon suggested that, as a consequence of their use as expected output prices, the fed cattle futures price is more important than the cash price in explaining the course of feeder cattle prices.

These three studies are very similar. In arriving at the theories presented, each study uses the attributes of the feedlot profit function. Also in representing expected fed cattle prices in the future, each study uses futures and/or current prices of fed cattle. Paul and Wesson [18] calculate two spreads, or margins, representing the price of feedlot services; one using the futures price of fed cattle, the other using the cash price. From analyzing the graphical relationship between each margin and cattle placements, Paul and Wesson conclude that feedlot operators were responding to fed cattle futures prices, rather than current prices, in the number of cattle they placed on feed. However, in analyzing the cash-futures spread of beef cattle to feed cost and futures price levels given a constant weight ratio, Ehrich [6] contends that feeder cattle cash prices adjust to expected fed cattle price while the number of feeder placed on feed is determined by short-run feedlot capacity rather than price changes.

Miller and Kenyon [16] update Paul and Wesson's study and use regression analysis. With the addition of seasonal shifters to the regression, Miller and Kenyon conclude that the use of fed cattle futures prices as expected output prices is doubtful. They argue that due to an inelastic supply of feeder cattle over a quarter, feeder cattle prices should be estimated as a function of the quantity of feeder cattle. They develop an econometric model for feeder cattle based on current and futures prices of fed cattle, quantity, input costs, and trend indicators. From the results of the regression, Miller and Kenyon suggest that the fed cattle futures price is more important than cash prices in explaining the course of feeder cattle prices.

Two studies on estimating basis, as defined earlier, are presented next. The first study develops a theoretical model of live beef cattle basis; whereas, the second study develops a statistical model of feeder cattle basis.

Leuthold [11] developed and empirically tested a theoretical model to identify the variables which affect the basis for live beef cattle. He hypothesized that "the basis for cattle is a function of the expected shift in supply." Leuthold expressed that the futures price is a result of expected demand and supply conditions; whereas, the cash price is a result of current demand and supply conditions. He argued that since the time interval of the basis for live beef cattle never exceeds seven months, the current and expected demand functions are the same. Therefore, the resulting price spread comes mainly from the difference between current and expected supply conditions.

To represent these supply conditions, Leuthold chose the following variables. The number of cattle slaughtered was a proxy for current quantity supplied while the price of beef, price of corn, number of cattle on feed, and current price of feeder steers were proxies for expected supply. Four basis regressions were estimated representing the various closing basis values for different futures contracts. Leuthold concluded from the empirical results that the factors which determine a shift in the supply can explain a high proportion of the variation of live beef cattle basis (particularly two to seven months prior to contract delivery).

Schimkat [20] developed a time series model utilizing spectral analysis to predict feeder cattle basis movements for a six-month hedging period. Since the cash model is expected to have cyclical fluctuations, the basis is also expected to be influenced by cyclical variations. Lagged values of basis changes were used to represent cyclical movements, while lagged values of cash prices were used to represent structural changes in the Florida feeder cattle industry. An amplitude adjustment factor was included to represent the fact that the amplitude of the basis changes was greater in the earlier years of the data base than in later years. A dummy variable to designate a negative or positie value of the value of the change in basis over a period of a year also was included because the residuals, without this variable in the equation, indicated that a different relationship existed between the dependent variable (ΔBt) and ΔBt-52 when ΔBt-52 was less than zero versus when ΔBt-52 was greater than zero. The model was run for both heavy (600-700 pound) and light (300-400 pound) feeder cattle. The lighter feeder cattle model had a much higher R^2 values than the heavier feeder cattle model. After examining the time series of basis changes, Schimkat concluded that the higher R^2 for the light feeder cattle was due to the more pronounced cyclical pattern in the light feeder cattle time series. These two models were then transformed for use in predicting the closing basis.

Leuthold [11] and Schimkat [20] both developed models to predict basis values. Leuthold's model explained the live beef cattle basis, while Schimkat's model explained the feeder cattle basis. These two models would be extremely difficult to compare since each was on a different commodity; however, the main difficulty in comparing them was in the method used to predict the basis. Leuthold used a econometric model in which variables are used which have explanatory power. Schimkat, on the other hand, used a time series model in which variables are used to catch movements in the data.

Although time series models may have good predicting capability, they are devoid of explanatory power. Therefore, when the model begins predicting the wrong values, there is no indication of the factors which are causing the error.

The basis theory, hedge theory, and literature review presented in this chapter and the institutional framework of the cash and futures market presented in Chapter II will be beneficial in specifying a theoretical model of feeder cattle basis. In the following chapter, a theoretical model is developed which identifies the variables hypothesized to explain the variation in the feeder cattle basis of the Pacific Northwest.

CHAPTER IV

MODEL SPECIFICATION

The previous two chapters have set forth a background from which to develop a theoretical model to explain the basis of Pacific Northwest feeder cattle. Chapter II presented the institutional framework of the PNW cattle industry and the commodities exchange market and the factors which determine the feeder cattle price in each respective market. Chapter III presented the theory of basis and hedging and a review of literature. The basis theory section discussed the components, behavior, and types of basis values. The value of the closing basis was related to hedging theory to show how it affects the realized price received from hedging feeder cattle. A literature review of studies on inter-temporal price relationships dealing with the cattle industry was presented in the last section of Chapter III.

The major objective of this research is to develop and test a theoretical model which identifies factors affecting the nearby basis of PNW feeder cattle for two weight categories. The development of the model will be presented in this chapter, while the testing of the model will be presented in the following chapter.

An econometric model, rather than a time series model, is developed in order to verify the factors influencing the feeder cattle basis for PNW producers. The emphasis placed in this research is similar to Leuthold's concentration on the factors which influence the predominant market conditions of the corresponding market. For fed cattle, the supply factors are emphasized in Leuthold's study, whereas for feeder cattle, the demand factors will be emphasized. Leuthold concentrates on the supply factors influencing fed cattle futures and cash prices, assuming demand is constant over the feeding period. This research will concentrate on the derived demand factors believed to influence feeder cattle prices. Although supply factors are expected to influence feeder cattle prices and, therefore, basis, they are not included in this research. The incorporation of supply factors is left up to future research as explained in Chapter VI.

Only one futures price for feeder cattle exists for a futures contract.[1/] However, several cash prices exist depending on the weight of the feeder cattle marketed. For hedging to be beneficial to the feeder calf producer, the closing basis corresponding to the weight of the feeder cattle expected to be marketed is of importance. For the purposes of this research, a feeder cattle basis model will be developed for two weight categories marketed in the PNW cash market. The weight categories of interest are the 500-600 and 700-800 pound feeder cattle. These two weight categories are chosen to represent the light and heavy weight feeder cattle categories respectively.

As explained in Chapter II, the feeder cattle cash price is influenced by the factors of the feedlot's profit function, whereas the futures price is influenced by the use of technical indicators and, to some extent, the factors of the feedlot's profit function. Since the basis of feeder cattle is defined as the difference between the futures and cash price, the basis is expected to be a function of the factors of

---

1/ Various weights of feeder cattle can be delivered on the futures contract; however, a premium or discount on the futures price specified is given for the different weights. Therefore, even though various weights can be delivered, only the futures price stated on the contract corresponds to the specified weight on the contract (550-650 pounds).

the feedlot's profit function and technical indicators.

Given a beginning and finishing weight of the feeder cattle in the feedlot, the break-even price of feeder cattle is influenced by the expected finished price and input costs. Past events are also expected to influence the price. Technical indicators which influence the futures price are based on some type of moving average to capture the trends of prices. If speculators are trading on the futures market and basing their decisions on the feedlot's profit function, the futures price of feeder cattle will also be influenced by the expected finished price and the input costs. The following section discusses the variables expected to represent these factors.

Proxy Variables

Proxy variables are used in econometric studies to represent the actual factors expected to influence the dependent variable being estimated. In the following paragraphs, proxy variables are presented which are believed to represent the factors mentioned in the previous section.

Expected Slaughter Price

Futures prices are usually interpreted as the expected price at a future time given current available information. Leuthold [12] examined the forward pricing function of the fat cattle futures contract relative to the corn futures contract. He concluded that fed cattle futures prices estimate subsequent cash prices as well as corn futures prices. However, he also found that for distant futures, the fat cattle cash price is a more accurate indicator of distant cash price values than the futures price.

Studies by Miller and Kenyon [16] and Dickens [5] on the fed cattle producers' utilization of fed cattle futures market strengthen the use of the fed cattle futures price as an expected price. Miller and Kenyon's results suggest that the fat cattle futures price has been influencing the course of feeder cattle cash price as a consequence of their use as expected slaughter prices. Dickens reproduces this study but adapts it to the Pacific Northwest. His results imply that the same relationship exists for the Pacific Northwest fed cattle producers.

Given the forward pricing function and the effect on feeder cattle prices of the fed cattle futures price, the live beef futures price will be used as a proxy of the expected slaughter price. Of course, the particular futures contract price used for each weight of feeder cattle will correspond to the future time period in which the fed cattle are expected to be marketed for slaughter.

As shown in Table 1, 500-600 pound feeder cattle require eight months to reach a slaughter weight of 1050 pounds. Therefore, the futures price of the nearest live beef cattle contract corresponding to eight months in the future, FPS8, is used as a proxy to represent expected output price. Similarly, 700-800 pound feeder cattle require four months to reach slaughter weight so that the futures price of the nearest live beef cattle contract corresponding to four months in the future, FPS4, is used as a proxy. Table 4 presents the particular live beef cattle contract used to obtain the appropriate price corresponding to both weight categories.

Expected Input Costs

Feed and borrowing costs are expected to represent the major costs

Table 4. The Appropriate Led Live Beef Cattle Futures Contract for 500-600 and 700-800 Pound Feeder Cattle.[a/]

Date	FPS4	FPS8
JAN	JUN	OCT
FEB	JUN	OCT
MAR	AUG	DEC
APR	AUG	DEC
MAY	OCT	FEB
JUN	OCT	FEB
JUL	DEC	APR
AUG	DEC	APR
SEP	FEB	JUN
OCT	FEB	JUN
NOV	APR	AUG
DEC	APR	AUG

a/ The appropriate leads of eight months, FPS8, and four months, FPS4, which relate to 500-600 and 700-800 pound feeder cattle, respectively, correspond to calculations presented in Table 1.

of feedlots. Proxy variables expected to represent these costs are explained in detail below. Other costs such as labor and feed supplements are not included due to the difficulty in obtaining data to represent these costs.

Feed Costs

A major input for feedlot operations is feed costs. Although feedlots do not necessarily use corn in their feed rations, the price of corn is expected to be representative of feed costs because the price of corn is highly correlated with other feed costs.

Referring again to Leuthold's results, both the cash and futures prices of corn are expected to be appropriate proxy variables for expected corn prices [12]. Depending on the assumption made about feedlots' purchasing behavior of feed, either the cash or futures price may be appropriate proxies. If feedlots are expected to purchase all of the feed inputs when the feeder cattle are purchased, then either the current cash price, CPC, or the nearby futures price, NFPC, of corn is expected to represent feed costs.

However, if the feedlot is expected to purchase feed over the feeding period, an average of the expected corn prices which correspond to the cash purchase timing of feed inputs should represent feed costs. In this research, the feedlot is assumed to purchase feed inputs at two-month intervals beginning when the feeder cattle are purchased. The futures prices of the nearest corn contract corresponding to two, four, and six months in the future, FPC2, FPC4, FPC6 respectively, are used to represent expected corn prices while the price of the nearby futures corn contract is used to represent current purchase of feed. For 500-600 pound feeder cattle, an average of the alternate corn contract prices led out six months, FAV8, is used to represent feed costs since eight months is the feeding requirement for these feeders. The calculation of this average is:

$$FAV8 = \frac{NFPC + FPC2 + FPC4 + FPC6}{4} \quad (8)$$

Similarly, for 700-800 pound feeder cattle, an average of the alternate corn contract prices led out two months, PAV4, is used as a proxy of feed costs. The calculation of this average is:

$$FAV4 = \frac{NFPC + FPC2}{2} \quad (9)$$

Table 5 presents the particular corn contract months used to obtain the appropriate prices corresponding to the feed purchasing behavior of feedlots. If feedlots are expected to purchase all feed inputs when the feeder cattle are purchased, either the current or nearby futures price of corn will be used to represent feed costs. However, if feedlots are expected to purchase feed inputs over the feeding period, an average of alternate corn contract prices will be used to represent expected feed costs.

Borrowing Costs

The cost of borrowing money to purchase the feeder cattle is also a major cost of feedlot operations. This borrowing cost is determined by the amount borrowed, the interest rate, and the length of time the loan is outstanding. Although the interest rate is constant over the weight categories of feeder cattle, its affect on the borrowing cost for each weight category will be influenced by the feeding period re-

Table 5. The Appropriate Led Corn Futures Contract for 500-600 and 700-800 Pound Feeder Cattle.

Date	NFPC[a]	FPC2	FPC4	FPC6
JAN	MAR	MAR	MAY	JUL
FEB	MAR	MAY	JUL	SEP
MAR	-MAR	MAY	JUL	SEP
APR	MAY	JUL	SEP	DEC
MAY	-MAY	JUL	SEP	DEC
JUN	JUL	SEP	DEC	DEC
JUL	-JUL	SEP	DEC	MAR
AUG	SEP	DEC	DEC	MAR
SEP	-SEP	DEC	MAR	MAR
OCT	DEC	DEC	MAR	MAY
NOV	DEC	MAR	MAR	MAY
DEC	-DEC	MAR	MAY	JUL

[a] The dashes signify that the nearby contract ends in the middle of the corresponding month; the remainder of the month uses the following contract.

quirement. That is, as the interest rate changes its affect on the borrowing costs of one weight category versus another, the borrowing costs will vary for each weight category due to the time requirement involved. Therefore, the longer the feeding period (the lighter the feeder calf), the higher the borrowing costs. The interest rate will be used as a proxy for borrowing costs.

The prime interest rate charged by the largest[2/] bank in Oregon is used in this research to represent borrowing costs. Although this bank is not necessarily the largest in the Pacific Northwest, it is expected to represent the Pacific Northwest for three reasons. These reasons are:

1. the bank was ranked the largest in Oregon for the majority of the time period analyzed in this research,

2. the bank was ranked number 38, in 1979, in a national ranking, and

3. the interest rate of the banks on the West Coast are identical except for a one or two day lag period among the banks as they change the interest rate to correspond to the rate set on the East Coast.

Also, the prime interest rate is chosen because it is expected to come the closest to representing the interest rate which feedlots would have to pay to borrow money.

[2/] The term largest refers to the amount of assets and money deposited in the banks. The largest bank in Oregon based on this analtsis is the First National Bank of Oregon.

Past Events

A trend variable incorporating lagged values of basis is used as a proxy to incorporate past events into the model. There is no a-priori idea on the past time interval which traders are basing a trend on; therefore, several combinations of lagged values were used. A trend variable using a trend of the basis values over the past two time periods is chosen as the best indicator of past events on current basis. The calculations of the lag-trend variables for 500-600 and 700-800 pound feeder cattle, respectively, are:

$$LAG5 = BASIS5_{t-1} + (BASIS5_{t-1} - BASIS5_{t-2}) \quad (10)$$

and

$$LAG7 = BASIS7_{t-1} + (BASIS7_{t-1} - BASIS7_{t-2}) \quad (11)$$

where:

LAG5 = the lag-trend variable for 500-600 pound feeder cattle

LAG7 = the lag-trend variable for 700-800 pound feeder cattle

BASIS5 = the nearby basis of 500-600 pound feeder cattle

BASIS7 = the nearby basis of 700-800 pound feeder cattle

t-1 = a one-period lag

t-2 = a two-period lag.

Since basis is composed of both futures and cash prices, these trend variables are expected to represent the period of past prices which traders in both markets are analyzing to determine current prices. Speculators in the futures market analyze various types of moving averages (technical indicators) to determine the trend of futures prices, whereas producers in the cash market analyze past cash prices to determine the current cash price and maybe expected profits. This composite trend variable of basis is an attempt to incorporate the analysis of past events into the model.

The proxy variables expected to represent expected slaughter prices, input costs, and past events for the two basis models are, respectively:

a. the live beef cattle futures price of the contract month corresponding to the marketing period of the fed cattle for slaughter (FPS8 and FPS4),

b. the nearby corn futures price representing feed costs (NFPC) and the current interest rate representing borrowing costs (I), and

c. a lag-trend variable corresponding to the past two time periods (LAG5 and LAG7).

These proxies will be used in a following section in which the actual basis models are developed.

Dependent Variable

As discussed in the hedging theory section of Chapter III, knowledge of the closing basis is an important basis value for feeder cattle producers in terms of hedging. The closing basis corresponds to the time period in which the contract is maturing and the commodity is deliverable. The nearby basis is chosen to represent the closing basis in this research because it is identical to the closing basis during the contract maturing month. This basis also possesses a continuous time pattern, whereas if the closing basis is used, the data will be discontinuous, jumping from one maturing contract month to another.

However, in using the nearby basis, the basis values will be jumping from one nearby contract to another over time. Dummy variables are included in the basis models to represent each nearby futures contract for feeder cattle. These dummy variables are denoted MAR, APR, MAY, AUG, SEP, and OCT to represent the contracts presented in Table 3.[3/]

Model Development

As stated earlier in the introduction, the basis of feeder cattle is expected to be a function of the factors influencing the feedlot's profit function and technical indicators. The expected slaughter price, corn price, interest rate, and lag-trend variables corresponding to the basis of the light and heavy weight feeder cattle are presented in the previous section. Combining these proxy variables and dummy variables, the following weight category basis models are specified as:

$$\text{BASIS5} = f(\text{FPS8, NFPC, I, LAG5, MAR, APR, MAY, AUG, SEP, OCT}) \qquad (12)$$

and

$$\text{BASIS7} = f(\text{FPS4, NFPC, I, LAG7, MAR, APR, MAY, AUG, SEP, OCT}) \qquad (13)$$

where the notation of these variables is as previously defined.

Two methods of identifying, a-priori, the effects of these variables

3/ The January contract is not included in this research because it did not begin trading until 1978.

on basis are established in attempting to specify the models. A discussion of these two methods is presented in the following section.

Factors' Effect on Basis

As discussed earlier, the demand side of the feeder cattle market is emphasized in this research. Since the use of the feedlot's profit function in explaining the cash price is well established by previous research [2, 3], the factors of the feedlot's profit function, or profit factors, are expected to explain a large proportion of the variation in the cash price of the basis models. These profit factors are also expected to explain a portion of the futures price; however, empirical support of this hypothesis is almost non-existent. For now, the effect of the profit factors on the futures price is assumed to be minimal.

Therefore, the influence of the profit factors on the basis is basically through the cash price rather than the futures price. Through the influence of the profit factors on the cash price, the effect of these factors on basis can be hypothesized if the movement of the futures price is known. Two assumptions are presented on the movement of the feeder cattle futures price. These assumptions are:

1. the futures price of feeder cattle follows the cash price of feeder cattle corresponding to the weight category in highest demand, and

2. the futures price of feeder cattle is constant over all weight categories of feeder cattle at a particular time period.

A detailed discussion of the assumptions and the hypothesized effects of the variables on basis are presented in the following sections.

Responsive Futures Price

Carpenter [4], in studying the feasibility of establishing a futures delivery point for feeder cattle in the Pacific Northwest, identified the relationship between delivery incentive and feeder cattle weight categories. An analysis of each nearby delivery period is made to determine the relationship between the incentive to deliver and the weight categories of feeder cattle. This incentive to deliver is based on the idea that as the basis widens, the difference between the futures and cash price increases, which makes delivery more plausible and profitable given the futures price is greater than the cash price by the amount of delivery costs.

During the period of high corn prices, August 1974 - December 1976, the incentive to deliver 700-800 pound feeder cattle changed to an incentive to deliver 500-600 pound feeder cattle. The high corn prices prompted feedlots to demand heavy weight feeder cattle relative to light weight cattle. This relationship implies that the basis for 500-600 pound feeder cattle was wide enough to justify delivery, whereas the basis for 700-800 pound feeder cattle was narrow so that delivery was not profitable. In periods of relatively low corn prices, the incentives were just the opposite. After analyzing the incentive to deliver various weight categories, Carpenter concluded that the feeder cattle futures price follows the price movements of the feeder cattle weight category in highest demand. This response of the futures price is related to the widening and narrowing of basis as mentioned above. If the feeder cattle futures price responds to the cash price of the weight category in highest demand, relationships between factors influencing the cash price of feeders and, therefore, basis can be hypothesized.

The relationship between the nearby basis of light and heavy feeder cattle and corn prices presented above makes intuitive sense when viewed from the feedlot's profit function. Feedlots are flexible in their ability to feed either light or heavy calves to slaughter weight. Through adjusting the purchase weight of the feeder calf, the feedlot operator can control, in part, the impact of a change in market prices. Expected output and input prices are important market prices in considering the weight of feeder cattle to purchase.

When input costs are high, feedlot operators will prefer feeding heavier feeder cattle because of the time requirement involved. Heavy feeder cattle require less feed, labor, interest, etc., to reach slaughter weight and, therefore, less input costs. From the profit function, with increasing corn prices, the feeder cattle prices will decrease due to a decrease in demand, given all else constant. Although prices are being bid down, feedlots will prefer heavy wieght feeders to light weight feeders. The cash price corresponding to heavy feeders will decrease less rapidly than the cash price corresponding to light feeders. Therefore, a relative "premium" price exists for the weight category in highest demand. The term "premium" refers to the relative price increase of one weight category to another due to the relative higher demand for that weight category.

An analysis of nearby basis values of feeder cattle over the time period January 1972 - May 1979 presents the following:

1. the nearby basis for 700-800 pound feeder cattle is almost always positive, and

2. the nearby basis for 500-600 pound feeder cattle deviates from being positive and negative; however, the value is usually negative.

Analyzing Carpenter's conclusion closer, relationships among cash prices, futures prices, and corn prices develop. Generally, 500-600 pound PNW feeder cattle prices are greater than 700-800 pound feeder prices. When corn prices are low, the spread between the light and heavy weight feeder cattle prices is relatively wide. Holding all else constant in the profit function, with decreasing corn prices, feeder cattle prices will increase. However, 500-600 pound prices will increase more rapidly than 700-800 pound prices producing a wide spread. Due to a stronger demand for light feeders, the futures price tends to favor the light weight feeder price. This relationship implies a narrower basis for the light feeders when corn prices are low, whether or not the light weight basis is positive or negative in value. In an analysis of the data, these relationships are found to exist.

The opposite holds true for high corn prices. Feeder prices for 700-800 pound cattle decrease less rapidly than 500-600 pound prices due to increasing corn prices, producing a narrow spread between prices. The futures price tends to favor the premium market of 700-800 pound feeders; therefore, a narrower basis exists for heavy weight feeders when corn prices are high. However, when corn prices are extremely high, the price relationship between light and heavy feeders reverses and the futures price tends to overestimate cash price. That is, 700-800 pound feeder prices are greater than 500-600 pound feeders and decrease less rapidly creating a wide cash price spread. Even though the price relationship reversed, the basis for heavy feeder cattle remains relatively narrow than the basis for light feeder cattle because the futures price tends to favor this premium market.

Given the assumption of a responsive futures price which follows the cash price corresponding to the weight category in highest demand, the previous relationships are graphically summarized in Figures 2, 3, and 4. In the situation in which 500-600 pound prices are greater than 700-800 pound prices and the basis values are negative and positive, respectively, the futures price must lie between the cash prices. When corn prices are decreasing, the cash spread will widen and the futures price will approach the 500-600 pound price. Therefore, a narrow and wide basis develop for 500-600 and 700-800 pound feeders, respectively. Figure 2 presents this relationship. However, for increasing corn prices, the cash spread will narrow and the futures price will approach the 700-800 pound price. This relationship creates a narrow basis for 700-800 pound feeders and a wide basis for 500-600 pound feeders. If the value for both the 500-600 and 700-800 pound bases is positive, the futures price will approach and lie above the 500-600 pound price. The basis of 500-600 pound feeders narrows given a decreasing corn price; however, the movement of the 700-800 pound basis depends on the relative slope of the futures and 700-800 pound prices. Figure 3 presents this relationship.

For extremely high corn prices, the 700-800 pound feeder cattle price is greater than the 500-600 pound price and a positive basis exists for both weight categories. The relationship implies that the futures price lies above the 700-800 pound price. For increasing corn prices,

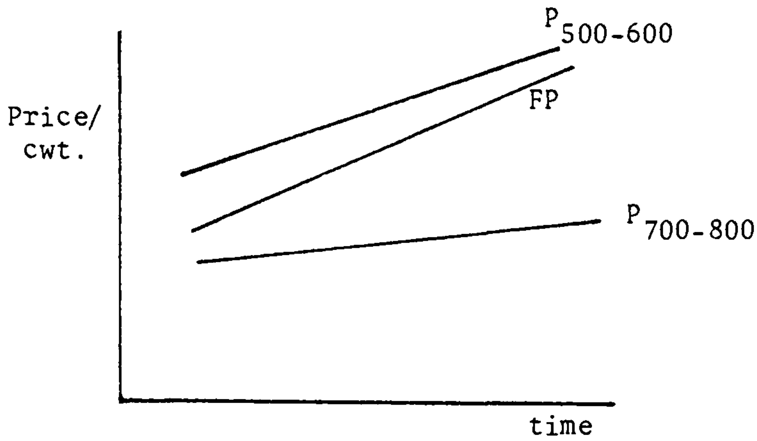

Figure 2. Price Relationships Corresponding to Decreasing Corn Prices With Negative and Positive Basis Values for 500-600 and 700-800 Pound Feeder Cattle, Respectively.

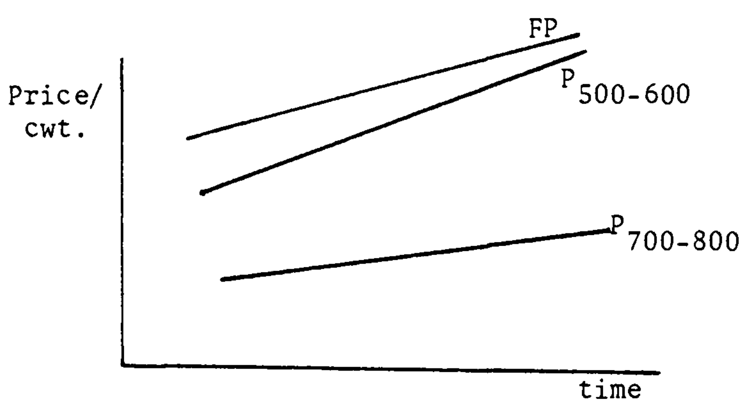

Figure 3. Price Relationships Corresponding to Decreasing Corn Prices With Positive Basis Values for 500-600 and 700-800 Pound Feeder Cattle.

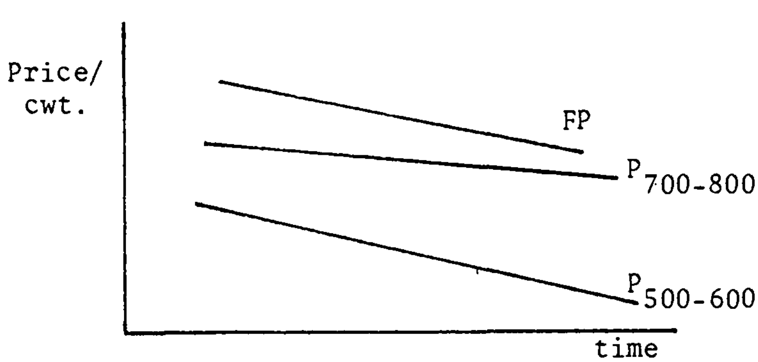

Figure 4. Price Relationships Corresponding to Increasing Relatively High Corn Prices With Positive Basis Values for 500-600 and 700-800 Pound Feeder Cattle.

the cash spread will widen and the futures price will approach the 700-800 pound price. Therefore, the 700-800 pound basis will narrow while the movement of the 500-600 pound basis depends on the relative slope of the futures and 500-600 pound prices. Figure 4 presents this relationship.

After an analysis of these price relationships, the price of corn is expected to have a positive influence on the 500-600 pound nearby basis and a negative influence on the 700-800 pound nearby basis.

The cost of borrowing money to purchase the feeder cattle and feed is another input cost expected to influence the price of feeder cattle. For one interest rate, borrowing costs are higher for longer loan periods and larger loan amounts. Generally, the price of 500-600 pound feeders is greater than the price of 700-800 pound feeders and the feeding period is longer; therefore, borrowing costs should be larger for 500-600 pound feeders. Since interest rates and corn prices are both costs to the feedlot, their effects on basis will be the same; that is, the same effect in direction but not necessarily in magnitude. The effect of interest rates on basis is hypothesized to be positive.

An example is presented to reinforce the price relationships. Holding all else constant, increasing interest rates will decrease feeder cattle prices. Heavy feeder prices will tend to decrease less rapidly than light feeder prices, narrowing the price spread. The futures price will follow the price movements of the heavier feeders because a premium price exists for these feeders. Therefore, with increasing interest rates, feedlots will prefer feeding heavy feeders and a negative (positive) influence will exist between interest rates and the basis of heavy (light) feeders. The opposite is expected to hold for decreasing interest rates.

Output prices are also expected to influence the cash price of feeder cattle through the profit function and, therefore, the basis. The effect of output prices on basis is not as clear as input prices. Holding all else constant, output prices have a positive effect on feeder prices. Different expected slaughter prices exist for each weight category due to the different feeding period requirements; therefore, the relative influence of these slaughter prices on their respective feeder cattle prices is indeterminate. The relationships between expected slaughter price and basis movements of 500-600 and 700-800 pound feeder cattle are, therefore, not hypothesized.

The following effects are based on the assumption that the feeder cattle futures price follows the cash price corresponding to the weight category in highest demand. The expected effect of these profit factors on the 500-600 pound basis model are:

1. the effect of corn price is expected to be positive,
2. the effect of interest rates is expected to be positive, and
3. the effect of expected slaughter price is unknown.

The expected effects of the respective factors on the 700-800 pound basis are:

1. the effect of corn price is expected to be negative,
2. the effect of interest rates is expected to be negative, and
3. the effect of expected slaughter price is unknown.

The following section discusses the effects of the profit factors based on the second assumption made about futures price movements.

Constant Futures Price

At a given time period, the futures price is constant over all weight category cash prices. That is, several feeder cattle cash prices will exist while only one feeder cattle futures price exists. Of course, over time this futures price will change and so will the cash prices. In this analysis, the futures price is assumed to be relatively constant over time, with the cash prices narrowing toward or widening away from the futures price.

The same effects of input and output prices on the cash prices of the different weight categories exist in this analysis as in the previous analysis; however, their effects on basis will differ due to the assumption made. The relationships and values of the data base explained in the previous section also remain unchanged.

Given the futures price is relatively constant, the movement of the feeder cattle cash prices will determine the movement of the respective basis values. The effect on the basis values of the factors influencing the cash prices can, therefore, be determined.

For a positive basis, the futures price will be greater than the cash price. The narrowing or widening of the basis for light or heavy feeders will depend on the relative price movements of the cash prices. The cash price which is at a premium will approach the futures price, therefore narrowing the respective basis. For a negative basis, however, the cash price will be greater than the futures price. The premium cash price will widen away from the futures price, therefore, widening the respective basis in absolute terms. Table 6 identifies these relationships. The relationships presented in this table are in absolute value terms. The effect of a factor expected to explain basis can be easily obtained by referring to this table.

With increasing corn prices, feeder cattle prices will decrease. Feedlots will prefer the heavier feeders; therefore, a premium price will exist for 700-800 pound feeder cattle. For the premium weight category, the basis will narrow for a positive basis and widen for a negative basis. Since the basis value, for the time period analyzed, of 700-800 pound feeder cattle is almost always positive, an increasing corn price is hypothesized to narrow the basis.

With decreasing corn prices, feedlots will prefer the lighter weight feeders and a premium price for these feeders will exist with increasing feeder prices. The basis for light weight feeders will widen for a negative basis and narrow for a positive basis. Assuming the basis value for 500-600 pound feeder cattle is negative over time, a decreasing corn price is hypothesized to widen the basis.

As explained in the previous section, the interest rate is also a cost of feedlots. This factor will, therefore, have the same effects as corn prices on the cash prices and, therefore, the basis of light and heavy weight feeder cattle.

Output prices have a positive influence on feeder cattle prices. Given the relationships in Table 6, for a positive (negative) basis, a premium cash price will narrow (widen) the basis. However, the relative influence of expected slaughter prices on their respective cash prices is indeterminate. The direction and magnitude of the price movements of the expected slaughter prices will differ due to the feeding period

Table 6. Relationships Between the Feeder Cattle Cash Price and Basis for Positive and Negative Valued Bases.

Basis Value	Significance of Cash Price	Effect on Basis
Positive B = FPF - CPF	premium discount	narrowing widening
Negative -B = CPF - FPF	premium discount	widening narrowing

of the feeder cattle. Therefore, as in the previous method, the relationship between expected slaughter prices and the basis movements are not hypothesized.

The following hypotheses are based on the assumption that the feeder cattle futures price remains relatively constant over time. The expected effects of the respective factors on the 500-600 pound basis, as based on a negative value, are:

1. the effect of corn price is expected to be negative,
2. the effect of interest rate is expected to be negative, and
3. the effect of expected slaughter price is unknown.

The expected effects of the respective factors on the 700-800 pound basis, as based on a positive value, are:

1. the effect of corn price is expected to be negative,
2. the effect of interest rate is expected to be negative, and
3. the effect of expected slaughter price is unknown.

Past values of the basis also are expected to influence the present value of basis through the influence of past futures and cash price values on current values of the futures and cash prices. When bidding prices, participants in both markets are expected to take into consideration past values of the respective prices in their market. If the price is trending upward, the current price is expected to be higher than last period's price and vica verse. This increasing and/or decreasing trend of futures and cash prices will have a widening or narrowing effect on basis. If the trends are consistent over the past time period under consideration, past basis values are expected to have a positive influence on the current basis value, whether or not the basis is consistently positive or negative in value. That is, a narrowing trend of basis, whether positive or negative, is expected to decrease the current basis in absolute terms and vica versa. This relationship is expected to exist for light and heavy weight basis values.

Table 7 summarizes the hypothesized effects of the factors expected to influence basis. Method I refers to the assumption that the futures price follows the cash price corresponding to the category in highest demand, whereas Method II refers to the assumption that the futures price is relatively constant over time. The hypothesized effects on both methods are identical for the basis of 700-800 pound feeder cattle. However, the hypothesized effects are different for the 500-600 pound basis. This relationship may be due to the fact that for Method II these effects were based on a negative valued basis over time when, in fact, the 500-600 pound basis is not always negative.

The actual hypothesized basis models are presented in the following section. Both methods are presented.

Specification of Model

The previous sections have discussed the factors hypothesized to influence the basis of feeder cattle, the expected effects of the hypothesized factors, and the proxy variables expected to represent the influencing factors. In this section, the actual basis models for 500-

Table 7. The Influence of Factors Expected to Explain Basis Variation for 500-600 and 700-800 Pound Feeder Cattle.

Influencing Factor	500-600 Basis		700-800 Basis	
	Method I	Method II[a/]	Method I	Method II[b/]
Corn Price	+	-	-	-
Interest Rate	+	-	-	-
Slaughter Price	?	?	?	?
Past Events	+	+	+	+

a/ This method is based on a negative valued basis.

b/ This method is based on a positive valued basis.

600 and 700-800 pound feeder cattle are specified incorporating this information.

The nearby basis for 500-600 and 700-800 pound feeder cattle, denoted BASIS5 and BASIS7, are hypothesized to be a function of expected output prices, expected input costs, and past events, Proxy variables assumed to represent these factors, as presented previously, are as follows. For the 500-600 pound basis:

1. the futures price of the live beef cattle contract corresponding to eight months in the future, FPS8, is a proxy for expected output price,

2. the nearby futures price of corn, NFPC, is a proxy for expected feed costs assuming the feedlot purchases all feed required when the feeder cattle are purchased,

3. the current interest rate, I, is a proxy for borrowing costs, and

4. the lagged trend variable, LAG5, is a proxy for the incorporation of past events (or prices).

For the 700-800 pound basis:

1. the futures price of the live beef cattle contract corresponding to four months in the futures, FPS4, is a proxy for expected output price,

2. the nearby futures price of corn, NFPC, is a proxy for expected feed costs assuming the feedlot pur-

chases all feed required when the feeder cattle are purchased,

3. the current interest rate, I, is a proxy for borrowing costs, and

4. the lagged trend variable, LAG7, is a proxy for the incorporation of past events (or prices).

The two basis models are expected to be linear in form. The reason for this hypothesis is that the calculations of the basis from definition are all linear in form. Therefore, given the proxy variables expected to represent the actual factors and the factors' hypothesized effects, the basis models for both methods and weight categories are as follows. Different hypothesized effects of the factors exist for the basis of 500-600 pound feeder cattle depending on the method used. The following hypothesized models represent the expected effects of Method I (responsive futures price) and Method II (constant futures price) respectively:

$$BASIS5_i = b0 + b1FPS8_i + b2NFPC_i + b3I_i + b4LAG5_i + b5MAR_i + b6APR_i + b7MAY_i + b8AUG_i + b9SEP_i + b10OCT_i + U_i \quad (14)$$

and

$$BASIS5_i = b0 + b1FPS8_i - b2NFPC_i - b3I_i + b4LAG5_i + b5MAR_i + b6APR_i + b7MAY_i + b8AUG_i + b9SEP_i + b10OCT_i + U_i \quad (15)$$

where:

$BASIS5_i$ = nearby basis (FPF_i - $CPF5_i$) for 500-600 pound feeder cattle during a particular week i. FPF_i is the Thursday closing price for the nearby feeder futures contract of week i quoted on the Chicago Merchantile Exchange. $CPF5_i$ is the average weekly prices for 500-600 pound feeder cattle sold through direct trading and quoted at Moses Lake, Washington, during week i.

$FPS8_i$ = the Thursday closing price of slaughter cattle of week i corresponding to the nearby live beef cattle futures contract quoted on the Chicago Merchantile Exchange eight months from week i.

$NFPC_i$ = the Thursday closing price of corn of week i for the nearby corn futures contract quoted on the Chicago Board of Trade.

I_i = the prime interest rate of week i charged by the largest bank in Oregon.

$LAG5_i$ = last period's nearby basis plus the difference between the last two periods' nearby basis.

MAR_i = 1 if the nearby feeder futures contract is March in week i; 0 otherwise.

APR_i = 1 if the nearby feeder futures contract is April in week i; 0 otherwise.

MAY_i = 1 if the nearby feeder futures contract is May in week i; 0 otherwise.

AUG_i = 1 if the nearby feeder futures contract is August in week i; 0 otherwise.

SEP_i = 1 if the nearby feeder futures contract is September in week i; 0 otherwise.

OCT_i = 1 if the nearby feeder futures contract is October in week i; 0 otherwise.

U_i = the error term.

The hypothesized basis model for 700-800 pound feeder cattle is identical for both methods; therefore, the model is specified as:

$$BASIS7_i = b0 + b1FPS4_i - b2NFPC_i - b3I_i + b4LAG7_i + b5MAR_i + b6APR_i + b7MAY_i + b8AUG_i + b9SEP_i + b10OCT_i + U_i \quad (16)$$

where:

$BASIS7_i$ = nearby basis ($FPF - CPF7_i$) for 700-800 pound feeder cattle during a particular week i. FPF_i is the Thursday closing price for the nearby feeder futures contract of week i quoted on the Chicago Merchantile Exchange. $CPF7_i$ is the average weekly prices for 700-800 pound feeder cattle sold through direct trading and quoted at Moses Lake, Washington, during week i.

$FPS4_i$ = the Thursday closing price of slaughter cattle of week i corresponding to the nearby live beef futures contract quoted on the Chicago Merchantile Exchange four months from week i.

$LAG7_i$ = last period's nearby basis plus the difference between the last two periods' nearby basis.

and the other variables are defined identically to those in the BASIS5 model.

The following chapter presents the empirical results of these estimated equations and statistically tests their significance.

CHAPTER V

QUANTITATIVE ANALYSIS

In the previous chapter basis models for 500-600 and 700-800 pound feeder cattle are developed through a theory of price relationships among output and inputs to basis. The empirical results of the hypothesized models are presented in this chapter along with an analysis of the significance of the results.

For easy reference, the initial nearby basis models are presented below. From the previous chapter, the functional form of the nearby basis of 700-800 and 500-600 pound feeder cattle are presented for both methods of analysis. The basis model for 700-800 pound feeder cattle is the same for both methods and is specified as:

$$BASIS7_i = b0 + b1FPS4_i - b2NFPC_i - b3I_i + b4LAG7_i + b5MAR_i + b6APR_i + b7MAY_i + b8AUG_i + b9SEP_i + b10OCT_i + U_i \quad (17)$$

The basis model for 500-600 pound feeder cattle is different for both methods and is specified for Method I and Method II, respectively, as:

$$BASIS5_i = b0 + b1FPS8_i + b2NFPC_i + b3I_i + b4LAG5_i + b5MAR_i + b6APR_i + b7MAY_i + b8AUG_i + b9SEP_i + b10OCT_i + U_i \quad (18)$$

and

$$BASIS5_i = b0 + b1FPS8_i - b2NFPC_i - b3I_i + b4LAG5_i + b5MAR_i + b6APR_i + b7MAY_i + b8AUG_i + b9SEP_i + b10OCT_i + U_i \quad (19)$$

Definitions of the variables are presented in the previous chapter.

The data base corresponding to the previous models are weekly observations for the period January 1972 through May 1979. Data for all the futures prices correspond to the prices traded at the Chicago Mercantile Exchange and/or the Chicago Board of Trade are obtained from the Wall Street Journal. The cash price data for the feeder cattle traded at Moses Lake, Washington, are obtained from LS 214 forms of the Federal-State Market News Service.[1/]

Analysis of the Original Models

This section presents an analysis of the original models estimated. The term original models refers to the specified models presented above. The following subsections present an analysis of the variables' significance and the models' appropriateness.

Significance of the Variables

Table 8 presents the empirical results of the initial models estimated. Ordinary least squares is used to estimate the hypothesized models. The estimated regression coefficients and statistical results are summarized in Table 8.

[1/] Most of the collected data corresponding to this research will be placed on a tape for easy reference. Contact Dr. Carl O'Connor of the Department of Agricultural and Resource Economics, Oregon State University, for additional information.

Table 8. Empirical Results of the Full Basis Models for 500-600 and 700-800 Pound Feeder Cattle.[a/][b/]

Dependent Variable	Independent Variables											R^2
	Const	Fed	Corn	Int	Lag	Mar	Apr	May	Aug	Sep	Oct	
		FPS8	NFPC									
BASIS5	-1.83	0.03	1.60	-0.34	0.34	0.30	-0.52	-1.80	-1.07	0.19	-0.60	.519
	(-2.68)	(1.81)**	(7.50)*	(-4.22)*	(12.18)*	(0.77)	(-1.11)	(-3.70)*	(-2.66)*	(0.40)	(-1.23)	
		FPS4	NFPC									
BASIS7	-2.14	0.15	-1.13	0.09	0.37	-0.20	-0.93	-1.38	-1.10	-0.22	-0.28	.697
	(-3.33)	(9.30)*	(-5.59)*	(1.23)	(13.07)*	(-0.55)	(-2.05)**	(-3.00)*	(-2.88)*	(-0.49)	(-0.60)	

a/ Values in parentheses are calculated t-statistics.

b/ The significance tests of the variables Mar, Apr, May, Aug, Sep, and Oct are based on a two-tailed test, whereas, the significance tests of the variables Fed, Corn, Int, and Lag are based on a one-tailed test.

* Significant at the one percent significance level.

** Significant at the five percent significance level.

Referring to Table 8, the estimated coefficients of the BASIS5 model corresponding to the March, April, September, and October feeder cattle contract dummy variables are not significantly different from zero at the 90 percent confidence level. The estimated coefficients corresponding to the March, September, and October feeder cattle contract dummy variables of the BASIS7 model are not significantly different from zero at the 90 percent confidence level. The interest rate parameter is also not significantly different at this confidence level for the BASIS7 model. These insignificant variables are dropped from their respective equation except for the interest rate variable. The interest rate variable is not omitted because it is expected to be a viable explanatory factor of the feeder cattle cash price and basis, expecially in years of highly fluctuating rates as in 1980.

The two models are estimated again, retaining the significant variables. The results of these models are presented in Table 9. The variables in each model appear to be significantly different from zero at first glance; however, a more in-depth analysis of each model will be discussed below.

An analysis of the BASIS7 model will be discussed first. Referring back to Chapter IV, the nearby futures corn price and lag-trend indicator are expected to have a negative and positive influence on basis, respectively. Statistically testing the significance of NFPC and LAG7 at a 99 percent confidence level results in the null hypotheses being rejected implying that:

1. the nearby futures corn price is significantly less than zero, and

Table 9. Empirical Results of the Reduced Basis Models for 500-600 and 700-800 Pound Feeder Cattle.[a/][b/]

Dependent Variable	Independent Variables											R^2
	Const	Fed	Corn	Int	Lag	Mar	Apr	May	Aug	Sep	Oct	
		FPS8	NFPC									
BASIS5	-1.74	0.03	1.59	-0.33	0.35			-1.78	-1.07			.507
	(-2.85)	(1.67)**	(7.36)*	(-4.11)*	(12.64)*			(-4.97)*	(-4.50)*			
		FPS4	NFPC									
BASIS7	-2.32	0.15	-1.14	0.10	0.37		-0.74	-1.19	-0.91			.697
	(-4.04)	(9.39)*	(-5.62)*	(1.26)	(13.11)*		(-2.26)**	(-3.53)*	(-4.00)*			

a/ Values in parentheses are calculated t-statistics

b/ The significance tests of the variables Mar, Apr, May, Aug, Sep, and Oct are based on a two-tailed test, whereas, the significance tests of the variables Fed, Corn, Int, and Lag are based on a one-tailed test.

* Significant at the one percent significance level.

** Significant at the five percent significance level.

2. the lag-trend indicator is significantly greater than zero.

Therefore, the influences of NFPC and LAG7 are as hypothesized.

The effect of the interest rate on the basis is hypothesized to be negative in both methods; however, the sign corresponding to this variable is positive. This may be due to the insignificance of this parameter and the influence of multicollinearity found to exist in the model.

The effect of the led futures slaughter price on basis is not hypothesized in the previous chapter. However, the parameter corresponding to FPS4 is significantly greater than zero at the 99 percent confidence level. The influence of this factor on basis is, therefore, significantly positive.

Of the dummy variables representing the change of the nearby futures feeder cattle contract over time, the April, May, and August dummies remain in the model at confidence levels of 95, 99, and 99 per cent, respectively. The significance of these particular variables is thought to represent the seasonality of feeder cattle trading in the cash market.

The analysis of the BASIS5 model is not as clear as the one on the BASIS7 model. In attempting to specify the hypothesized effects of the profit factors, the effects are hypothesized differently depending on the assumptions of the feeder cattle futures price movements. The value of BASIS5 is slightly more negative than positive over the time period analyzed; therefore, the hypothesized signs of the profit variables are based on a negative basis in using Method II (constant futures price) as presented in Chapter IV. These hypothesized signs are opposite of those hypothesized using Method I (responsive futures price). However, if the hypothesized signs of the profit variables are based on a positive basis in using Method II, these signs would be identical to those of Method I.

All of the parameters corresponding to the factors expected to influence basis are either significantly less than or greater than zero at the 99 percent confidence level, except for the parameter corresponding to FPS8. Statistically testing the significance of NFPC, I, and LAG5 at the 99 percent confidence level and FPS8 at the 95 percent confidence level results in the null hpohteses being rejected, implying that:

1. the futures slaughter price corresponding to eight months in the future is significantly greater than zero,

2. the nearby futures corn price is significantly greater than zero,

3. the interest rate is significantly less than zero, and

4. the lag-trend indicator is significantly greater than zero.

The signs of the profit factors in the empirical results have the correct hypothesized signs depending on the method used in the analysis. The nearby corn futures price variable has the sign hypothesized in Method I; whereas the interest rate variable has the sign hypothesized in Method II. The positive sign on NFPC may be picking up the correlation between the corn price and the positive basis values of 500-600 pound feeders. If this relationship exists, Method II should be based on a positive basis. If Method II is based on a positive basis, both Method I and II will hypothesize a positive influence between the interest rate and basis; however, the empirical sign of the interest rate parameter is negative.

As in the BASIS7 model, the effect of the led futures slaughter price on BASIS5 is not hypothesized; however, its parameter is significantly greater than zero. This relationship implies that the futures price of slaughter cattle has a positive influence on BASIS5.

The lag-trend indicator is hypothesized to have a positive influence on basis in the previous chapter. The parameter corresponding to this variable is significantly greater than zero at the 99 percent confidence level; therefore, its effect on BASIS5 is as hypothesized.

The significant dummy variables remaining correspond to the May and August feeder cattle futures contract. As in the BASIS7 model, these dummy variables are thought to represent the seasonality of feeder cattle trading.

Appropriateness of the Models

The revised estimated models of BASIS5 and BASIS7 are tested to see if the assumptions made when using ordinary least squares are violated. The following conditions are tested:

1. regression relationship
2. serial correlation
3. homoscedasticity
4. multicollinearity

Using the typical F test for linearity, the alternative hypothesis that not all b_k are equal to zero could not be rejected for both models at the 99 percent confidence level. This result implies that a relationship exists between the dependent variable and the respective independent variables for each model.

The Durbin-Watson statistic is typically used to test for autocorrelation; however, this test does not apply to equations in which a lagged dependent variable is incorporated as an independent variable. Both the BASIS5 and BASIS7 models have a lagged dependent variable, LAG5 and LAG7 respectively, incorporated into the model as an independent variable. Therefore, a revised statistic of the Durbin-Watson statistic has been developed by Durbin [9] to take this problem into consideration. Using this revised statistic, the BASIS5 and BASIS7 models are found not to be serial correlated. Since the lagged dependent variable is a calculation of two lagged periods, the validity of the statistic used above is questioned. Therefore, graphs and regressions of residuals against one-period lagged residuals are plotted and estimated to determine if a relationship exists between them. An analysis of the results also implies that serial correlation does not seriously exist in either model. Due to the results of the multiple testing, the BASIS5 and BASIS7 models are concluded not to be serial correlated.

The Goldfeld-Quant test is used to test for heteroscedastic tendencies in both models. The sample of observations in divided into three groups; the middle group is composed of 51 observations, while the outer two groups are composed of 167 observations. Comparing the calculated F statistic with the table value, the null hypothesis that the error terms are homoscedastic cannot be rejected in either model. Therefore, the error terms are assumed to be homoscedastic in both the BASIS5 and BASIS7 models.

In testing for multicollinearity, using the Farrar-Glauber method, tendencies of multicollinearity are found to exist in both models, especially between the profit variables. However, the model is not changed for the following reasons:

1. all of the profit variables are important factors in explaining the cash price and basis of feeder cattle,

2. the R^2 values are not extremely high, and

3. all the variables are significant at a high or reasonable level.

Analysis of Various Model Specifications

Other proxy variables were applied to the regressions in an attempt to better specify for instance the feed purchasing behavior of feedlots and the expectations of future slaughter price. These various proxy variables are discussed below. The estimated equations incorporating these proxies are also presented and analyzed.

The current cash price of corn, CPC, was used in place of the nearby futures price of corn, NFPC, to also represent all the feed being purchased at the current time. However, to represent the feed purchasing behavior of a feedlot who purchases feed in increments, an average of the nearby futures corn prices of two month intervals over the feeding period was used. This average of futures corn prices corresponding to 500-600 and 700-800 pound feeder cattle is represented by FAV5 and FAV7 respectively.

The nearby futures slaughter price of the contract month corresponding to the time period when the fed cattle are expected to be marketed, FPS8 and FPS4, was used to represent expected output prices. The current cash price of slaughter, CPS, was also incorporated into the model to represent expected slaughter price because of Leuthold's [12] findings that the current cash price was a better estimate than futures prices of distant slaughter prices. A trend variable calculated by subtracting the current cash price of slaughter, FPS, from the respective led-out futures price of slaughter, FPS8 or FPS4, was also considered to represent expectations of slaughter prices. The trend variable corresponding to 500-600 pound feeder cattle, FAT8, is calculated as:

$$FAT8 = FPS8 - CPS$$

whereas the trend variable corresponding to 700-800 pound feeder cattle, FAT4, is calculated as:

$$FAT4 = FPS4 - CPS$$

All possible combinations of these independent variables were incorporated into the full model and estimated using ordinary least squares. The full model results using these combinations for both basis models are presented in Appendix A. (Appendix B includes additional statistics, such as the mean and standard deviation of each variable and a correlation matrix of the variables, for further analysis.) Insignificant dummy variables are dropped from the equations while all of the profit variables are retained in the models whether they are significant or not. These revised models are presented in Tables 10 and 11 for the BASIS5 and BASIS7 models, respectively,

In analyzing the results of the BASIS5 models, each combination of proxy variables produces similar results to the original model hypothesized. The coefficients for the corn price, interest rate, lag-trend indicator, and relevant dummy variables have approximately the same signi-

Table 10. Various Combinations of Proxy Variables Corresponding to the Revised 500-600 Pound Feeder Cattle Basis Models.[a/][b/]

Dependent Variable	Independent Variables											
BASIS5	Const	Fed	Corn	Int	Lag	Mar	Apr	May	Aug	Sep	Oct	R^2
		FPS8	NFPC									
Model 1	-1.74 (-2.85)	0.03 (1.67)**	1.59 (7.36)*	-0.33 (-4.11)*	0.35 (12.64)*			-1.78 (-4.97)*	-1.07 (-4.50)*			.507
		FPS8	FAV5									
Model 2	-1.77 (-2.92)	0.02 (1.48)	1.68 (7.66)*	-0.34 (-4.28)*	0.35 (12.51)*			-1.62 (-4.57)*	-0.95 (-4.04)*			.512
		FPS8	CPC									
Model 3	-1.97 (-3.14)	0.02 (1.13)	1.53 (7.37)*	-0.31 (-3.94)*	0.35 (12.60)			-1.76 (-4.91)*	-1.14 (-4.74)*			.507
		CPS	NFPC									
Model 4	-1.48 (-2.38)	0.15 (1.01)	1.57 (7.15)*	-0.29 (-3.75)*	0.35 (12.66)*			-1.80 (-4.90)*	-1.12 (-4.61)*			.505
		CPS	FAV5									
Model 5	-1.62 (-2.61)	0.16 (1.06)	1.68 (7.51)*	-0.32 (-4.07)*	0.35 (12.51)*			-1.65 (-4.56)*	-1.00 (-4.18)*			.511
		CPS	CPC									
Model 6	-1.64 (-2.59)	0.004 (0.30)	1.50 (7.20)*	-0.27 (-3.57)*	0.35 (12.63)*			-1.74 (-4.75)	-1.15 (-4.74)*			.506
		FAT8	NFPC									
Model 7	-0.99 (-2.20)	0.02 (0.94)	1.48 (7.00)*	-0.25 (-4.00)*	0.35 (12.74)*			-1.64 (-4.50)*	-1.02 (-4.11)*			.505
		FAT8	FAV5									
Model 8	-1.13 (-2.48)	0.14 (0.57)	1.60 (7.33)*	-0.27 (-4.31)*	0.35 (12.59)*			-1.53 (-4.23)*	-0.93 (-3.79)*			.510
		FAT8	CPC									
Model 9	-1.45 (-3.02)	0.03 (1.26)	1.48 (7.19)*	-0.26 (-4.21)*	0.35 (12.64)*			-1.62 (-4.47)*	-1.06 (-4.28)*			.508

a/ Values in parentheses are calculated t-statistics.

b/ The significance tests of the variables may and Aug are based on a two-tailed test, whereas the significance of the variables Fed, Corn, Int, and Lag5 variables are based on a one-tailed test.

* Significant at the one percent significance level.

** Significant at the five percent significance level.

Table 11. Various Combinations of Proxy Variables Corresponding to the Revised Feeder Cattle Basis Models.[a/][b/]

Dependent Variable	Independent Variables											
BASIS7	Const	Fed	Corn	Int	Lag7	Mar	Apr	May	Aug	Sep	Oct	R^2
		FPS4	NFPC									
Model 1	-2.32	0.15	-1.14	0.10	0.37		-0.74	-1.19	-0.91			.697
	(-4.04)	(9.39)*	(-5.62)*	(1.26)	(13.11)*		(-2.26)**	(-3.53)*	(-4.00)*			
		FPS4	FAT7									
Model 2	-2.29	0.15	-1.17	0.10	0.37		-0.75	-1.24	-0.95			.698
	(-3.45)	(9.44)*	(-5.73)*	(1.36)	(13.10)*		(-2.31)**	(-3.68)*	(-4.17)*			
		FPS4	CPC									
Model 3	-2.01	0.16	-1.19	0.11	0.37		-0.72	-1.21	-0.87			.702
	(-3.45)	(9.89)*	(-6.20)*	(1.44)	(13.00)*		(-2.24)**	(-3.61)*	(-3.82)*			
		CPS	NFPC									
Model 4	-0.98	0.09	-1.16	0.27	0.44		-0.62	-1.14	-1.08			.651
	(-1.57)	(5.27)*	(-5.33)*	(3.46)*	(15.33)*		(-1.74)	(-3.06)*	(-4.28)*			
		CPS	FAT7									
Model 5	-0.95	0.09	-1.19	0.28	0.44		-0.63	-1.18	-1.12			.652
	(-1.52)	(5.26)*	(-5.36)*	(3.52)*	(15.36)		(-1.77)	(-3.19)*	(-4.43)*			
		CPS	CPC									
Model 6	-0.76	0.95	-1.20	0.28	0.44		-0.63	-1.19	-1.06			.656
	(-1.20)	(5.85)*	(-5.82)*	(3.62)*	(15.20)*		(-1.78)	(-3.21)*	(-4.21)*			
		FAT4	NFPC									
Model 7	1.37	0.12	-1.45	0.49	0.57							.640
	(2.98)	(5.03)*	(-6.62)*	(7.20*	(16.83)*							
		FAT4	FAT7									
Model 8	1.38	0.12	-1.48	0.44	0.47							.643
	(3.01)	(5.15)*	(-6.65)*	(7.24)	(16.88)*							
		FAT4	CPC									
Model 9	1.68	0.11	-1.33	0.48	0.48							.637
	(3.43)	(4.62)*	(-6.31)*	(7.00)*	(17.21)*							

a/ Values in parentheses are calculated t-statistics.

b/ The significance tests of the variables Apr, May, and Aug are based on a two-tailed test, whereas the significance tests of the variables Fed, Corn, Int, and Lag7 are based on a one-tailed test.

* Significant at the one percent significance level.

** Significant at the five percent significance level.

ficance in each model. However, the significance of the expected slaughter price coefficients varies depending on the proxy used. The led futures slaughter price, FPS8, appears to be the appropriate proxy for expected slaughter price as compared to CPS and FAT8 for the BASIS5 model. After analyzing the results of each BASIS5 model, the original model estimated is concluded to be the most appropriate model.

The analysis of the BASIS7 results is more complicated than for the BASIS5 models. The coefficients of the proxy variables of corn price have approximately the same significance for each combination; however, the other variables do not. The interest rate and lag-trend indicator proxies gain significance with the use of CPC and FAT4 as proxies for expected slaughter price. However, the CPC and FAT4 proxies of expected slaughter price are less significant than the FPS4 proxy; yet they are still highly significant. The last obvious comparison is that the dummy variables of the models incorporating FAT4 to represent expected slaughter price drop out of the equations.

No one model of these combinations for the BASIS7 model is particularly better than another unless a specific result is wanted. Since interest rates are expected to influence feeder cash prices and basis and the dummy variables are expected to pick up seasonal trends, the models incorporating the current cash price of slaughter may be the appropriate models to represent the basis of 700-800 pound feeder cattle. However, the original model does explain more of the variation in BASIS7 than the models incorporating CPS.

Although the various models of BASIS5 and BASIS7 cannot be compared since two difference dependent variables exist, a general analysis of the results may prove to be informative. In studying the significance of the profit variables for each model, the following relationships appear to exist. For the original models of BASIS5 and BASIS7, the proxy for expected slaughter prices is more significant than the proxy for corn prices in the BASIS7 model; whereas the opposite holds true in the BASIS5 model. Also the interest rate variable is highly significant in the original BASIS5 model; whereas it is not in the original BASIS7 model. These relationships make intuitive sense from the feedlot's viewpoint. Although the relative movements of expected slaughter and corn prices are important in determining the weight category of feeder cattle to feed and the price of each weight category, the input costs of corn and interest would appear to be more important than output prices to the feedlot operator for light feeder cattle due to the lengthy feeding period; whereas the output price would seem to be more important than the input costs for heavy feeder cattle due to the short feeding period required. The relative significance of profit variables in the BASIS5 and BASIS7 models mentioned above is congruent with the analysis of the feedlot's viewpoint of important factors.

In continuing this analysis on the significance of the profit variables of the various BASIS5 and BASIS7 models, the relationships change slightly. For the BASIS5 model, the proxy variables of input costs still remain highly significant compared to the proxy of output price. However, for the various combinations of the BASIS7 model, the significance of the slaughter and corn price variables are relatively the same and the interest rate variable becomes highly significant. This relationship of the BASIS7 model may be more realistic because, due to the short feeding period, better expectations of output and input costs can be made by the feedlot operator. Therefore, with better price expectations, feedlot operators can more accurately weight the importance of the price information in making decisions.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The previous chapters have presented the institutional framework of the Pacific Northwest cattle industry and commodities exchange market, the theoretical framework of basis and hedging, the method and logic in specifying an econometric model to estimate the basis corresponding to two weight categories, and an analysis of the empirical results of the estimated basis models. This chapter presents a summary of the material presented in the previous chapters and presents the implications of this research on hedging decisions and future research.

Summary

Highly variable feeder cattle prices in the Pacific Northwest directly affect the revenue variability of feeder cattle producers. Hedging in the commodity futures market can, if properly used, reduce financial risk of feeder cattle producers. The fact that a price can be established for the feeder cattle when a hedge is placed, if the closing basis is known, prompted this research project in determining the factors which affect feeder cattle basis.

The composition of the basis for non-storable commodities, such as feeder cattle, is not as easily identified as for storable commodities. For storable commodities, the difference between the current cash price and a future price is well established as the price of storage which, in turn, is related to inventories. However, for non-storable commodities, the form of the commodity changes over time and the commodity is non-storable. Therefore, the analysis used in explaining the basis of storable commodities is not useful in explaining the basis of feeder cattle.

This research is an attempt to identify the factors which influence basis through their influence on the prices which compose the basis--i.e., cash and futures prices. The feeder cattle cash price has been established as a function of the factors affecting the profit of feedlot operations. This relationship has been supported by previous research through the theory of derived demand as applied to agricultural products. Controversy still exists on the factors which influence the futures price of livestock products though. The use of technical indicators by speculators to determine the price they want to bid is well established in the literature; however, with increased technology in computers, speculators may be using complex forecasting models to determine the price to bid.

For the purposes of this research feeder cattle basis is developed as a function of the profit factors and a lag-trend indicator along with dummy variables which indicate feeder cattle futures contracts over time. The profit factors include expected slaughter price, corn price, and interest rate. Of course, expected slaughter price represents the output price expected by the feedlot when the fed cattle are marketed, while corn price and interest rate represents the input costs accrued by the feedlot in fattening the feeder cattle. These profit factors are expected to influence the cash price in this research. The lag-trend indicator is a calculated trend of the basis over the past two time periods and is expected to represent the analysis made by traders, in both the futures and cash markets, of past events or prices. This analysis by traders in the futures market will be similar to their use of technical indicators.

In attempting to specify the model, two methods of analyzing the expected affects of the profit factors on the basis are acknowledged. In this research, the profit factors are assumed to influence only the cash price. Therefore, the effect of the factors on basis is hypothesized by making assumptions about the price movement of the feeder cattle futures price. Two assumptions are made:

1. the futures price follows the PNW cash price corresponding to the weight category in highest demand, and

2. the futures price is relatively constant over all weight category cash prices over time.

These analyses produce various hypotheses about the expected effects of the profit factors on basis depending on the futures price assumption made and the positive or negative value of the basis over time. The effects hypothesized in using the second assumption depend on whether the basis values are positive or negative over time; however, this fact does not apply to the first assumption.

Basis models for both 500-600 and 700-800 pound feeder cattle are developed. The basis for 700-800 pound feeders is almost always positive over the time period analyzed; this information is used in the analysis when futures price is assumed constant. The hypothesized effects are the same using both assumptions for 700-800 pound feeders. The effect of the expected slaughter price is not hypothesized; however, the input costs are hypothesized to have a negative effect on the basis of 700-800 pound feeder cattle.

The analysis of the 500-600 pound feeder cattle basis is more complicated. This basis value is both negative and positive over time; however, it is slightly more negative than positive. Therefore, in using the assumption that the futures price is constant, the analysis is based on a negative valued basis. The hypothesized effects of the profit factors on basis are different in using the two assumption--i.e., futures price constant and responsibe. The effect of the expected slaughter price is also not hypothesized for this model. The input costs are hypothesized to have a negative effect on the 500-600 pound basis when the futures price is assumed constant; however, they are hypothesized to have a positive effect when the futures price is assumed to be responsive to the cash price in highest demand. There is obviously a discrepancy here. However, if the analysis in assuming a constant futures price is based on a positive valued basis, the effects hypothesized are identical to the effects hypothesized when a responsive futures price is assumed.

Conclusions

The empirical results produce evidence that the estimated equations explain a good proportion of the Pacific Northwest basis of feeder cattle for light and heavy weight categories. The corn price variable especially has a significant effect on both basis models. For the basis model of heavy weight feeders, the coefficient of the corn price is negative which is as hypothesized. For the base model of light weight feeders the coefficient of the corn price is positive which is as hypothesized when a responsive futures price is assumed and when a constant futures price is assumed but it based on a positive valued basis.

The empirical results do not support the hypothesized effects of the interest rate variable on its respective basis. The parameter of the interest rate variable is significantly less than zero for the 500-600 pound basis model; however, this parameter associated with the 700-800 pound basis model is not significant at the specified testing level.

The effect of expected slaughter price on basis is not hypothesized since the expected prices differ for each weight category and their relative movements to each other are important in determining the cash price. Although the effects are not hypothesized, the empirical results imply that expected slaughter prices have a positive influence on basis for both weight categories. However, the parameter of the expected slaughter price is much more significant in the BASIS7 model than in the BASIS5 model.

A summary of the empirical results follows for the 500-600 and 700-800 pound feeder cattle basis models, respectively. From an analysis of the empirical results, corn prices have a positive influence, interest rates have a negative influence, and expected slaughter prices have a positive influence on the basis of 500-600 pound feeder cattle. On the other hand, corn prices have a negative influence, interest rates have a positive influence, and expected slaughter prices have a positive influence on the basis of 700-800 pound feeder cattle.

From the hypotheses, empirical results, and price relationships analyzed, corn prices are concluded to have a negative effect on the basis of 700-800 pound feeder cattle. Although less confidence is placed on the relationship between corn prices and the basis of 500-600 pound feeder cattle, corn prices are concluded to have a positive effect on the basis especially if the basis value is expected to be positive.

Implications to Hedging

The information is important to a hedger. If corn prices are expected to increase over the time of the hedge, the basis for 500-600 pound feeders will widen and the basis for 700-800 pound feeders will narrow. In this situation, the 700-800 pound feeder calf producer is in a good position to reduce his price risk. With increasing corn prices, feeder prices will decrease and hedging in the futures market can reduce the downward price risk. Although the specific closing basis value is unknown, knowledge of a narrowing basis is helpful. Given the hedged price formula in Chapter III, the hedged price is basically equal to the sell futures price minus the expected basis. The sell futures price and the current basis are known; therefore, with a narrowing positive basis, the hedged price will increase as the basis narrows during the maturity of the contract and the marketing of the cattle.

A narrowing basis is not necessarily beneficial for the producer of 500-600 pound feeder cattle if a positive basis value exists. A narrowing basis for light feeders implies that the corn price is decreasing which in turn implies that feeder prices are increasing. If the feeder price is expected to increase, hedging will probably not be beneficial because hedging takes the opposite transactions in the futures market; therefore, the hedged price will be less than the cash price received without hedging. This transaction is not in the best interest of the producer who raises light feeder cattle.

Surprisingly, a widening positive basis is beneficial for the producer of 700-800 pound feeder cattle. With a widening of the 700-800 pound basis, corn prices are increasing which yields decreasing feeder prices. Although the hedged price decreases as the basis widens, the hedged price will be greater than the cash price received without hedging.

The above analysis has been on a positive valued basis; however, the 500-600 pound basis is often a negative value. In this situation, either a narrowing or widening basis is beneficial when feeder cattle prices are expected to decrease in value. Although both effects will produce greater realized prices than the cash price, a widening basis will realize a greater price than a narrowing basis. This situation can be seen by analyzing the hedged price formula. That is, subtracting a larger and larger negative basis from the futures price will yield a much greater hedged price. However, if feeder cattle prices are expected to increase given a negative valued basis, the hedged price will be less than the cash price received without hedging.

Although this research does not supply forecasted values of the closing basis, the feeder cattle producer can apply the information about corn prices in making better marketing decisions. Information concerning the price movements of feeder cattle prices, corn prices and, therefore, basis should be analyzed thoroughly before deciding to hedge. The producer's risk aversion and monetary constraints should also be included in analyzing the decision. This section focuses on the implication of this research on hedging decisions. The following section focuses on problems of this research and the implication of this research to future research.

Implications to Future Research

Confidence in the specified models is questioned in this section. Various questions on several aspects of the models have appeared in writing this thesis. The following paragraphs exemplify these questions and their implications on future research.

Due to the inability to hypothesize the effect of slaughter price on the basis values and/or to hypothesize, with consistency, the correct signs of the input cost variables, the appropriateness of the assumptions made about the movement of the futures price of feeder cattle is questioned. These assumptions are:

1. the futures price follows the cash price corresponding to the weight category in highest demand, and

2. the futures price is relatively constant through time and over all the cash weight categories.

First, why should a national market be responding to local market conditions in determining the futures price? And, second, why should the futures price remain relatively constant over time when factors used to determine the price will change? If the model developed in this research is to be of much help in determining the effect of expected slaughter prices and interest rates on basis, the movement of the futures price in relation to the cash price should be researched. This movement could be due to the use of technical indicators or the analysis of expected supply and demand conditions. If the movement is due to supply and demand conditions, which market does it correspond to and what weight category?

The specification of these models is also questioned for the following reasons. First of all, as mentioned earlier, supply factors are not included in this research. Supply factors will, to some extent, have an influence on the price of feeder cattle. Although the R^2 values of the models suggest that the factors explain a good proportion of basis variation, incorporation of supply variables into the model may increase the explanatory power of the models.

Second, although autocorrelation is found not to exist in either basis model, a plot of the residuals of both models over time suggests that a cyclical relationship exists. Therefore, the functional form of the models may be better specified if a sine or cosine functional form is used.

Except for the incorporation of a lag-trend variable expected to represent to some extent the use of technical indicators in the feeder futures market, factors influencing the futures price are ignored. However, if speculators are using complex forecasting models in determining the futures price of feeder cattle, the profit factors in the model may be attempting to explain the variation of both the cash and futures price and, therefore, indirectly the basis value. If this condition is the case, two separate models should be developed--i.e., one model for the futures price and one model for the cash price. After these models are developed and estimated, the reduced model corresponding to both weight categories can be estimated either by:

1. hypothesizing the relative effects of the various factors in each model on the basis, then estimating a reduced model of the basis incorporating all the factors of the cash and futures models and statistically testing the hypothese proposed, or

2. subtract the coefficients of the cash and futures models to obtain a reduced basis model.

A preliminary run of the futures and cash price models are presented in Appendix C. Each model is based on the appropriate profit factors and lag-trend indicator corresponding to the respective price.

Future research into these areas is expected to further support the assumptions and models hypothesized in this research or to develop a more accurate model of basis for light and heavy weight feeder cattle. This information will be useful in developing a forecasting model of feeder cattle basis which can be used to predict a specific closing basis value with some degree of accuracy.

BIBLIOGRAPHY

[1] Allen, R.C. How to Use the 4-Day, 9-Day and 18-Day Moving Averages to Earn Larger Profits from Commodities. Chicago: Best Books, 1974.

[2] Beare, Stephen C. "An Econometric Model of the Effects of Feed Grain Prices in the Feeder Cattle Market and Breeding Inventories." Master's Thesis, Oregon State University, June 1980.

[3] Brokken, Raymond F. "Economics of Grain Roughage Substitution in the Beef Sector," Forage-Fed Beef: Production and Marketing Alternatives in the South. Edited by John A. Stuedeman, Dale L. Huffman, J. C. Purcell, and Odell L. Walter. Bulletin 220, Southern Cooperative Series. Southern Regional Association of State Agricultural Experiment Stations, Raleigh, N.C., June 1977.

[4] Carpenter, John T. "The Feasibility of Establishing a Futures Market Delivery Point for Pacific Northwest Feeder Cattle." Master's Thesis, Oregon State University, June 1980.

[5] Dickens, Michael L. "Pacific Northwest Producers' Utilization of the Fed Cattle Futures Market." Term Paper for Applied Econometrics Oregon State University, Agricultural and Resource Economics, May 1979.

[6] Ehrich, Rollo L. "Cash-Futures Price Relationships for Live Beef Cattle." American Journal of Agricultural Economics 51(1):26-40, February 1969.

[7] Erickson, Steven P. "Selective Hedging Strategies for Cattle Feeders." Illinois Agricultural Economics 18(1):15-20, January 1978.

[8] Gum, Russell and John Wildermuth. "Hedging on the Live Cattle Futures Contract." Agricultural Economics Research 22(4):104-107, October 1970.

[9] Johnston, J. Econometric Methods. 2nd edition. New York: McGraw-Hill Book Company, 1972, pp. 312-313.

[10] Kaufman, P. J. Commodity Trading Systems and Methods. New York: John Wiley & Sons, Inc., 1978.

[11] Leuthold, Raymond M. "An Analysis of the Futures-Cash Price Basis for Live Beef Cattle." North Central Journal of Agricultural Economics 1(1):47-52, January 1979.

[12] ________. "The Price Performance on the Futures Market of a Nonstorable Commodity: Live Beef Cattle." American Journal of Agricultural Economics 56(2):271-279, May 1974.

[13] Massaro, James W. "The Reverse Feeder Spread." Commodities 8(10): 38-39, October 1979.

[14] Maxwell, J. R., Sr. Commodity Futures Trading with Moving Averages. Port Angeles, Washington: Spear Books, 1975.

[15] McCoy, John H. and Robert V. Price. "Cattle Hedging Strategies." Kansas Agricultural Experiment Station Bulletin 591, August 1975.

[16] Miller, Steve and David Kenyon. "Producers' Utilization of the Fed Cattle Futures Market." Blacksburg, Virginia: Virginia Polytechnic Institute and State University, Department of Agricultural Economics Staff Paper SP-77-13, July 1977.

[17] Oster, Merrill J. "Timing Techniques for Hedgers." Commodities 6(8):26-30, August 1977.

[18] Paul, Allen B. and W. T. Wesson. "Pricing Feedlot Services Through Cattle Futures." Agricultural Economics Research 19(2):33-45, April 1967.

[19] Purcell, Wayne D., Terry M. Hague, and David Holland. "Economic Evaluation of Alternative Hedging Strategies." Oklahoma Agricultural Experiment Station Bulletin 702, 1972.

[20] Schimkat, Gregory. "A Basis Model for Hedging Florida Feeder Cattle." Master's Thesis, University of Florida, 1979.

[21] Teweles, Richard J., Charles V. Harlow, and Herbert L. Stone. The Commodity Futures Game--Who Wins? Who Losses? Why? 2nd edition. New YOrk: McGraw-Hill Book Company, 1974.

[22] Tomek, William G. and Kenneth R. Robinson. Agricultural Product Prices. 2nd edition. Ithaca, New York: Cornell University Press, 1972, Chapter 12, pp. 229-250.

[23] Working, Holbrook. "The Theory of Price and Storage." American Economic Review 39(5):1254-1262, December 1949.

APPENDIX A

ESTIMATED FULL MODELS OF THE VARIOUS COMBINATIONS OF PROXY VARIABLES FOR 500-600 AND 700-800 POUND FEEDER CATTLE BASIS MODELS AND ADDITIONAL STATISTICS

Table A-1. Empirical Results of the Full 500-600 Pound Feeder Cattle Basis Models of Various Proxy Variables.[a/b/]

Dependent Variable	Independent Variables											
BASIS5	Const	Fed	Corn	Int	Lag5	Mar	Apr	May	Aug	Sep	Oct	R^2
		FPS8	NFPC									
Model 1	-1.83	0.03	1.60	-0.34	0.34	0.30	-0.52	-1.80	-1.07	0.19	-0.60	.519
	(-2.68)	(1.81)**	(7.50)*	(-4.22)*	(12.18)*	(0.77)	(-1.11)	(-3.70)*	(-2.66)*	(0.40)	(-1.23)	
		FPS8	FAV5									
Model 2	-1.89	0.20	1.69	-0.35	0.34	0.34	-0.41	-1.59	-0.90	0.23	-0.58	.524
	(-2.78)	(1.56)	(7.77)*	(-4.35)*	(12.07)*	(0.88)	(-0.88)	(-3.30)**	(-2.26)**	(0.49)	(-1.21)	
		FPS8	CPC									
Model 3	-2.01	0.20	1.54	-0.32	0.34	0.24	-0.60	-1.82	-1.18	0.93	-0.59	.518
	(-2.89)	(1.27)	(7.47)*	(-4.04)*	(12.16)*	(0.63)	(-1.27)	(-3.74)*	(-2.91)*	(0.19)	(-1.22)	
		CPS	NFPC									
Model 4	-1.63	0.20	1.60	-0.31	0.34	0.29	-0.56	-1.84	-1.13	0.18	-0.59	.517
	(-2.36)	(1.27)	(7.32)*	(-3.89)*	(12.19)*	(0.75)	(-1.16)	(-3.69)*	(-2.75)*	(0.38)	(-1.21)	
		CPS	FAV5									
Model 5	-1.78	0.19	1.71	-0.33	0.33	0.33	-0.46	-1.64	-0.96	0.23	-0.57	.522
	(-2.59)	(1.25)	(7.66)*	(-4.16)*	(12.05)*	(0.86)	(-0.96)	(-3.33)*	(-2.37)**	(0.47)	(-1.19)	
		CPS	CPC									
Model 6	-1.74	0.009	1.52	-0.28	0.34	0.25	-0.58	-1.80	-1.19	0.09	-0.58	.517
	(-2.50)	(0.56)	(7.32)*	(-3.68)*	(12.18)*	(0.55)	(-1.21)	(-3.63)*	(-2.90)*	(0.19)	(-1.19)	
		FAT8	NFPC									
Model 7	-1.11	0.02	1.50	-0.25	0.34	0.36	-0.34	-1.59	-0.96	0.21	-0.59	.515
	(-1.96)	(0.81)	(7.12)*	(-4.02)8	(12.30)*	(0.93)	(-0.72)	(-3.24)*	(-2.32)**	(0.43)	(-1.20)	
		FAT8	FAV5									
Model 8	-1.27	0.01	1.61	-0.27	0.34	0.38	-0.28	-1.44	-0.83	0.24	-0.57	.521
	(-2.25)	(0.48)	(7.44)*	(-4.32)*	(12.16)*	(1.00)	(-0.59)	(-2.96)*	(-2.03)**	(0.50)	(-1.18)	
		FAT*	CPC									
Model 9	-1.51	0.03	1.49	-0.29	0.34	0.30	-0.42	-1.62	-1.05	-0.11	-0.59	.518
	(-2.58)	(1.09)	(7.27)*	(-4.21)*	(12.22)*	(0.78)	(-0.89)	(-3.30)*	(-2.54)**	(0.23)	(-1.20)	

a/ Values in parentheses are calculated t-statistics.

b/ The significance tests of the variables Mar, Apr, May, Aug, Sep, and Oct are based on a two-tailed test, whereas the significance tests of the variables Fed, Corn, Int, and Lag5 are based on a one-tailed test.

* Significant at the one percent significance level.

** Significant at the five percent significance level.

Table A-2. Empirical Results of the Full 700-800 Pound Feeder Cattle Basis Models of Various Proxy Variables.[a/][b/]

Dependent Variable	Independent Variables											
BASIS7	Const	Fed	Corn	Int	Lag7	Mar	Apr	May	Aug	Sep	Oct	R^2
		FPS4	NFPC									
Model 1	-2.14	0.15	-1.13	0.09	0.37	-0.20	-0.93	-1.38	-1.10	-0.22	-0.28	.697
	(-3.33)	(9.30)*	(-5.59)*	(1.23)	(13.07)*	(-0.55)	(-2.05)**	(-3.00)*	(-2.88)*	(-0.49)	(-0.60	
		FPS4	FAV7									
Model 2	-2.10	0.15	-1.17	0.10	0.37	-0.21	-0.95	-1.44	-1.15	-0.25	-0.30	.698
	(-3.27)	(9.35)*	(-5.71)*	(1.33)	(13.06)*	(-0.56)	(-2.10)**	(-3.14)*	(-3.01)*	(-0.53)	(-0.66)	
		FPS4	CPC									
Model 3	-1.86	0.16	-1.19	0.10	0.37	-0.16	-0.88	-1.37	-1.02	-0.14	-0.28	.702
	(-2.88)	(9.76)*	(-6.17)*	(1.41)	(12.95)*	(-0.44)	(-1.96)**	(-3.00)*	(-2.69)*	(-0.31)	(-0.62)	
		CPS	NFPC									
Model 4	-0.89	0.09	-1.17	0.28	0.44	-0.05	-0.71	-1.23	-1.18	-0.24	-0.23	.652
	(-1.27)	(5.17)*	(-5.31)*	(3.47)*	(15.27)	(-0.13)	(-1.45)	(-2.45)*	(-2.82)*	(-0.48)	(-0.46)	
		CPS	FAV7									
Model 5	-0.85	0.09	-1.19	0.28	0.44	-0.05	-0.73	-1.28	-o.22	-0.26	-0.25	.652
	(-1.21)	(5.16)*	(-5.35)*	(3.53)*	(15.30)*	(-0.14)	(-1.49)	(-2.56)*	(-2.93)*	(-0.52)	(-0.51)	
		CPS	CPC									
Model 6	-0.68	0.09	-1.21	0.28	0.44	-0.02	-0.69	-1.25	-1.12	-0.15	-0.23	.657
	(-0.98)	(5.76)*	(-5.80)*	(3.63)*	(15.14)*	(-0.04)	(-1.42)	(-2.50)*	(-2.70)*	(-0.32)	(-0.48)	
		FAT4	NFPC									
Model 7	1.43	0.10	-1.44	0.49	0.46	0.12	0.09	-0.27	-0.42	-0.15	-0.25	.645
	(2.47)	(4.34)*	(-6.56)*	(7.24)*	(16.35)*	(0.31)	(0.18)	(-0.55)	(-1.02)	(-0.29)	(-0.50)	
		FAT4	FAV7									
Model 8	1.49	0.11	-1.48	0.50	0.46	0.12	0.06	-0.34	-0.48	-0.17	-0.28	.646
	(2.56)	(4.42)*	(-6.65)*	(7.33)*	(16.35)*	(0.30)	(0.13)	(-0.69)	(-1.15)	(-0.34)	(-0.56)	
		FAT4	CPC									
Model 9	1.69	0.10	-1.32	0.48	0.47	0.18	0.17	-0.24	-0.34	-0.06	-0.25	.641
	(2.80)	(3.99)*	(-6.24)*	(7.03)*	(16.74)*	(0.45)	(0.35)	(-0.49)	(-0.82)	(-0.13)	(-0.50)	

a/ Values in parentheses are calculated t-statistics.

b/ The significance tests of the variables Mar, Apr, May, Aug, Sep, and Oct are based on a two-tailed test, whereas the significance tests of the variables Fed, Corn, Int, and Lag7 are based on a one-tailed test.

* Significant at the one percent significance level.

** Significant at the five percent significance level.

APPENDIX B

ADDITIONAL STATISTICS RELATING TO EACH AND EVERY VARIABLE USED IN THE BASIS5 AND BASIS7 MODELS

CORRELATION OUTPUT

	MEAN	STANDARD DEVIATION	SUM
BASIS5	.4015	2.6917	153.8
FPS8	45.2644	8.4156	.1734E+05
FAT8	.3028	4.2721	116.0
CPS	44.9616	8.4156	.1722E+05
FPCN	2.4337	.6161	932.1
BPC	2.8475	.6404	1091.
FAV5	2.4365	.6102	933.2
NAT	8.0346	2.0426	3077.
LAG5	.4007	3.8148	153.5

CORRELATION MATRIX

	BASIS5	FPS8	FAT8	CPS	FPCN	BPC	FAV5	NAT	LAG5
COL / ROW	1	2	3	4	5	6	7	8	9
1	1.0000	.0240	.1832	-.0690	.3542	.3527	.3843	.0601	.6340
2	.0240	1.0000	.2538	.8712	.2657	.3131	.2972	.6527	.0136
3	.1832	.2538	1.0000	-.2538	.1712	.1348	.2235	.1682	.1118
4	-.0690	.8712	-.2538	1.0000	.1788	.2447	.1837	.5673	-.0431
5	.3542	.2657	.1712	.1788	1.0000	.9755	.9860	.6086	.2500
6	.3527	.3131	.1348	.2447	.9755	1.0000	.9821	.6166	.2497
7	.3843	.2972	.2235	.1837	.9860	.9821	1.0000	.6259	.2710
8	.0601	.6527	.1682	.5673	.6086	.6166	.6259	1.0000	.0417
9	.6340	.0136	.1118	-.0431	.2500	.2497	.2710	.0417	1.0000

CORRELATION OUTPUT

	MEAN	STANDARD DEVIATION	SUM
BASIS7	3.3399	3.2208	1279.
FPS4	44.9192	8.7221	.1720E+05
FAT4	-.0425	4.5232	-16.26
CPS	44.9616	8.4156	.1722E+05
FPCN	2.4337	.6161	932.1
BPC	2.8475	.6404	1091.
FAV7	2.4324	.6110	931.6
NAT	8.0346	2.0426	3077.
LAG7	3.3562	4.0512	1285.

CORRELATION MATRIX

	BASIS7	FPS4	FAT4	CPS	FPCN	BPC	FAV7	NAT	LAG7
COL / ROW	1	2	3	4	5	6	7	8	9
1	1.0000	.6382	.3420	.4777	-.1391	-.1274	-.1264	.3268	.7495
2	.6392	1.0000	.3259	.6613	.2265	.2702	.2379	.6386	.5164
3	.3420	.3259	1.0000	-.1997	.1041	.0658	.1211	.1760	.2593
4	.4777	.6613	-.1997	1.0000	.1788	.2447	.1815	.5673	.3958
5	-.1391	.2265	.1041	.1785	1.0000	.9755	.9957	.6086	-.1133
6	-.1274	.2702	.0658	.2447	.9755	1.0000	.9843	.6166	-.0986
7	-.1264	.2379	.1211	.1815	.9957	.9843	1.0000	.6194	-.1015
8	.3266	.6386	.1760	.5673	.6086	.6165	.6194	1.0000	.2653
9	.7495	.5164	.2593	.3958	-.1133	-.0986	-.1015	.2653	1.0000

APPENDIX C

SEPARATELY EXIMATED MODELS FOR CASH AND FUTURES PRICES OF 500-600 AND 700-800 POUND FEEDER CATTLE

Table C-1. Empirical Results of Separately Estimated Models of Cash and Futures Prices of 500-600 and 700-800 Pound Feeder Cattle.[a/]

Dependent Variables	Independent Variables											
	Const	Fed	Corn	Int	Lag7	Mar	Apr	May	Aug	Sep	Oct	R^2
		FPS8	NFPC									
CPF5	0.40	0.82	-7.14	0.49	0.47			1.97	1.05			.972
	(0.52)	(18.12)	(-16.46)	(4.77)	(18.25)			(4.28)	(3.51)			
		FPS8	NFPC									
FPF5	-1.14	0.94	-6.56	0.25	0.41			0.61	0.22			.997
	(-1.71)	(22.48)	(-19.00)	(2.84)	(17.17)			(1.56)	(0.84)			
		FPS4	NFPC									
CPF7	2.09	0.58	-3.98	0.18	0.53		0.58	1.09	1.09			.959
	(2.79)	(15.34)	(-11.83)	(1.78)	(20.34)		(1.57)	(2.42)	(3.55)			
		FPS4	NFPC									
FPF7	0.35	0.66	-4.62	0.24	0.55		0.17	0.17	0.42			.968
	(0.45)	(15.63)	(-12.47)	(2.26)	(21.98)		(0.37)	(0.36)	(1.32)			

a/ Values in parentheses are calculated t-statistics.