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An analysis of two equilibrium models relating to live-beef cattle futures market

Michael Fuchs-Carsch

To the Graduate Council:

I am submitting herewith a thesis written by Michael Fuchs-Carsch entitled "An analysis of two equilibrium models relating to live-beef cattle futures market." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

James S. Snell, Major Professor

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Charles Sappington, David W. Brown

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March 5, 1971

To the Graduate Council:

I am submitting herewith a thesis written by Michael Fuchs-Carsch entitled "An Analysis of Two Equilibrium Models Relating to the Live-Beef Cattle Futures Market." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

James S. Smith

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AN ANALYSIS OF TWO EQUILIBRIUM MODELS RELATING TO THE LIVE-BEEF CATTLE FUTURES MARKET

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Michael Fuchs-Carsch

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ABSTRACT

The live-beef cattle futures contract has been traded since November, 1966. As a marketing device for price stabilization, it has received relatively little theoretical attention. Ehrlich postulated that the cash-futures price spread reflects feeding costs. Several equilibrium models exist which explain the simultaneous determination of futures and cash market prices. One such model, developed by Telser, implicitly assumes that the basis must reflect the cost of storage for commodities marketed seasonally.

The overall objective of this study was to determine whether the cash-futures price spreads were reflected by the cost of feeding feeder animals and whether Telser's equilibrium model could be applied in the analysis of the live-beef cattle futures market and feedlot marketings. A secondary objective was to determine whether short hedgers, such as feedlot operators, have benefited from the use of this market as a hedging medium or whether the market was biased in favor of long positions.

It was found that cash-futures price spreads were reflected by feeding costs but that commercial placements were inversely related to net short hedging positions. Also, a consistent bias in favor of routine long positions was evidenced since futures prices consistently under-estimated distant cash prices. Although short hedgers were able to realize the returns they had locked in over and above total feeding costs at the beginning of the hedging operation, unhedged positions yielded higher returns than hedged positions.

It could not be concluded that Telser's equilibrium model applied to the live-beef futures market. Finally, contrary to the implications of Ehrlich's analysis, it could not be determined whether the fact that cash-futures price spreads were reflected by feeding costs was a necessary condition for an equilibrium relationship between the feedlot industry and the live-beef cattle futures market.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The live beef cattle futures market contract, which has been traded since November, 1964, has received little theoretical attention, despite the fact that as an institution, the market serves a distinctive function to both hedgers and speculators in the beef industry. In times when the question of U.S.D.A. farm subsidies is becoming increasingly controversial, the examination of a free market mechanism, such as the futures markets which also provide price stabilizing facilities,[1] is particularly important.

This study is concerned with an examination of the live beef futures market in light of previous research. In particular the work of Ehrlich (5) and Paul and Wesson (12) provided the initial impetus for the study's orientation.

R. L. Ehrlich postulated the following equilibrium relationship between feeder cattle prices and futures market prices of slaughter animals for delivery in Chicago.

$$f_{it} - P_t = (f_{it} - C_n)\ (1 - \frac{W_s}{W_f})\ , \qquad (1)$$

where:

[1]Power (14) recently showed that since the inception of both the live beef and hog contracts cash market prices have shown less variability compared to the period before these commodities were traded on the futures market.

f_{it} = futures market price in dollars per cwt. of the i^{th} contract quoted in period t.

P_t = price of feeder cattle in dollars per cwt. quoted in period t.

C_n = per hundredweight cost in dollars of fattening a feeder over n periods.

W_s = finished weight of slaughter animal (lbs.).

W_f = beginning weight of feeder steer (lbs.).

He assumed that prices of feeder cattle adjust to expected prices of fed animals (i.e., f_{it}) and that the quantity of feeders placed depends primarily on feedlot capacity.

Equation (1) implies that the difference, or spread, between cash and future prices should reflect the cost of feeding. The reason for this is that as f_{it} increases relative to feeder prices and the cost of feeding, the feedlot operator, attempting to "lock-in" a profit above the expected value[2] of the finished animal, assumes a short position[3] in the futures market. Such action on the part of many feedlot operators will decrease f_{it} and force the cash-futures spread in line with the cost of feeding. Equation (1) also implies that if $C_n > f_{it}$, then $f_{it} - P_t > 0$,

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[2]An estimate of the expected value of the finished animal can be obtained as follows. Multiply the beginning weight of the feeder animal by its purchase price. Add to this sum the expected weight gain multiplied by the total cost of achieving this gain. This total is divided by the expected weight of the finished animal to obtain a per hundredweight value or price to which the futures price can be compared.

[3]This is equivalent to selling a futures contract either for future delivery, or as a temporary merchandising contract which will be offset by a purchase of the futures contract at the same time as the fed animals are sold on the local market.

or that if the cost of feeding exceeds the futures price, the cash-futures price spread will be positive. Furthermore, as costs increase $f_{it} - P_t$ becomes a larger positive number, requiring the futures market price to increase at a greater rate than the feeder cattle price until overall equilibrium prices are finally attained in the feedlot industry.

Ehrlich tested his hypothesis by comparing monthly average cost estimates with feeder cattle and futures market prices. He assumed a beginning weight (W_f) of 650 pounds and a finished weight (W_s) of 1,100 pounds. The weekly average price of choice 550-750 pound steers at Omaha quoted for the week closest to the 15th of the month was taken as the feeder price variable. The futures price variable was the average weekly price quoted for delivery at Chicago six months after the data relevant to the feeder cattle price. Ehrlich's cost estimates were based on a six month feeding program using Van Arsdall's (20) results obtained from a random sample of corn belt feedlot operators. Cash-futures price spreads were then plotted separately against cost estimates and ($f_{it} - C_n$) showing that: (1) spreads were negative when futures market prices exceeded costs, and (2) feeder prices increased at a greater rate than futures market prices as future market prices increased relative to feeding costs.

Finally, Ehrlich showed that during months of disequilibrium, the cash-futures spread adjusted toward equilibrium in the following months. He concludes "that the evidence shows fairly clearly that competitive forces tend to cause feeder-cattle prices to adjust relative to relevant futures price in a manner consistent with the assumptions of pure competition, given uncertainty regarding future events" (5, p. 37).

Since the live-beef cattle futures market was not extensively used by feedlot operators during the period which Ehrlich examined,[4] it is not surprising that he states that the evidence is not sufficient to prove his hypothesis. Also, in view of the weak statistical techniques which he employs, it is not surprising that he found no grounds for rejecting the hypothesis.

Paul and Wesson (12) were the first to suggest that the cash-futures spread represented pricing of feedlot services. They reasoned that just as the basis[5] of storable commodities, such as corn, reflects the marginal cost of storage, so the difference between feeder cattle (plus cost of feed) and futures prices of slaughter animals reflects the price of feedlot services; moreover, this price, they hypothesized, is positively and significantly related to the quantity of feeding services. They estimated price of feedlot services by establishing a margin given by the difference between the futures price (f_{it}) and feeder cattle plus cost of feed. Then, using quarterly data they regressed this margin on cattle placed on feed and came up with fairly good results, though the number of observations were small.

From Ehrlich's and Paul and Wesson's studies it is not clear whether the fact that cash-futures price spreads reflect costs is a condition for equilibrium between the live beef futures market and the cash

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[4]Paul and Wesson (12) estimated that at the end of 1966, about 8 percent of slaughtered cattle in the North Central States were hedged.

[5]The basis is also the difference between cash and future market prices. For the cattle industry the basis is the difference between cash fed cattle and futures prices, whereas the spread is the difference between feeder cattle and futures prices.

market to which it applies. Chapter III of this study reviews two equilibrium models which purport to explain the forces determining the relation between cash and futures market prices for grain commodities. These models differ primarily on the definition of hedging they use.

The first model, developed by Telser (17), uses a narrow definition of hedging; narrow in the sense that cash market transactions are offset at the same time and in the same magnitude by futures market transactions.[6]

In this situation the equilibrium futures market price is determined by the equality between the number of futures contracts bought and sold both by long and short speculators and hedgers.[7] As will be explained in more detail later, only if the increase in short hedging is accompanied by an increase in stock holdings (or cattle placed on feed, if this reasoning is applied to the beef futures market) will cash market prices follow futures market prices so as to reflect the cost of storage (or feeding).

The second model, developed by Stein (16), is based on a broader definition of hedging. Futures market transactions only partially offset cash market transactions. In this case the hedger does not routinely hedge his entire stock but uses the futures market to maximize his returns from both unhedged and hedged stock holdings subject to the

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[6]This corresponds to the notion that hedging is done purely for the purpose of avoiding risk.

[7]Short means to sell and long means to buy a futures contract. The distinction between hedgers and speculators will be developed throughout this study. For the moment, however, hedgers presently possess or want possession of the commodity they hedge. Those who do not require the commodity for their normal business practices are speculators.

amount of risk he is willing to incur. It will be explained in a later chapter that Stein's model develops a simultaneous determination of cash and futures market prices without the condition that cash-futures price spreads reflect cost of storage or feeding.

I. OBJECTIVE

The primary objective of this study is to ascertain whether trading in the live beef cattle futures market can be explained by Telser's equilibrium model to which Ehrlich's analysis seems to conform.

Specifically, the following hypothesis will be tested:

1. That short hedging patterns reflect commercial movements (cattle placed on feed).
2. That cash-futures price spreads reflect cost conditions in the feedlot industry.
3. That prices of feeder steers adjust to changes in expected prices as given by futures prices.
4. That there exists no consistent bias in favor of either sellers or buyers of futures market contracts.[8]

If all four hypotheses are accepted, then Telser's model is presumed to be a fairly accurate representation of trading in the live-beef cattle futures market. If all or several are rejected, it will be difficult to derive a conclusion. Stein's model might be seen as a more accurate representation of futures trading of the beef contract.

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[8]This hypothesis is included to determine the performance of the futures market itself. The reason for its inclusion will be explained in more detail in Chapter III.

However, a different set of hypotheses will have to be developed to determine how well this model applies to the beef contract. For the purpose of this study Stein's model is included to show that other equilibrium models exist. If, in the analysis, it is concluded that the beef futures market does not entirely correspond to Telser's model, then it should not be assumed that the beef futures market has failed in its economic performance.[9] Rather the need for the development of new concepts of futures market trading should be recognized.

II. ORGANIZATION OF THE THESIS

This study is divided into five chapters. Chapter II reviews some of the predominant theories which purport to explain the functions which a futures market "ought to" perform within the overall marketing system of a particular commodity. A discussion of these theories will enable the researcher to develop a set of criteria to determine the extent to which the live-beef cattle futures market relates to the beef industry in general.

Chapter III describes and compares two different equilibrium models which explain the determination and relation of cash and futures market prices. These models differ on the definition of hedging they assume. The implication of these different definitions of hedging will have considerable bearing on the conclusions derived from the analysis.

The analysis is contained in Chapter IV which is divided into four sections. Section I is concerned with an analysis of the relation

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[9] What the economic performance or a function of the futures market "ought" to be is explained in Chapter II.

between hedging positions and commercial movements within the beef industry. Section II examines the relation between feeding costs and cash-futures price spreads. Section III reviews some aspects of the performance of the beef futures market. In particular returns of speculative holdings are related to hedging costs and returns from hedged feeding operations are compared to those of unhedged feeding operations. Section IV examines the type of positions taken in the futures market by different trading groups in the beef industry, specifically those of feedlot operators.

The summary of conclusions is outlined in Chapter V and suggestions for further research are given.

III. JUSTIFICATION OF THESIS

The live-beef futures contract has been traded a short time relative to the more established grain futures markets. Ehrlich and Paul and Wesson have attempted to analyze the beef futures market on the same lines as the grain futures markets have been analyzed. It is hoped that this study will point to some of the complexities pertaining to futures trading of a commodity which is not storable and less seasonal in production than the grain commodities. This results in hedging needs and uses of the futures market by participants in the beef industry that find little correspondence to hedging needs and uses of the futures market by traders of the respective grain commodities. Consequently, models which explain equilibrium conditions between the grain futures markets and the respective commodity markets, do not necessarily trace out the factors that determine equilibrium conditions between the live-beef cattle market and its futures market.

In general, it is hoped that this study will point to the need for developing new concepts in analyzing the relation between the live-beef cattle futures market and the marketing system of which it is a part; in particular, it is hoped that this study will provide some impetus for additional research work explaining the specific hedging needs of feedlot operators and to relate these to the hedging programs that are available in the use of the beef futures market.

CHAPTER II

REVIEW OF LITERATURE

The number of divergent views about the role of the futures market in a modern exchange economy appear to be directly related to the number of scholars who have written on the subject. The following are some examples.

H. Bakken (2) sees the futures market as a mechanism to facilitate forward pricing. He deems hedging use as incidental to this function and goes so far as to state that present cash or spot prices are nothing more than premium or discount quotations of futures prices.

H. B. Arthur's (1) interpretation follows more traditional lines. The futures market is a device for hedgers to manage price risks. This risk management commands a wage which is represented by a profit or a loss to the hedger depending on his skill to forecast the variability of the basis.

Paul and Wesson (13), on the other hand, hold that the futures market allows speculators to serve their economic function as a financial stock carrier through time; accordingly, hedgers merely provide the services required to allow speculators to carry the stock.

These views, and others too numerous to be mentioned here, continue to be views rather than testable hypotheses because they contain propositions which do not render easily to statistical analysis.

Therefore, rather than attempting to ascribe a particular role to the futures market in general other scholars have attempted to specify the conditions under which a given commodity is traded successfully. Fortunately, this line of attack has been more fruitful in gaining an understanding of the functioning of a contract as it relates to the overall marketing system of a commodity.

Working (21) and Gray (7), attempting to develop testable criteria to adjudge the "performance" of a futures market, cite hedging use as the primary determinant of a successful[1] futures market, and, secondly, that such a market must attract a sufficient amount of speculation to offset the tendency for short hedging to exceed long hedging.

According to Gray's theory, hedgers are attracted to a futures market because they want to "substitute futures contracts temporarily for merchandising contracts. The reason may be financing of inventories, forward pricing, or obtaining shopping convenience. In order to appeal to hedgers the contract, delivery terms, and locations must all confirm closely to the commercial movement" (7, p. 122) of the commodity. In short, with a need for hedging and a critical amount of speculation a futures market "can grow to its optimal level and continue over long periods to provide balanced price estimates" (7, p. 122). Both Rockwell (15) and Gray (6) have tested several markets for their ability to provide balanced price estimates. Their techniques have been rather unusual and an explanation will require a digression on a discussion of a concept known as normal backwardation.

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[1]Successful is used in the sense that the commodity market is not lopsided, favoring neither buyer nor seller of the contract. This will be discussed in greater detail below.

Keynes (8) was the originator of this concept. A heavy speculator himself, Keynes noticed that in those markets where hedgers were net short, the futures market price tended to rise during the life of a contract. Since speculation would be long in these markets they would receive a selling price higher than the buying price at the time they liquidated their position in the market. This price differential Keynes termed normal backwardation. He conceived it as a wage (risk premium) that hedgers paid speculators in return for assuming the risk which hedgers do not want to incur.[2] The return to speculators is thus equivalent to the cost of hedging.[3] Furthermore, if the cost is too great (bearing out biased futures prices), then hedgers will be discouraged from using the futures market and, consequently, the market will diminish in its function of providing an effective hedging medium.

The evidence for normal backwardation has been analyzed by a good number of investigations in an attempt to determine whether or not these risk premiums have existed in the older futures markets.

Telser (18) was the first to take issue with the theory of normal backwardation, primarily because he held that speculators have a special forecasting ability. However, it was virtually impossible for Telser to separate the components attributable to forecasting ability and normal backwardation from the speculative returns. Therefore, he attempted to show that no upward seasonal movement of prices occurred during the

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[2]This proposition also implies that speculators are risk averters and have no forecasting ability; therefore, they must receive a risk premium as a wage.

[3]This does not include margin deposit and brokers commission.

life of a large number of corn and wheat futures contracts.

Cootner (4) disagreed with Telser's results, and, using a different proxy variable for total hedging commitments,[4] showed that "prices of futures contracts rise on the average after the peak of net short hedging and fall on the average after the peak of net long hedging" (4, p. 87).

Since Telser and Cootner publications and their insuing controversies, other scholars have contributed to the search for risk premiums in several futures markets. Most of these studies indicated that large futures market did bear out upward trends in prices, though there was little agreement about the extent to which such upward trends in prices gave evidence in support of the normal backwardation theory.

The most wide scale and impressive findings, however, came from Rockwell's recent study (15). He attempted to estimate speculative returns of 25 futures market over a period of 18 years. His profit estimates were derived by multiplying the price change of a contract by the average value of open interest[5] pertaining to the respective trading group. Rockwell concluded that large scale speculators made consistent and considerable returns[6] on all markets, on both their long and short

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[4]The proxy variable was movement of visible supplies of wheat; the reasoning--as greater amounts are moved into storage, net short hedging commitments increase proportionally.

[5]Open interest (or contracts) published for each contract by the Commodity Exchange Authority (CEA) show the commitments, long or short, for each trading group (i.e., speculators or hedgers). Of course, on any day total short must equal total long commitments.

[6]These do not include transaction costs.

positions. However, these results do not apply to small scale speculators whose average returns were zero. He also showed that the largest proportion of these profits were made in the larger futures markets (corn, wheat, and soybeans) and that these gains were won almost entirely from short hedgers.

Rockwell then asks whether these findings are consistent with normal backwardation, which assumes that speculators have no forecasting ability. He defines normal backwardation as returns which a naive speculator earns by routinely buying futures contract when hedgers are net short and selling when hedgers are net long. Since considerable profits were made by long speculators when hedgers were net long, Rockwell concludes that normal backwardation has not been evidenced in the small markets and is present in the three larger markets only when hedgers are net short.

Gray (6) has done a similar analysis to determine whether profits from a routine long position are significantly different from zero for a large number of futures markets. His conclusions are similar to Rockwell's but his inferences are more interesting in that he applies them to particular commodity futures markets.

Gray explains that these future markets (i.e., middlings, bran, lard, cottonseed meal, and eggs) have ceased trading, precisely because they allowed such high returns to speculators relative to what hedgers were willing to pay for using the market. He offers the following reasons that might cause lopsidedness (i.e., expectational bias) of a market. First, the delivery terms or commodity description of a contract may favor either buyer or seller. Secondly, concentration of market power may prevent a certain class of trader from supporting the futures market. This is especially true for those markets where a large amount of forward contracting is prevalent and competes with the futures market in providing temporary merchandising contract facilities. Thirdly, a market may either attract too little or too much speculation relative to hedging needs. Since short hedging is greater than long hedging in most futures markets, the lack of long speculation to provide market liquidity will tend to depress futures prices; this, in turn, causes underestimates of futures prices when the relevant contract matures. On the other hand, over-estimates of the price level is an indication that speculation is in excess of hedging use or that there exists excess hedging capacity. The latter is borne out by the fact that only a minor fraction of the stocks of a particular commodity are hedged.

Recently, newer techniques have been devised to ascertain whether a futures market attracts a sufficient amount of speculation. These techniques have centered on the analysis of the price movement of a contract. Rather than examining the price behavior of futures market in terms of determining the net profits accruing to a certain class of traders, price behavior is analyzed in terms of the predictability of price movements.

These types of studies implicitly test the hypothesis that the futures market should primarily be a mechanism for price discovery. For example, Larson (9) uses a statistical test of randomness to determine whether egg future market prices bear out cyclical oscillations similar to the cycle in cash egg prices. He postulated that a lack of predictability would be evidenced if the two cyclical oscillations moved sympathetically.[7] Egg futures market prices approached random price changes in the short term; however, a long term downward bias, much greater than that of cash prices, was evident. In any case, Larson showed that the 30-month cycle in cash egg prices found little correspondence in the movement of futures prices, although there was some degree of correspondence between the 12 months seasonal movements of both price series.

The relative lack of predictability Larson attributed to the speculators inability to determine the extent of the price discount arising from the deterioration in the quality of eggs during prolonged storage. Additionally, if the futures price is quoted too high relative to the cost of storage, a greater amount of eggs will move into storage than anticipated.[8] This will contribute to the distortion of anticipated prices.

Finally, since open interest and volume of trading varied closely with inventories, Larson concluded that "the price discovery function of the futures market appears to be incidental to speculation instituted in response to hedging" (10, p. 63). This conclusion is in line with Gray's hypothesis although it is not in accordance with the notion of some researchers who hold that futures market prices should be good predictors of future cash market prices.

Working (22) has attempted to displace these views. To clarify Working's contribution, it is necessary to distinguish between random

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[7]Moving in opposite direction, as opposed to harmonically.

[8]This is so because carrying charge hedging is more profitable; i.e., it is more profitable to hold larger amounts of hedged stock.

variation of prices and random walk. The variation of prices occurring purely by chance is known as random. However, a random deviation from expected values is known as random walk. Now, to quote Working "Pure random walk in a futures price is the price behavior that would result from perfect functioning of a futures market, the perfect futures market being defined as one in which the market price would constitute at all times the best estimate that could be made, from currently available information, of what the price would be at the delivery date of the futures contract" (22, p. 446). This statement differs radically from the view that the expected price, as given by the futures market price, should be an unbiased estimate (or fair predictor) of the actual price, or cash market price, in the future. According to Working's concept of random walk, a "good" futures price is reliably anticipatory; that is, a price that bears out a close correspondence between the expected and what ought to be expected in the light of available information" (22, p. 447).[9] Again, this is in marked contrast toward finding a correspondence between the expected and actual price.

Unfortunately, random walk does not yield easily to statistical testing. In a sense, its presence in a price series is evidenced by a lack of any structure underlying the series. Yet the absence of, say, autocorrelation of first differences is just a necessary condition for random walk, leaving unspecified a multitude of other structures that might be contained in a price series. Little empirical work has been done along these lines; therefore, the researcher is left to his own

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[9]Larson made the mistake in his analysis of equating reliably anticipatory prices with random variation instead of random walk.

devices in determining whether a price series is reliably anticipatory.

The introduction and the preceding outline of the more important contributions to futures trading theory have described a good number of characteristics which a well functioning futures market ought to possess. In summary, these are:

1. (a) net hedging commitments should conform closely to the commercial movement of a commodity;

   (b) the cash-futures price spread should reflect economic forces within the market system of a commodity (for example, cost of storage or feeding);

2. (a) speculative activity should not be the primary price determinant of futures prices (for example, it should not be excessive relative to hedging needs);

   (b) the returns to speculators should be predominantly related to their ability to forecast price changes; the risk premium component of returns should be small so as not to effect hedging costs;

   (c) the market should not be lopsided favoring either buyer or seller of the contract (for example, expectational bias caused by consistent over or underestimates of actual cash prices);

3. (a) futures market prices should be reliably anticipatory, representing something like a random walk.

Before attempting to ascertain the extent to which the live-beef cattle futures contract conforms to these characteristics several points should be mentioned.

First, little discussion has been made about the desirability of basis stability. This is so because no group of traders expects the basis to be stable throughout the life of a contract. Both speculators and hedgers earn their livelihood from predicting its variability. The essence of futures trading is simply that the variability of the basis is more predictable than the variability of the absolute price level.

Secondly, the above set of characteristics as a whole should not be taken as hard and fast criterion to which all futures markets must conform. Too little is known about the detailed mechanics of futures trading and their relation to price determination to afford a hint of evidence that the set exhausts most of the factors underlying a well functioning market.[10]

However, for the purpose of this study the set of criteria above has been designed to conform to the predominant views pertaining to futures market trading and to serve as a framework for analyzing the performance of the live-beef contract.

Third, nothing has been said so far about (1) the motivations on the part of inventory holders (or feeders) to hedge their stock, and (2) the equilibrating forces within the futures market itself which ultimately determine futures prices. A discussion of these matters will be made in the following chapter.

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[10]Working (22) only recently has attempted to examine the price influences of floor traders (scalpers) and Gray (7) of inter- and intra-market spreaders.

CHAPTER III

THEORY OF FUTURES MARKET TRADING

Prior to Working's publication (21) hedging was an operation for the purpose of risk avoidance. Working, however, maintained that hedgers do not take a position in the futures market solely to avoid risk. Since then various and often confusing definitions of hedging have been used.

The Appendix lists the Commodity Exchange Authority's (CEA) definition of a bona fide hedging transaction. Briefly, it states that hedging (long or short) must be offset by the sale or purchase of the commodity in question. Two points are noteworthy about this definition. They are: (1) it does not specify that offsetting cash market purchases or sales must be made at the same time that positions are taken in the futures market; and (2) it does not specify that the entire purchase or sale of the cash commodity must be hedged.

If hedging were a complete form of arbitrage, as is often assumed in the most rudimentary examples given of hedging operations, then points one and two would have to be included in any definition of bona fide hedging. In this situation, a purchase of a commodity would be completely offset (in exact amount) by an opposite sale of commodity contract on the same day; likewise, the subsequent sale of the commodity would exactly coincide with an equivalent purchase of the commodity contract.

Such a hedging operation would conform most closely to the ideal risk avoidance type of hedging believed common practice before Working's study. However, this operation is not entirely risk free, since the cash market price and the futures market price may not be equal[1] when the hedger liquidates his position in both markets. Rather, it is less risky than the situation in which the inventory holder had not hedged at all.

It is possibly because the CEA did not include points one and two in its definition of hedging that it may have recognized, along with Working, the more complex motivations which induce an inventory holder to take a position in the futures market.

Stein's (16) and Telser's (17) studies are good examples of the confusion that results when different definitions of hedging are used. Stein uses a broad definition of hedging. In his model the hedger is not confined to the restrictions if points one and two above were to pertain. Telser, however, implicitly assumes the narrow definition of hedging that would apply if points one and two were included.

Although both studies deal with different aspects of futures market theory, both Stein and Telser obtain surprisingly different results. Stein concludes that an increase in the futures market price may or may not increase net short hedging commitments, and that an increase in net short hedging commitments will not be associated with an increase in total shock holdings. Telser concludes that an increase in the futures market price will increase net short hedging commitments and, therefore, the total level of stock holding.

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[1]Making allowance for transportation costs between a given cash market and the respective futures market to which the commodity can be delivered if the futures price exceeds the cash market price by an amount greater than the cost of transport.

It is necessary to review both models in some detail since an understanding of their differences is an essential part of the analysis of the live beef contract that follows in the ensuing chapters.

Basically, Stein postulates that inventory holders hedge in order to maximize their expected return subject to a maximum amount of risk they are willing to assume. For example, let U, the expected gain from holding unhedged stock, be equal to:

$$U = P_{t+n} - (P_t + C_n) \qquad (1)$$

where:

P_{t+n} = future cash price in period t + n in dollars per cwt.

P_t = current spot price in period t in dollars per cwt.

C_n = marginal cost of storage net the marginal conveniences in dollars per cwt. yield[2] over n periods.

Now let H, the expected gain from holding hedged stock, be equal to

$$H = (P_{t+n} - P_t) - (F_{it+n} - F_{it}) - C_n \qquad (2)$$

where:

F_{it} = future market price of the i^{th} contract quoted in period t quoted in dollars per cwt.

F_{it+n} = futures market price of the i^{th} contract maturing in period t+n, quoted in dollars per cwt.

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[2]Marginal convenience yield is simply the gain to an inventory holder from holding stock for a variety of reasons. It has been introduced to explain the fact that cash prices exceed futures prices, thereby showing that the gain from holding stock (for sale) is greater than the cost of stock carrying.

The risk of holding unhedged stocks is given by

$$\text{var } U = \text{var } P_{t+n} \tag{3}$$

and the risk of holding hedged stocks by

$$\text{var } H = \text{var } P_{t+n} + \text{var } F_{it+n} - 2 \text{ cov } P_{t+n} F_{it+n}. \tag{4}$$

Now, if the percentage of unhedged stock to total stocks is varied from zero to 100 percent, the risk due to price changes must vary from

var H to var U.

It should be noted that Stein's analysis implies that, insofar as risk management is concerned, the relevant decision is not whether to hedge or not but how much of the stock should be hedged.[3]

Figure 1 describes the forces which determine the amount of stock an inventory holder will want to hedge by selling a futures market contract. Assuming that unhedged stocks are riskier but bear a higher rate of return than hedged stocks line HU represents the trade-offs between expected return and risk for different percentages of unhedged stock relative to a given level of total stocks.[4]

Indifference curve I_1 traces the rate at which a stock holder is willing to substitute units of expected return for an additional unit of risk. It is drawn convex to show that for incurring successively higher units of risk, the individual must be given successively greater amounts

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[3]This has important bearing on much of what follows; I shall return to this later.

[4]Point H represents var H and H given by equations (4) and (2). Point U is given similarly.

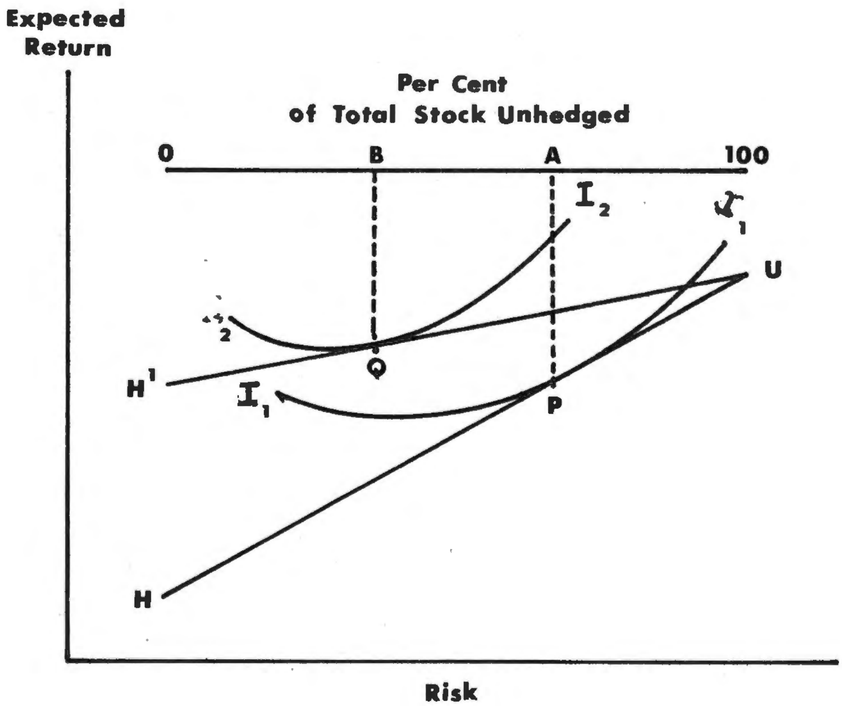

Figure 1. Determination of equilibrium hedged and unhedged position held by an individual.

Source: J. L. Stein, "The Simultaneous Determination of Spot and Futures Prices," American Economic Review, LI (December, 1961), 1012-1025.

of expected return.[5] Indifference curve I_2 is preferred to curve I_1 since "a higher expected return (at lower levels of risk) must imply a higher expected utility of income" (16, p. 1016). Point P, the tangent of HU and I_1 shows that for the expected utility of holding stocks to be maximized, OA percent of stock should be unhedged and 100-OA percent should be hedged.

Now with an increase in the futures price (F_{it}) the line HU moves to H'U since the expected return from holding hedged stock has increased, whereas the expected return from holding unhedged stock has remained constant.

Stein explains that in moving to a new equilibrium position, both an income and a substitution effect are operative. The substitution effect will encourage the inventory holder to decrease his holdings of unhedged stock relative to a given level of total stocks. The income effect, however, will offset the substitution effect since "the higher expected utility, made possible by the rise in the price of the future contract may affect the individual's aversion to risk. Insofar as he is more willing to take on additional unit of risk per increment of expected return, when his expected utility is increased, the income effect will induce him to increase the ratio of unhedged to total shock" (16, p. 1016).

In this example the substitution effect is dominant and the individual moves to a new equilibrium position given by Q where a larger percentage of total stocks are hedged than previously.

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[5]This is equivalent to the assumption that the individual has a declining marginal utility of income (after he owns a critical amount of income).

Stein's analysis is not helpful in tracing out the effect of an increase in the futures market price on the total level of stocks held by an individual if 100 percent of the stocks were hedged at the beginning.

To examine this possibility and its implication on overall futures market equilibrium, a discussion of Telser's model is appropriate. A short hedger, taking a position in the futures market receives a positive return from holding hedged stock if (manipulating equation (2)).

$$(P_{t+n} - P_t) \geq (F_{it+n} - F_{it}) + C_n.^{6} \qquad (5)$$

Likewise a long hedger's return can be described by

$$F_{it+n} - F_{it} \geq (P_{t+n} - P_t) - C_n. \qquad (6)$$

Therefore, given a futures market with no speculative activity, hedging equilibrium requires that short hedging equal long hedging and that

$$(P_{t+n} - P_t) = (F_{it+n} - F_{it}) + C_n. \qquad (7)$$

Equation (7) implies that if the futures market price at maturity were the same as the future cash market price (for example, $F_{it+n} = P_{t=N}$), then

$$F_{it} = P_t + C_n \qquad (8)$$

or that in pure hedging equilibrium the futures market price should be equal to the cash market price plus the marginal cost of storage.

[6]Note that this equation implies that an upward movement in the futures price during the life of its contract must be accompanied by an even greater upward movement of the cash price during the same period.

Schedule H'H in Figure 2 describes the equation system outlined above. Point A is the futures market price in pure hedging equilibrium (at zero net commitments). Segment AH depects the excess supply (net short commitments) of futures contracts hedgers wish to seel at higher futures prices. Similarly segment H'A shows net long commitments at lower futures prices.

Following equation (8), point C on the price axis represents the current cash market price of the commodity in question. Distance A-C along the vertical axis must therefore represent the marginal cost of storage.[7]

Next, speculators will be introduced in the model. For expositional purposes it is assumed for the moment that there are no hedgers in the market. Quite simply, speculators who believe that prices will rise are long, and those who believe that prices will fall are short. Again, given zero net commitments (at a positive level of contracts traded at point O along the horizontal axis), point B represents the price at which long equals short speculation. This is the expected future cash price reflected by what speculators currently agree to be the supply and demand situation in the future.

To derive other points on the speculative schedule, hedgers must now be introduced in the model. Hedging equilibrium occurred at price A and speculative equilibrium at price B. This means that speculators anticipate a higher price level than hedgers, and that the bullish speculators are willing to buy futures contracts and that short hedgers are

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[7]Marginal cost of storage is assumed to be greater than the marginal convenience yield of storage.

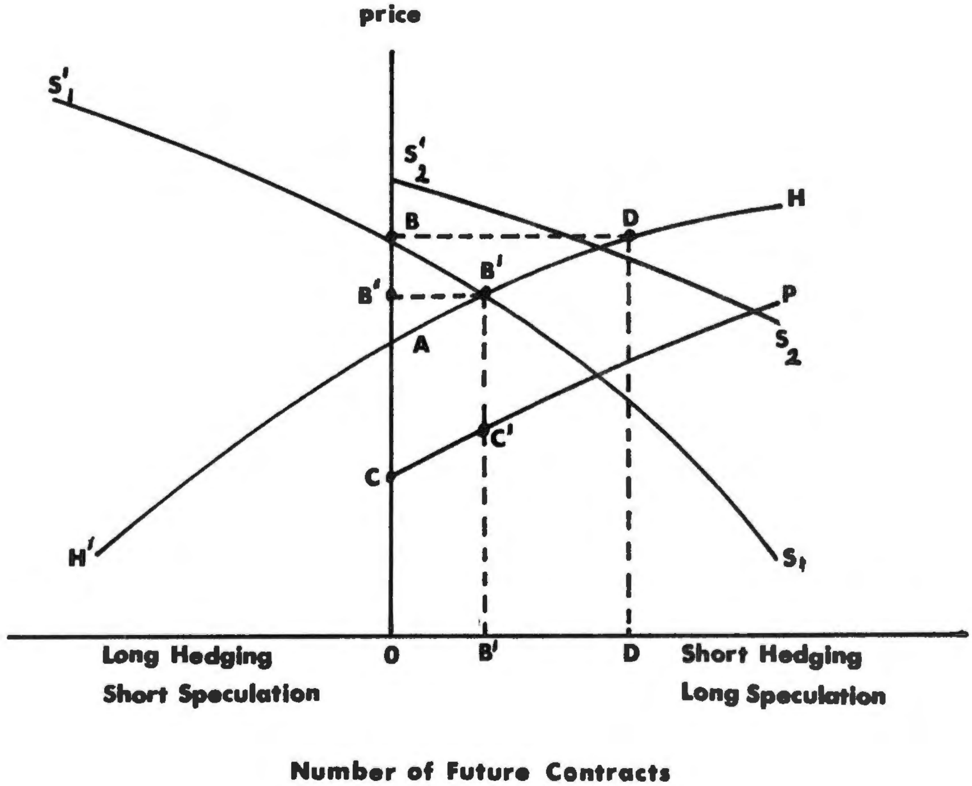

Figure 2. Determination of equilibrium futures prices and cash prices, following Telser.

Source: L. G. Telser, "Futures Trading and the Storage of Cotton and Wheat," Journal of Political Economy, LXVI, 3 (June, 1958), 153.

willing to sell contracts. At the price which speculators anticipate; i.e., B, short hedgers are willing to move along their excess supply schedule all the way to point D and supply an additional OD of contracts (OD representing net short commitments at price OB). However, net short hedgers will not be able to supply OD contracts at price OB. They must settle for less than that. This is so because: (1) speculators desire to buy their contract at a lower price than they expect in the future since they expect a profit for their risk bearing services, and (2) speculators expectation of future cash prices vary inversely with the amount of stocks held in storage for future consumption. (The amount of stocks held in storage being reflected by the amount of net storage commitment.)

This reasoning depicts the downward sloping speculative schedule, S_1S_1. Its intersection with H'H yields point B' the equilibrium futures market price at net short hedging commitments of OB'.

However, in equilibrium the futures market price B' exceeds the old cash market price by an amount greater than the marginal cost of storage (B'C, along the vertical axis, is greater than AC). Telser (16) claims this to be an untennable situation. The reasoning being[8] that if

$$f_{it} > P_t + C_n$$

hedgers would be encouraged to increase their total stock levels thereby subtracting from the amount available for current consumption. This action on the part of many inventory holders would increase the cash

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[8]Telser does not explicitly state this, however.

market price to a level commensurate to allow the future-cash price differential to reflect the marginal cost of storage. The new cash price is given by point C' in Figure 2, page 28.[9]

If at point O (zero net commitments) hedgers held their stock only partially hedged (i.e., according to Stein), then the cash market price, corresponding to the equilibrium futures market price would be indeterminate. This is so because total stocks would not increase with increased net short hedging commitments and the differential between cash and future prices would not necessarily reflect the marginal cost of storage. Additionally, since speculators are not able to base their expectation of future cash prices on a direct correlation between net short hedging and stock movements, it becomes impossible to specify the slope of the speculative function, and, therefore, an equilibrium futures price. It follows that if Telser's model were to be a good approximation of the real world, it must be assumed that inventory holders hedge all of their stocks and at nearly the same time that they purchase the commodity in question. If this applies then the equilibrium futures market price will be an unbiased estimate of the cash market price in the future, only if speculators as a group are indifferent to risk.

However, speculators, as any other trading group, are averse to risk and will endeavor to sell their contracts in the future at prices higher than they purchased them. Schedule S_2S_2 represents the locus of prices speculators anticipate receiving at the time they sell their

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[9]An increase in the marginal cost of storage can be represented by an upward shift of H'H and a downward shift of CC'. This is so because a rise in cost of storage reduces stocks and decreases spot prices. Yet lower stock levels means less available in the future.

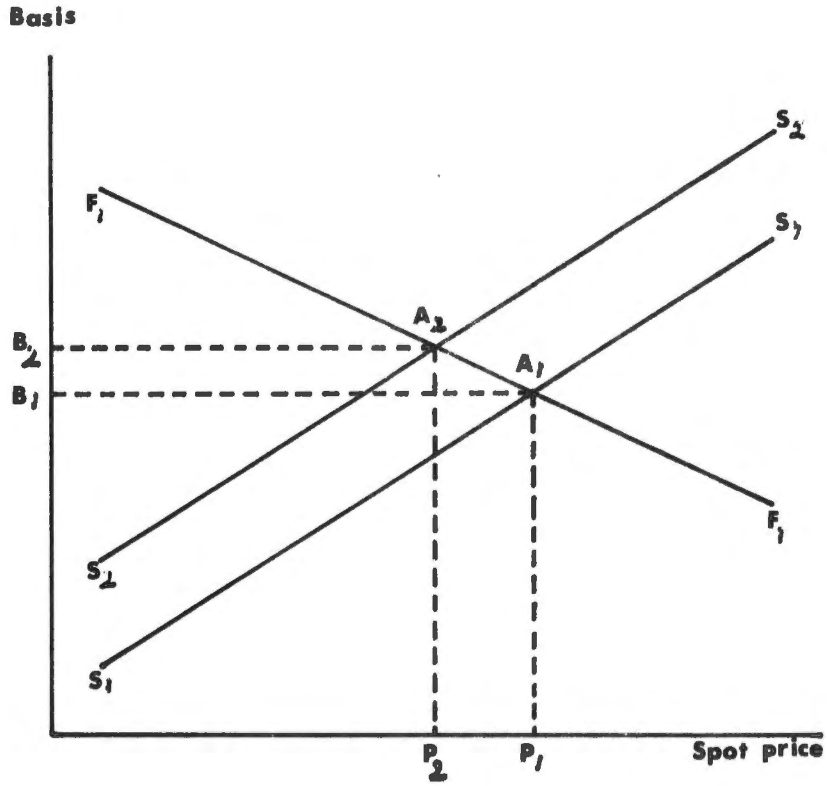

Figure 3. Simultaneous determination of equilibrium spot prices and the basis, following Stein.

Source: J. L. Stein, "The Simultaneous Determination of Spot and Futures Prices," American Economic Review, LI (December, 1961), 1019.

Schedule FF pertains to the supply and demand for futures contracts. It has a negative slope because a rise in the futures price will decrease the amount of contracts demanded by speculators. Now, if the basis remains unchanged, in that both the futures market price and the cash market price increases by an equal amount, hedgers will not want to change the amount of contracts they are willing to supply. The ensuing excess supply causes the futures market price and the basis to fall so as to bring about an equilibrium between futures contracts supplied and demanded. Finally, Stein states that the intersection between F_1F_1 and S_1S_1 at point A_1 brings about the simultaneous determination of the cash market price and the basis.

Stein's analysis of market equilibrium differs from Telser's in two important respects. Stein does not assert at any time throughout his analysis that the basis must change in such a manner as to reflect changes in the marginal cost of storage. This is so because any increase in the futures market price will not necessarily be accompanied by an increase in the number of contracts that short hedgers will want to supply nor by an increase in the total level of stock holdings.

In Telser's model, the futures market price is determined when net short hedgers supply an equal amount of futures contracts that net long speculators demand, given price expectations (vice versa if there exists net long hedging). The spot market price then adjusts to the futures market price to reflect the marginal cost of storage. Therefore, once the futures price is determined, the spot price and the basis will adjust to the equilibrium futures price.

CHAPTER IV

ANALYSIS OF THE LIVE-BEEF CATTLE FUTURES MARKET

I. RELATIONSHIP BETWEEN HEDGING POSITIONS AND COMMERCIAL MOVEMENTS

The growth of the live-beef futures contract since the beginning of trading in November, 1964 at the Chicago Mercantile Exchange is indicated in Table I.

The increase of the number of open contracts traded greatly exceeds the increase of cattle placed on feed, fed cattle marketed, and commercial slaughter[1] for all years except 1968. Two possibilities might explain this disproportionate increase in open contracts. First, in as much as the level of open contracts should reflect commercial movements, an increasing number of participants in the cattle business (i.e., slaughter houses, packers, feeders, and retail chains) are learning to use the futures market as an adjunct to their normal trading activities. For example, in 1966 the average level of open contracts represented only 10 percent of the number of commercial slaughter, 25 percent of cattle placed on feed, and 14 percent of fed cattle marketed. In 1969 these proportions had increased to 36 percent, 79 percent, and 46 percent, respectively.

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[1]These variables, logically, should reflect commercial hedging patterns. Short hedging given by cattle placed and fed cattle marketed long hedging by fed cattle marketed and slaughter.

TABLE I

AVERAGE MONTHLY OPEN CONTRACTS, AVERAGE MONTHLY VOLUME OF TRADING CATTLE PLACED ON FEED, FED CATTLE MARKETED, AND COMMERCIAL SLAUGHTER FOR THE YEARS 1965 THROUGH 1969

Year	Open Contracts	Volume of Trading	22 States: Cattle Placed on Feed	22 States: Fed Cattle Marketed	All States: Slaughter Under Federal Inspection
	Number of Contracts[a]		1,000 Head		
1965	3,307	4,941	1,529	1,478	2,218
1966	11,067	14,233	1,677	1,615	2,277
1967	19,769	23,982	1,746	1,733	2,314
1968	12,848[b]	21,087	1,946	1,853	2,466
1969	26,518[b]	83,267	2,041	1,980	2,561

[a]Source: Commodity Exchange Authority, "Trading in Live-Beef Cattle Futures" (Chicago: United States Department of Agriculture, 1970), pp. 8-9.

[b]During 1968 and 1969 contract units include both 25,000 and 40,000 pounds per contract (roughly 24 and 38 head of cattle) due to an increase in the size of contract effective August, 1969.

Secondly, however, it might be argued that the increase in the number of open contracts was independent of developments in the commercial sector and that the increase was mainly attributable to an increase in speculative activity. For example, the ratio of open contracts to volume of trading[2] has decreased from 77.8 percent in 1966 to 31.8 percent in 1969. If trading during any period of time is too large relative to the open contracts (or open interest) a degree of price instability is introduced into the market. This is so because futures prices will be primarily influenced by factors (speculation, for instance) other than those described in Chapter III which brought about an equilibrium between the futures market and the supply and demand for storage of a commodity.

In order to determine the extent to which the growth of trading of the live-beef futures contract has responded to an increased demand for its services on the part of feedlot operators, wholesalers, and retailers in the beef industry, it is necessary to examine in more detail the pattern of open interest on a monthly basis.

The Commodity Exchange Authority publishes the positions of open interest for most commodities. Data on the position of month end open contracts for the live-beef contract are only available since June, 1968. These positions list the number of contracts which are held long and short by reporting large scale (25 contracts) speculators and hedgers.[3]

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[2]Open interest reflects a position of the number of contracts being held long or short by traders. Volume of trading is a flow and shows the cumulative turnover of contracts during any period of time (i.e., monthly).

[3]Spreading is also reported by large scale traders.

There are two major difficulties in using these data for analysis. First, it is impossible to determine in which particular contract month the reporting traders have taken a position. Second, since small scale traders (24 contracts or less) are not required to report whether they are speculating or hedging, it is difficult to determine the total amount of short and long hedging, and also the total amount of short and long speculation. In an attempt to bypass this difficulty, Larson's (10) estimating equation is used to determine the net short (or long) hedging commitments outstanding for each month since June, 1968. To obtain total estimated short hedging equation is solved for H_S.

$$\text{Log}\ \frac{H_S}{H_S*} = -.12 + .006\ N_S \qquad (1)$$

where:

H_S = total estimated short hedging

H_S* = large traders (reporting) short hedging

N_S = small traders short commitments (non-reporting).

For total long hedging, equation (2) is solved for H_L.

$$\text{Log}\ \frac{H_L}{H_L*} = -.32 + .01\ N_L \qquad (2)$$

where:

H_L = total estimated long hedging

H_L* = reported long hedging

N_L = small traders long commitments.

Also, total estimated spreading is given by

$$S = 18 + 1.1\ E*.$$ [4]

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[4]For inter-market spreading, longs equal shorts.

where:

E^* = reported spreading.

Finally, since all reported values are expressed in terms of percentage of total open contracts, total estimated long and short speculation are given by equations (4) and (5), respectively.

$$S_L = 100 - S - H_L \quad (4)$$

$$S_S = 100 - S - H_S. \quad (5)$$

It follows from equations (1) through (5) that total long positions must equal total short positions and, also, be equal to total open contracts at any one time.

Figure 4 shows the relation between cattle placed on feed, total short hedging positions estimated by Larson's equation, and reported large scale hedging positions. The respective monthly observations are plotted in percentage deviations from the mean to facilitate standardization. The graph points out quite clearly that the monthly variation of cattle placed on feed is not very closely associated with the variation of total estimated short hedging, nor with large scale hedging.

An important inference can be drawn from the evidence borne out in Figure 4. Larson's estimating equation, which he derived from analyzing the soybean, wheat, and corn futures markets only, does not necessarily apply to the beef futures market.

One would not expect the motivations of small scale traders in the grain futures markets to be similar to those of the beef futures market. For example, the presumption that small scale positions in the grain markets are largely speculative does not apply to the beef market.

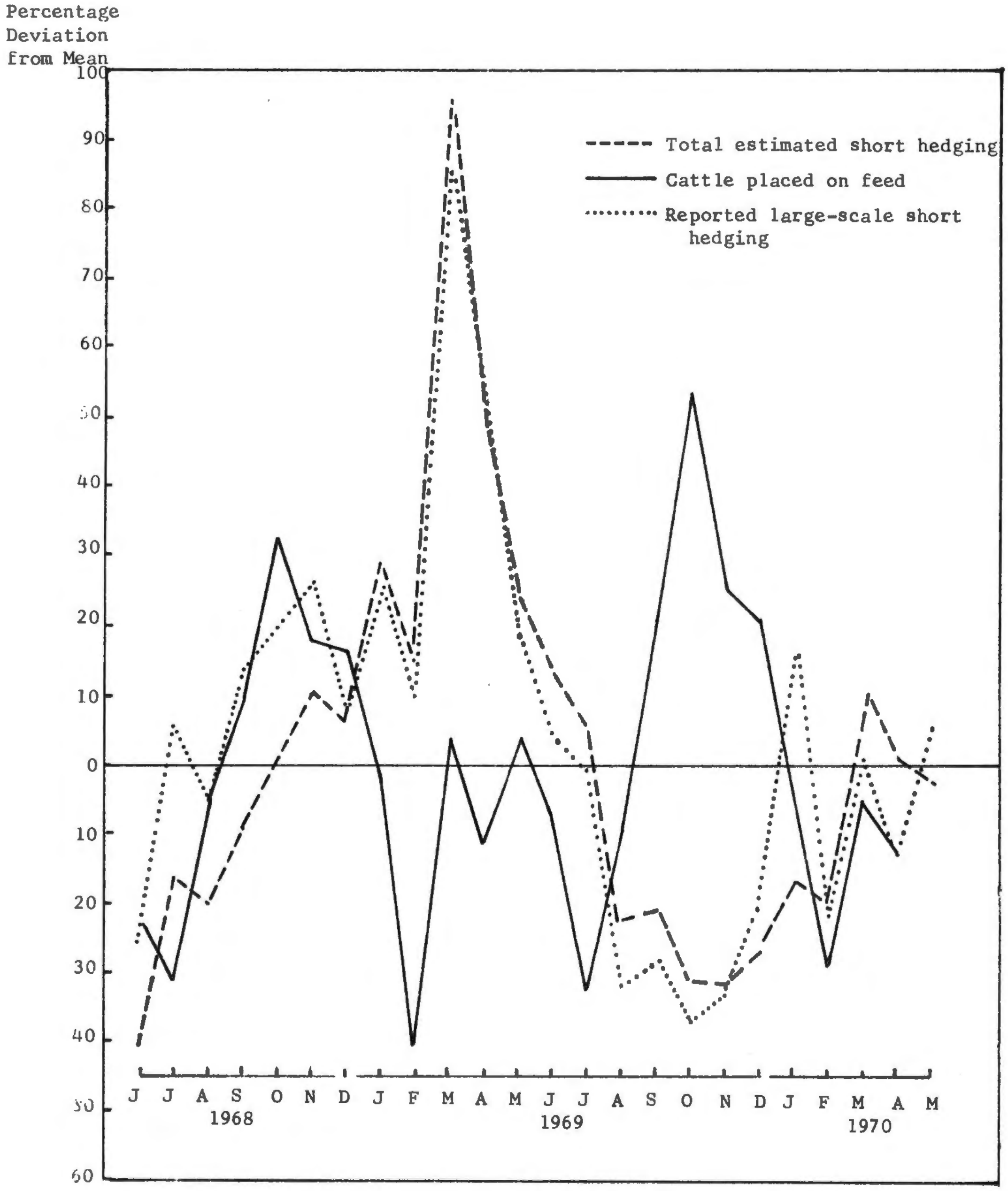

Figure 4. Relation between total estimated and reported large-scale short hedging positions to cattle placed on feed.

This presumption is evidenced in Table II, when comparing estimated small scale short hedging positions to non-reported (small scale) short position. Estimated small scale short hedging positions are derived by subtracting large scale short hedging commitments from total estimated short hedging position given by Larson's estimating technique. Column 5 in Table II shows that estimated small scale short hedging positions exceed 35 percent of non-reported short positions only 25 percent of the time. There exist reasons to expect that Larson's technique under-estimates the hedging component of the short positions of the small scale trader category. A feedlot operator taking a position in the future market is considered large scale if he hedges a minimum of about 950[5] head of cattle. Since the average size feedlot in the Midwest feeds out about 240 animals per year,[6] a large number of feedlot operators who hedge should be included in the small scale category. Therefore, Larson's technique may yield results which misrepresent the relation between hedging positions and commercial activity in the beef industry.

In order to obtain a more accurate indication of this relationship, simple correlation coefficients of the relevant variables have been estimated. If a large number of feedlot operators use the futures market, one would expect a high positive correlation between cattle placed on feed and reported large scale hedging, as well as non-reported short positions.

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[5]A contract represents 38 animals. The CEA defines a large scale trader as one holding 25 or more contracts at any one time.

[6]See Van Arsdall (20).

TABLE II

COMPARISON BETWEEN ESTIMATED TOTAL AND SMALL-SCALE POSITIONS, REPORTED LARGE-SCALE SHORT HEDGING POSITIONS, AND NONREPORTED SHORT HEDGING POSITIONS--(POSITIONS IN NUMBER OF MONTHEND CONTRACTS OUTSTANDING)

Month	I Total Estimated Short Hedging[a]	II Reported Large Scale Short Hedging[b]	III Estimated Small Scale Short Hedgings[c]	IV Non-Reported Small Scale Shorts[b]	V Percentage of Estimated Small Scale Short Hedging to Nonreported Short Positions
June, 1968	4,913	4,275	638	2,994	21
July	6,973	6,095	878	3,167	27
August	6,657	5,524	1,133	3,605	31
September	7,558	6,490	1,068	3,740	28
October	8,460	6,891	1,569	4,469	35
November	9,163	7,226	1,937	5,292	36
December	8,856	6,209	2,647	7,005	37
January, 1969	10,792	7,148	3,644	9,159	39
February	9,635	6,354	3,281	9,676	33
March	16,253	10,556	5,697	14,787	38
April	12,489	8,759	3,730	11,858	31
May	10,323	6,828	3,495	13,882	25
June	9,503	6,043	3,460	15,308	22
July	8,818	5,766	3,052	14,418	21
August	6,465	4,003	2,462	16,001	15
September	6,569	4,173	2,396	17,544	13
October	5,758	3,703	2,055	11,965	17
November	5,716	3,957	1,759	10,741	16
December	6,177	4,670	1,447	7,821	18
January, 1970	6,940	4,860	2,080	8,226	25
February	6,666	4,593	2,073	7,612	27
March	9,190	5,781	3,409	9,659	35
April	8,466	5,070	3,396	8,960	37
May	8,164	5,011	3,153	9,244	34
June	7,414	4,453	2,961	8,132	36

[a]Estimated by Larson's equation technique.

[b]Source: Commodity Exchange Authority, "Trading in Live-Beef Cattle Futures" (Chicago: United States Department of Agriculture, 1970), p. 30.

[c]Derived from subtracting column II from column I.

However, slaughter plants may also be on the short side of the market at the same time when they incur an obligation to take delivery of slaughter animals on a forward contract. This position will be offset when the dressed carcasses are sold. It should be noted that this type of hedging operation is incomplete since slaughter houses are hedging the final product, dressed beef, with a live-beef cattle futures contract. However, this type of hedge is consistent with normal business practices as long as the price differential between slaughter animals and dressed beef remains stable. In any case one would suspect a positive correlation between fed cattle marketed and short hedging commitments.

Contrarily, slaughter houses may also take a long position in the futures market. In this situation a futures contract is bought at the same time that the plant manager contracts to sell beef carcasses forward, to a retail chain, for example. Therefore, some degree of positive correlation should also be evidenced between long hedging positions and commercial slaughter.[7]

A relevant portion of the correlation matrix is presented in Table III. Three important facts are borne out by the evidence. First, there exists only a very small degree of association between hedging positions and the variables which one would logically consider to represent commercial movements in the beef industry. Second, contrary to *a priori* notions, short hedging positions are inversely related to cattle placed on feed and fed cattle marketings. Third, variations in cattle

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[7]Long positions should coincide with the time of a forward sale, though the latter need not coincide with the time of slaughter but rather with the time when prices are expected to be at their optimum level.

TABLE III

CORRELATION COEFFICIENTS OF HEDGING COMMITMENTS AND COMMERCIAL MOVEMENTS OF CATTLE

	Hedging Large Scale		Positions Non-Reported Small Scale		Hedging Estimated Total	
	Long	Short	Long	Short	Long	Short
Cattle Placed on Feed	.38	-.11	.07	.002	.26	-.13
Fed Cattle Marketed	.37	-.30	.36	.15	.40	-.05
Commercial Slaughter	.16	-.15	-.07	.22	.07	-.23

placed on feed and fed cattle marketings are more closely associated with variations in long hedging than short hedging positions.

Quite clearly these results are at variance with the <u>a priori</u> notions developed earlier about the relation between cattle placed on feed and short hedging positions. If the hypothesis that short hedging corresponds to commercial movements is rejected, it would be instructive to attempt to determine why variations in short hedging are not associated with variations in cattle placed on feed. This will be done in the following sections of this chapter. However, at the onset it is necessary to examine in more detail Ehrlich's results of his analysis of the cash-futures price spreads.

II. RELATIONSHIP BETWEEN CASH-FUTURES PRICE SPREADS AND FEEDING COSTS IN THE FEEDLOT INDUSTRY

Ehrlich's analysis was based on the proposition that feedlot operators take a short position in the futures market when the futures market price is high relative to feeder cattle prices and cost of feeding. An attempt on the part of many feedlot operators to sell futures contracts forces the cash-futures spread to reflect feeding cost in the feedlot industry, given that feeder prices adjust to changes in futures market prices. The first part of this proposition can be tested in the following manner. Ehrlich postulated that

$$F_{it} - P_t + (F_{it} - C_n)\left(1 - \frac{W_S}{W_F}\right) \qquad (1)$$

given that it takes about six months to feed out an animal from 650 (W_S) to about 1,150 (W_F) pounds, it is possible to derive an estimate of the cost of feeding, C_n, since the futures market price, F_{it}, quoted for delivery six months from now, and P_t, the price of the feeder animal (in pounds per cwt.) are also given at any one time. Having thereby derived an estimate of cost, C_n, (dollars per cwt.) this estimate can be regressed on the price of corn to determine how accurately changes in the cost estimate (cash-futures spread) are reflected by changes in the most important variable that determines feeding costs.

In selecting the appropriate feeder and cattle futures prices, values were selected so as to correspond to the narrow definition of hedging. That is, a feedlot operator would commence his feeding operation at the same time that he takes a short position in futures. Since there are only six contract months traded in the live-beef futures market[8] and since the last day of trading occurs on or near the 20th day of each delivery month, the number of average weekly observations over the entire history of trading is limited to 87.[9]

The following is an example of the type of hedging operation described above. On the first week of April, a feedlot operator has purchased and begins feeding about 76 head of feeder cattle. Since he expects to market the finished animal in the first week of October, he sells two October futures in the first week of April.[10] Now, to estimate feeding cost during this particular six month's period, the average

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[8]February, April, June, August, October, and December.

[9]Three average weekly observations per delivery month beginning in April, 1965.

[10]Again the narrow definition is assumed since the number of feeders is equal to the number of animals hedged.

weekly Kansas City feeder price is subtracted from the average weekly October futures price quoted in the first week of April; this difference is set equal to

$$-.69\ (F_{it} - C)^{11} \qquad (1a)$$

and solved for C. This is repeated for the ensuing two weeks in April and begun again during the first three weeks in June so as to coincide with the December delivery contract.

The result of regressing estimated feeding costs on the price of corn is given below:

$$X_1 = 10.43 + \underset{(.025)}{.13X_2}$$

$$S_{y.x} = 2.49 \qquad R^2 = .23 \qquad (2)$$

$$F \text{ ratio} = 25.6$$

where:

X_1 = estimated national weekly average feeding costs in dollars per cst.

X_2 = weekly average price of corn, No. 3 yellow quoted in Chicago in cents per bushel.[12]

The results in equation (2) conform to the <u>a priori</u> notions about the relation between feeding costs and the price of corn. The coefficient of price of corn is significant at the 5 percent level; however, the coefficient of determination shows that only 23 percent of the variation

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[11] Where -.69 is given by $(1 - \frac{1,100}{650})$.

[12] See reference (11).

feeding cost estimates is explained by the variation in corn prices. The F ratio indicates that the data were not generated by chance, at the 5 percent level of significance.

The hypothesis that cash futures price spreads reflect feeding costs cannot be rejected from these results. In order to accept the hypothesis, however, it is necessary to test Ehrlich's second proposition that feeder prices adjust to changes in expected prices, as given by changes in future prices. This was tested by the following regression model:

$$P_{FKN} = -17.7 + \underset{(.06)}{.83P_{SC}} + \underset{(.08)}{.89F_S} - \underset{(.00003)}{.00008Q_F} - \underset{(.008)}{.0061P_{CORN}} \quad (3)$$

$$S_{y,x} = 1.15 \qquad R^2 = .89$$

where observations are weekly averages and

P_{FKN} = price of feeder steers at Kansas in dollars per cwt.

P_{SC} = current price of choice slaughter steers at Chicago (1,100-1,300 lb.) in dollars per cwt.

F_S = futures price quoted for delivery in six months in dollars per cwt.

Q_F = number of feeder steers (501-700 lbs.) sold in eight markets

P_{CORN} = prices of corn, No. 3 yellow at Chicago (cents per bushel).

Equation (3)[13] postulates that feeder prices are a function of expected prices, quantity of feeder steers sold, and price of corn. All

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[13] Additional runs were made using prices of feeders at Sioux City, Omaha, and Oklahoma auctions. However, this model yielded the highest R^2, and Kansas is the largest feeder cattle market.

independent variables, except corn, were significant at the 5 percent level, the signs of all variables were consistent with economic theory and 89 percent of the variation of the price of feeder cattle was explained by the variation in the independent variables.

The model shows that feeder prices do adjust to changes in expected prices, given either by changes in current prices of slaughter steers or futures market prices. Ehrlich assumed that feeder prices must adjust to changes in expected prices (futures prices) so as to enable cash-futures price spreads to reflect feeding costs. For example, if feeding costs were less than futures prices, equilibrium forces would require the cash-future price spread to be negative (i.e., $F_{it} - P_t < 0$). If costs continued to decrease relative to futures prices, the equilibrating mechanism would require that the cash-futures spread becomes a larger negative number. This would be achieved only if feeder prices adjusted to futures prices in a direction commensurate with the attainment of equilibrium. Specifically, feeder prices would have to increase at a greater rate than futures prices. Relating this reasoning to Telser's model on page 27, the similarity between Ehrlich's and Telser's model will become clear. For example, it will be seen from the diagram that a decrease in the cost of storage (B'C') can be represented by an upward shift of the cash price schedule CP and a downward shift of the hedging schedule H'H. This is because a decrease in the cost of storage (or feeding) increases stocks (or cattle placed on feed) and increases cash market prices (of feeder steers). The hedging schedule shifts downward because the increase in short hedging contracts offered for sale in the future decreases futures market prices, given expectations of speculators. Yet, it was also shown in Chapter III that changes in short hedging positions must be accompanied by equal changes in stock holdings so that cash prices adjust to equilibrium futures market prices and that the spread reflects cost conditions.

If feeder placements are not directly related to short hedging positions then, following Telser's reasoning, cash futures price spreads cannot reflect feeding costs. Yet, so far it has been concluded that short hedging is not related to feeder placements, but that cash-futures spreads have tended to reflect feeding costs. (The latter conclusion has been reinforced by the findings that feeder prices do tend to adjust to futures prices.)

There exist three possible explanations for these contradictory results. First, the similarity between Telser's and Ehrlich's model may not be as real as it would appear. One might argue that the assumption that short hedging be directly related to feeder placements is not essential to Ehrlich's model. His model showed that if feeding costs were less than futures market prices, then feeder prices would increase relative to futures market prices. This is because a greater quantity of feeder animals will be demanded, increasing feeder prices. But it does not follow that this increase in placements will be hedged. The decision to hedge depends on the condition that the futures market price exceeds the total expected value[14] of the finished animal. The expected value of the finished animal is dependent not only on feeding costs but also on the price of the feeder animal. If the price of the feeder

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[14] This value is estimated on a price per hundredweight basis.

animal increases in a greater amount than the decrease in feeding costs, then the increase in feeders placed need not be accompanied by an increase in short hedging positions.

Second, one might argue that the condition for equilibrium which Ehrlich postulates is not a condition for equilibrium. Rather, the fact that cash-futures price spreads reflect feeding costs is incidental to (or an ex post reflection of) another equilibrium condition which Stein stipulated. This is that the relationship between cash-futures price spreads and cash market prices reflect a joint equilibrium between futures contracts bought and sold and stocks supplied and demanded. (See Figure 3, page 32). As was explained previously, an increase in short hedging need not be directly related to an increase in stock holdings because hedgers may hold only a part of their stocks hedged.

Third, it might be argued that Telser's model, dogmatically applied to the relationship between the feedlot industry and the beef futures contract, is too restrictive relative to the use that other participants in the beef industry make of this futures market. Trading in the beef futures market is not restricted to feedlot operators assumed net short in the market, but is representative of the activities of a large number of different trading groups. Their divergent reasons for using the beef futures market[15] are too complex to be abstracted by the type of model which applies to futures trading of grain commodities. These considerations apply also to Ehrlich's model. Ehrlich implicitly assumes

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[15]Particularly because feeder animals, unlike corn, are transformed into an entirely different product during time of storage, i.e., feeding.

that there exists little long hedging activity on the part of feedlot operators and that short hedging is confined to this trading group within the beef industry.[16] That these assumptions do not apply to trading of the beef futures contract will be shown in the final section of this chapter. At the outset, however, it is necessary to look deeper into the beef futures market itself to determine how well it meets up to some of the other criteria outlined in Chapter II.

III. EXAMINATION OF THE EVIDENCE FOR CONSISTENT BIASEDNESS IN THE LIVE-BEEF FUTURES MARKET

Figure 5 traces the returns to speculators which they would have received if they had taken a routinely long position when hedgers were net short in the beef futures market. A routine long position is established by buying a June contract on the first trading day of April and selling the June contract on June 1; the next delivery contract is purchased on the same day as the preceding future is sold, and so on. The graph compares the returns, or losses, for taking a position on the first trading day, the last trading day, and the mid-month trading day. Returns are expressed in dollars per hundredweight.[17]

One striking feature about the graph is that returns have been considerably greater than zero since the first contract (February) in

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[16]Ehrlich must assume this else long hedging positions by feedlot operators and short hedging positions by other traders will have an important influence on the determination of futures prices and their relation to feeder prices.

[17]To derive the return per contract simply multiply the return by 400.

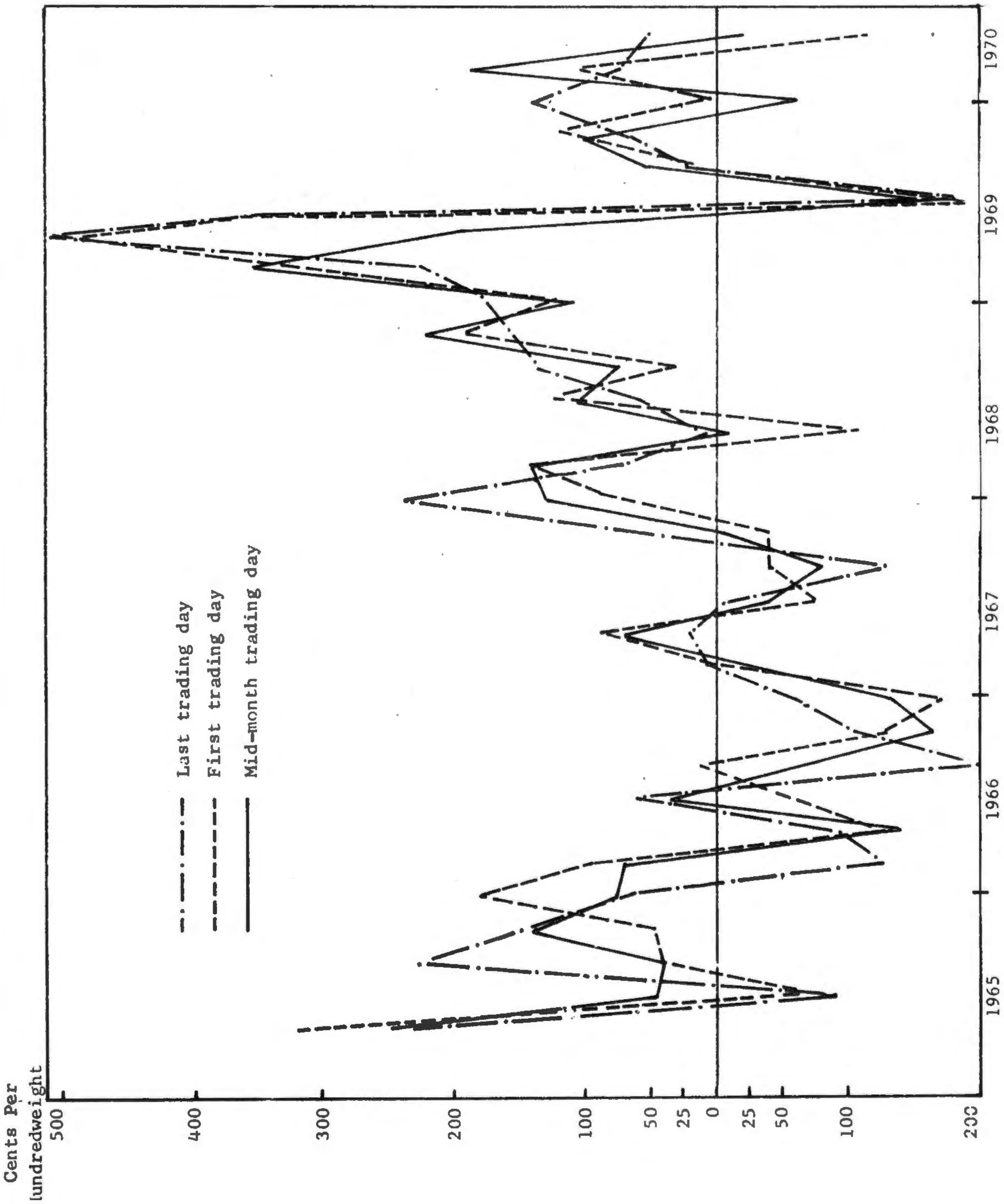

Figure 5. Returns from routine long positions taken on the first, last, and mid-month trading days of the delivery month.

1968 compared to delivery months before 1968; the returns on longs during the earlier period of trading appear much more random and not greatly different from zero. Another interesting feature is that, on the average, a position taken on the last trading day has been more profitable, particularly during the second half of the history of trading, then positions taken on the mid-month trading day; the mid-month positions, in turn, have averaged higher profit levels than the positions on the first trading day.

These results indicate the presence of normal backwardation during the later period of trading of the live-beef futures contract. This is so because profits are made from routine long positions when hedgers are net short in the market; these profits are made because futures prices tend to rise during the life of a contract. To determine whether the degree of normal backwardation is strong enough to cause lopsidedness or biasedness against the short positions, additional evidence must be examined.

Figure 6 is a plot of the residuals derived from regressing separately actual slaughter steer prices on futures market prices and cash slaughter prices quoted six months in the past. It can be seen from the graph that during the early period of trading, futures prices tended to overestimate future cash prices but consistently underestimated future cash prices during the recent period of trading beginning in 1968. In Chapter II, it was pointed out that insufficient long speculation, when hedging positions are net short,[18] caused futures prices to

[18] At least reported large scale positions.

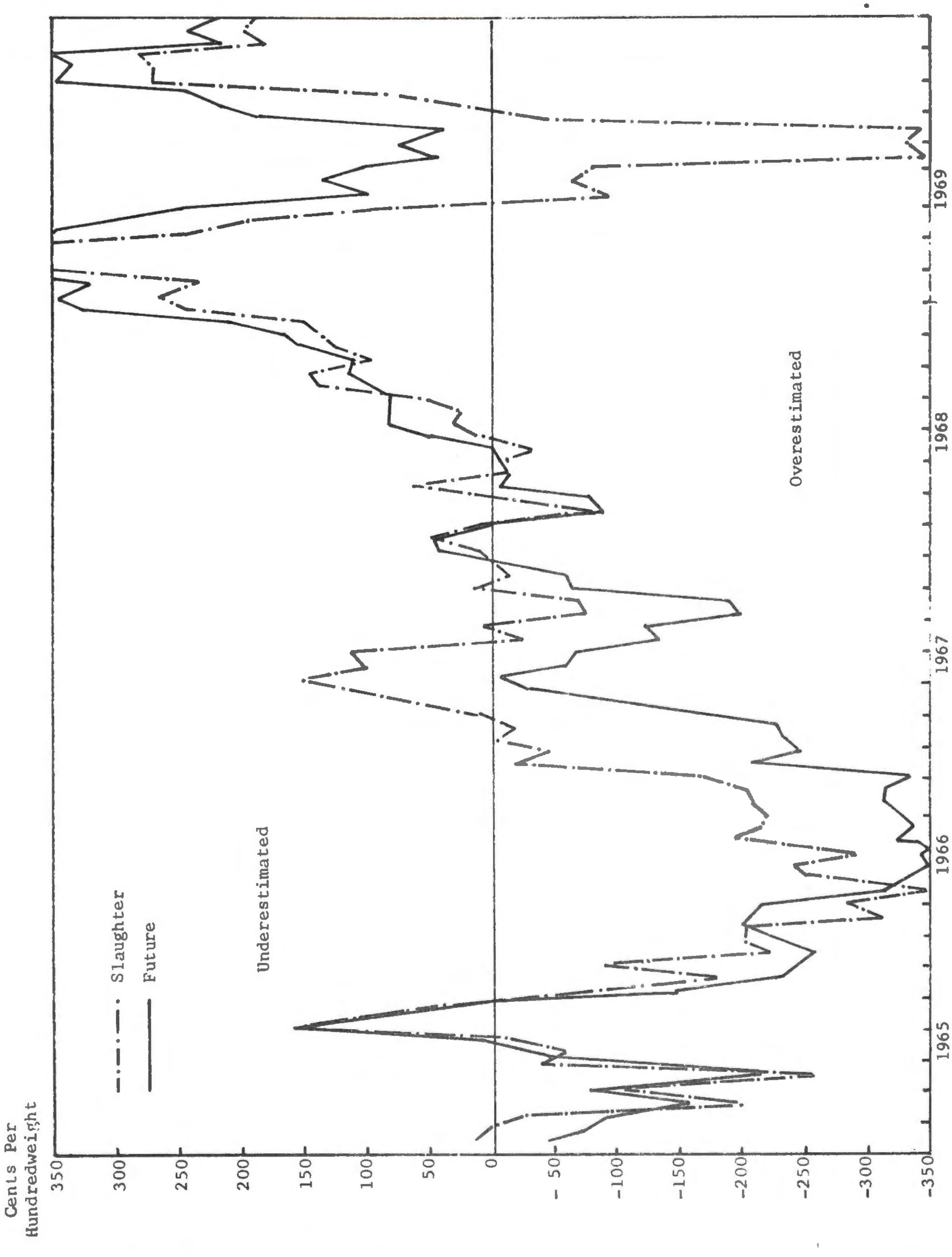

Figure 6. Comparison of current slaughter prices and futures prices in predicting actual slaughter prices six months in the future.

underestimate future cash prices. This is because excess selling of futures contracts causes futures prices to be depressed. A lack of long speculation is also indirectly evidenced by the large positive returns which accrue to a routinely long position.

In view of the evidence in favor of routine long positions, it might be argued that short hedgers are not able to use the live-beef cattle futures market effectively by taking a routine short position which coincides with cash market transactions. However, a short hedger will take a position only when total feeding costs, expressed in dollars per hundredweight, is less than the futures market price quoted for the relevant delivery month. In this case, the hedgers locks in a return above total feeding costs. He is assured this return if cash and futures prices come together when offsetting liquidating transactions are made.

Figure 7 is an attempt to approximate this type of hedging operation. Using the cost estimates derived in Section II above as a proxy variable for total feeding costs, the dotted line traces the differences between futures market prices and total costs. Only when this difference is greater than zero a short hedge will be made. Returns from hedged positions are given by

$$P_{t+n} - C_n - (F_{it+n} - F_{it}) \geq 0$$

where C_n is the cost estimate representing total feeding costs and unhedged returns are given by

$$P_{t+n} - C_n \geq 0.$$

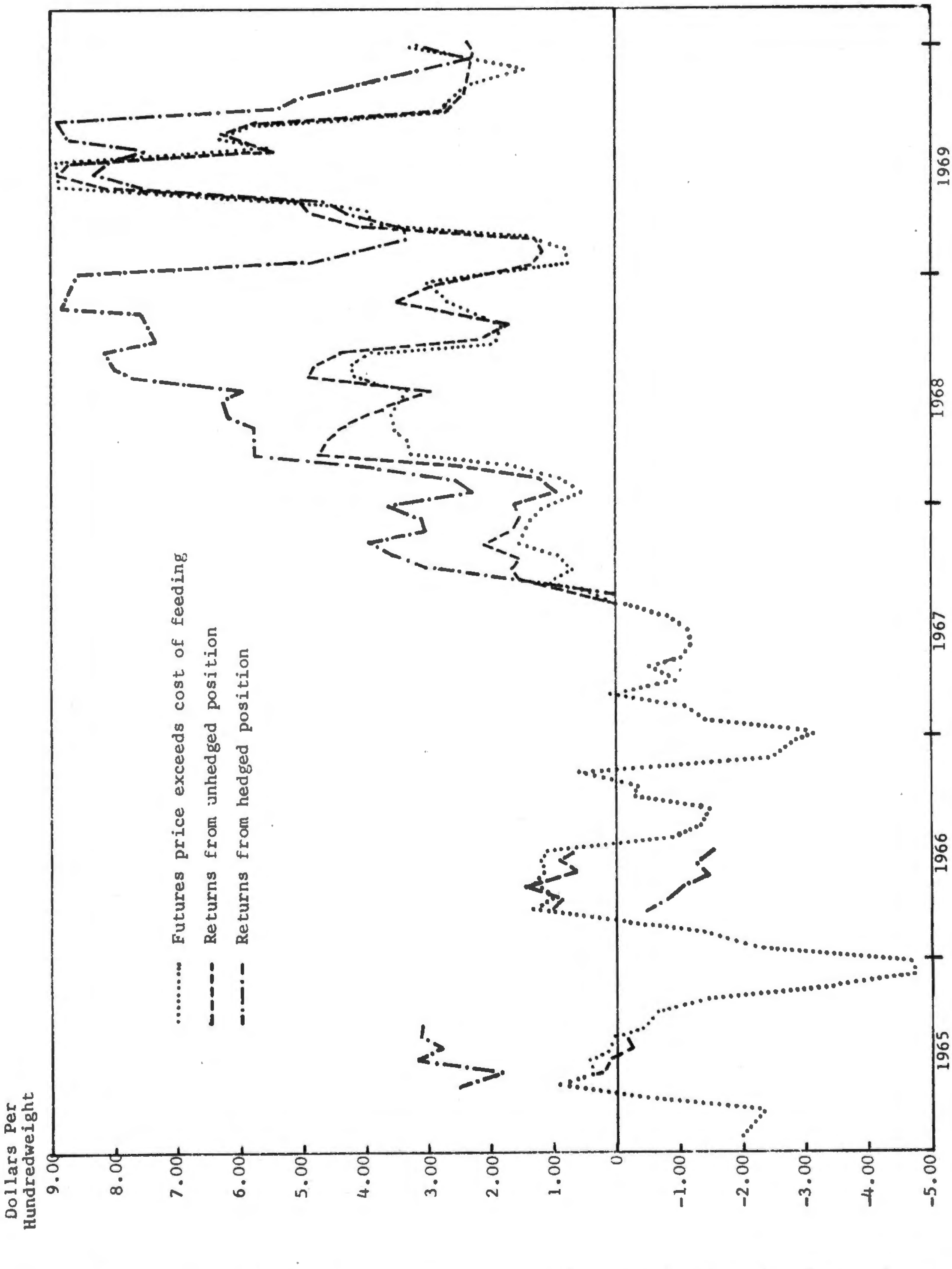

Figure 7. Comparisons of returns from hedged and unhedged positions when futures prices exceed feeding costs.

It should be noted that returns from hedged positions follow very closely the returns that the feedlot operator attempted to lock in at the start of the hedging operation. Although the feedlot operator, on the average, would have received higher profits by not hedging, this type of hedging operation shows that a short hedger can use the market effectively in spite of the returns to routine long positions.

From the evidence presented in this section, three conclusions can be made about the beef futures contract during its more recent history of trading.

First, routine long positions have received substantial returns on the live-beef futures market. Second, a discriminate hedger, taking a short position only when the futures price exceeded feeding costs, would have been able to realize the profit which he locked in at the beginning of his feeding program. (An important implication of this conclusion is that cash and futures prices have tended to converge during the last trading days of the delivery months.) Third, futures prices, quoted for delivery six months after the date applicable, have consistently underestimated cash prices of slaughter animals.

It has been shown that relative to estimated total feeding costs unhedged positions yielded higher returns than hedged positions. This evidence, however, should not serve as an indictment against the futures but rather be taken as a reflection of the inflationary conditions that have prevailed over the last three years. Also, the type of hedging operation assumed above ignores several options open to a short hedger which affect the returns of a hedging operation.

First, following Stein, he need not hedge his entire stock. Second, and most important, the feeder need not hold a hedged position during the entire length of his feeding program. Rather, he can commence his feeding operation with the intent of selling a futures contract some time in the future when the futures market price reaches higher levels relative to the total cost he incurs in feeding out the animals. Also, an experienced feedlot operator may have gained some expertise in predicting the changes of the price relationship (his local basis)[19] between his local cash market and the futures market. In this case, following Working's observations (22) the feeder places and lifts hedges in anticipation of these changes in the local basis. In short, the feeder has a multitude of options open to him, which enable him to use the futures market to best advantage in spite of the fact that long positions have been receiving positive returns during the past three years. It follows that the execution of these different types of hedging operations at different times during the life of a futures contract will exert different influences on futures market prices.

The tendency for futures prices to underestimate cash prices suggests that short selling activity is the primary influence on futures prices of distant contracts. One would suspect that speculators are less reluctant to take a distant long position in a market that lacks the type of seasonality, common to the grain markets, which speculators use to formulate their expectations. The purpose of the final section of this thapter is to obtain a more accurate notion about the type of

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[19]A feat much more easily accomplished than predicting changes in the absolute price level.

trader who takes a position in the live-beef futures market. It is hoped that such an analysis will bring to the forefront some of the complexities that must be considered in attempting to develop a model purporting to explain the relation between the futures market and the commodity market to which it pertains.

IV. AN EXAMINATION OF THE TYPE OF TRADING GROUPS PARTICIPATING IN THE LIVE-BEEF FUTURES MARKET

Ehrlich's analysis implies that as inventory holders are traditionally short in the well-established grain futures markets, so feedlot operators are predominantly short hedgers.

A recent survey by the Commodity Exchange Authority (3)[20] presented some interesting facts. The survey, taken on May 29, 1969, attempted to obtain more detailed information about the occupation, geographical distribution, and size of position of traders participating in the beef futures market. Two of the most striking facts borne out by this survey are discussed in more detail below, whereas other evidence will be mentioned in passing.

"Livestock farmers, beef producers and ranchers" (3, p. 35) comprised the professional group that took on by far the largest number (in terms of contract units) of short hedging positions. Now, this same professional group also assumed the largest number of long hedging positions. These, in turn, represented about 44 percent of the total

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[20]Unfortunately, this publication, though providing some useful data, contains little, if any, discussion of its findings.

hedging positions taken by this professional group. There are two possible explanations for this. First, feedlot operators use the live-beef futures contract as a partial hedge to protect themselves against adverse price changes of their most important input, feeder steers.[21] This type of hedging operation might take the following form: a feedlot operator has contracted to sell forward 38 finished animals at a given price per hundredweight. Fearing that the price of feeder cattle will go against him by the time he is ready to place them in feed, the feedlot operator purchases a future.[22] The operator can offset his long position when he purchases the feeder cattle and sell, if he chooses, a more distant future.

The second explanation of the fact that such a large number of livestock farmers take long positions is that they are spreading. For example, the beef futures market is an inverse-carrying change market. That is, distant futures are quoted at discounts relative to nearby futures. The feedlot operator, anticipating from experience that the spread between distant futures and nearby futures will narrow over time, will sell the near future and purchase the distant future.[23] One might wonder whether spreading is a normal adjunct to a hedging operation, since the risk of adverse price movements is increased. But, as has been explained previously, hedgers are not in the business of risk avoidance.

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[21]The feeder steer contract deliverable in Kansas City is not heavily traded.

[22]A live-beef contract is a substitute for a feeder contract if the price differential of feed and feeder animals is stable.

[23]If he expects the spread to widen, he will purchase the nearby and sell the distant future.

They are in the business of forecasting relative price changes and expect to profit from their futures market positions.

That feedlot operators use the futures market for reasons other than short hedging is evidenced by the second striking feature borne out by the survey. The report shows that livestock farmers and ranchers, as a trading group, are the second largest speculative group of both long and short commitments (brokerage houses being the largest group). This evidence, coupled with the fact that holdings by professional speculators are virtually non-existent, tends to suggest that livestock farmers and ranchers represent a rather "elite" trading group.[24] They are elite in the sense that a few large scale traders make up the largest proportion of short hedging positions. The survey indicated that about 50 percent of short hedging positions are held by traders having 150 or more contracts. Now, these traders represent, in part, positions of very large feeding operations that may trade on separate speculative and hedging accounts. These operators speculate simply because they have to be informed about the details of the beef business and, as such, believe that they are able to predict future price levels better than any other trading group.

The large speculative and long hedging positions of livestock farmers and ranchers suggest that feedlot operators are not such a homogeneous trading group as Ehrlich implies. Their motivations for using the beef futures market are diverse and complex and further research work

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[24]They are not a dominant trading group since they represent about 31 percent of the total number of traders holding about 34 percent and 38 percent of the total long and short positions, respectively.

needs to be done to explain the reasons why and how feedlot operators use the market.

However, for the purpose of this study, it is important only to recognize that these complexities exist and that they influence the relation between cash and futures prices. Following Ehrlich's analysis, the fact that feedlot operators are a homogeneous group (i.e., predominantly short hedgers) is a necessary condition for cash futures price spreads to reflect feeding costs. But the results of this survey show that feedlow operators are not consistently on one side of the market. An attempt to explain other economic factors in the beef industry to which cash futures prices spreads can be related is beyond the scope of this study.

CHAPTER V

SUMMARY AND CONCLUSIONS

In Chapter I it was explained that Ehrlich's analysis of the first two years of live-beef futures trading showed that cash futures price spreads reflected feeding costs in the feedlot industry. It was not clear, however, whether Ehrlich's conclusion that spreads reflect costs was a condition for the equilibrium relation between futures market prices and feeder steer prices.

Two models exist purporting to explain the equilibrium relation between futures market prices and cash market prices. These models differ on the definition of hedging. Telser's model assumed a narrow definition of hedging and showed that cash market prices adjust to equilibrium futures market prices so that the difference between these prices, the spread, reflect the cost of storage (or feeding). But, as was explained in Chapter III, spreads reflected costs only if changes in short hedging positions were directly related to changes in stock levels (or feeder placements). Ehrlich's model, however, postulated that cash futures price spreads reflected feeding costs if feeder steer prices adjusted to changes in expected prices, as given by futures prices.

Stein's model assumed a broader definition of hedging. Rather than constricting a hedger to a pure risk avoidance type of hedging operation, this model allowed the hedger to partially hedge his stock. In this model an equilibrium relation existed not between spreads and costs but between spreads and cash prices. The condition that spreads reflect cost was explained to be a restriction on the equilibrium relationship between spreads and cash market prices postulated in this model.

The objective of this study was to determine whether Telser's model could be applied to live-beef futures trading, in view of the apparent similarity between Ehrlich's and Telser's model. Specifically, the following hypotheses were tested:

(1) That short hedging was directly related to cattle placed on feed.

2. That cash-futures price spreads reflect feeding costs.

3. That feeder prices adjust to expected prices as given by future prices.

4. That the beef futures market is not biased either in favor of buyer or seller of futures contracts.

The last hypothesis was tested to determine whether the beef futures market itself conformed to the current theories purporting to establish the criteria of a "well" functioning futures market. These theories were reviewed in Chapter II of this study.

The discussion in Chapter IV, the analysis, led to the rejection of hypotheses 1 and 4. The fact that hypotheses 2 and 3 were not rejected tended to support the contention that cash-futures price spreads reflected feeding costs in the feedlot industry throughout its entire history of trading. However, the conclusions that short hedging was not related to commercial placements and that substantial returns accrued to long positions cast doubt on whether the fact that spreads reflected costs was a condition for equilibrium between futures prices and feeder prices. This was reinforced by the results of the CEA's survey which showed that a large part of long hedging and speculative positions were held by feedlot operators. These results, together with the evidence that insufficient speculative interests existed for futures contracts traded in distant delivery months, tended to distort equilibrium futures prices; in particular, futures market prices continually underestimated actual slaughter steer prices during the last two years of trading.

Whether the bias in favor of long positions served as an indictment against the beef futures contract could not be determined. If the returns to long positions approximated hedging costs, it was shown that a discriminate hedger, using a flexible hedging program, was able to realize the return which he locked in at the beginning of his hedging program; yet, an unhedged position would have resulted in greater returns.

The analysis in this study points to one overall conclusion. The reason of traders within the beef industry who use the futures market, particularly of feedlot operators, are too complex to be represented by Telser's equilibrium model. Further research is necessary to determine the specific hedging needs of feedlot operators and to relate these to the types of hedging programs that are available. Only when a typical hedging operation has been identified as being used by the majority of feedlot operators can a representative equilibrium model be developed to describe the function of the live-beef futures market and its relation to the beef industry.

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APPENDIX

APPENDIX

Section 4a, Paragraph 3, of the Commodity Exchange Act, as Amended[1] lists the following definition of hedging:

> No order issued under paragraph (1) of this section shall apply to transactions or positions which are shown to be bona fide hedging transactions or positions. For the purposes of determining the bona fide hedging transactions or positions of any person under this paragraph (3), they shall mean sales of, or short positions in, any commodity for future delivery on or subject to the rules of any contract market made or held by such person to the extent that such sales or short positions are offset in quantity by the ownership or purchase of the same cash commodity by the same person or, conversely, purchases of, or long positions in, any commodity for future delivery on or subject to the rules of any contract market made or held by such person to the extent that such purchases or long positions are offset by sales of the same cash commodity by the same person. There shall be included in the amount of any commodity which may be hedged by any person--
>
> (A) the amount of such commodity such person is raising, or in good faith intends or expects to raise, within the next twelve months, on land (in the United States or its Territories) which such person owns or leases;
>
> (B) an amount of such commodity the sale of which for future delivery would be a reasonable hedge against the products or byproducts of such commodity owned or purchased by such person, or the purchase of which for future delivery would be a reasonable hedge against the sale of any product or byproduct of such commodity by such person;
>
> (C) an amount of such commodity the purchase of which for future delivery shall not exceed such person's unfilled anticipated requirements for processing or manufacturing during a specified operating period not in excess of one year: Provided, that such purchase is made and liquidated in an orderly manner and in accordance with sound commercial practice in conformity with such regulations as the Secretary of Agriculture may prescribe.

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[1]United States Department of Agriculture, Commodity Exchange Authority, "Commodity Exchange Act as Amended, General Regulations," February, 1970.

VITA

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