AN ANALYSIS OF HEDGING EFFECTIVENESS IN LIVE BEEF CATTLE FUTURES AMONG TEN MAJOR CATTLE FEEDING REGIONS

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ABSTRACT

AN ANALYSIS OF HEDGING EFFECTIVENESS IN LIVE BEEF CATTLE FUTURES AMONG TEN MAJOR CATTLE FEEDING REGIONS

By

Keith Holaday Lacy

It has been observed that hedging activities, as measured by the number of open short contracts, in live cattle futures contracts on the Chicago Mercantile Exchange, have not progressed as expected. One possible explanation for this divergence from the expected growth pattern would be that effective hedging cannot, or can only occasionally, be achieved. The validity of this explanation will be explored in the subsequent pages.

The approach employed in attempting to either varify or discount the above probable explanation entailed several steps. They are, in respective order in which they were performed:

1. All known literature which was related, either directly or indirectly to the hedging of live cattle, was reviewed not only in order that an appropriate starting point be established, but also to establish foundation elements upon which my research would be built, Chapter II.

2. The arithmetic average of the 900 - 1100 pound choice steer, live cattle cash-futures price differential during each of the allowable delivery intervals was computed for the California, Chicago, Colorado, Detroit, Kansas City, Omaha City, Sioux City, South Saint Paul, Texas-New Mexico, and the Washington-Oregon fed cattle markets. Data employed in the determination of these price differentials were obtained from weekly slaughter prices as published in Livestock, Meat, Wool Market News, and daily futures closing prices as published in the Chicago Mercantile Exchange year books.

3. These price differentials were subsequently ploted, and their variances analyzed, Chapters III and IV, respectively. The technique employed in analyzing these cash-futures price differentials was that of ordinary least square, (OLS), regression. It should be noted that a step-wise version of the ordinary least squares regression routine was used.

Among those fed markets where there was a reasonably adequate number of observations, Chicago, Kansas City, Omaha City and Detroit, it was generally concluded that the cash-futures price differentials could, given the explanatory variables employed, predicted with only a moderate degree accuracy. Consequently the derived cash market price of relevance cannot be accurately determined. Hence, it was concluded that part, if not all, of the disappointing rise in the level of hedging activity may, in fact, be attributable to a lack of hedging offectiveness.

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A THESIS

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DEDICATION

To my parents

and my wife.

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I would like to take this opportunity to express my appreciation to my committee, which was comprised of Dr. Lester Manderscheid, Dr. George Dike, Dr. Henry Larzelere, and Dr. Richard Lewis, all from Michigan State University, and to Dr. Richard Heifner of the Economic Research Service of the United States Department of Agriculture for their criticisms of and recommendations for improvements of this and subsequent research efforts. And especially to Dr. Lester V. Manderscheid for his continual guidance and support, not only in the writing of this thesis but, throughout my entire graduate career.

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CHAPTER I

INTRODUCTION

Statement of Problem

On November 30, 1964 futures trading in live beef cattle became a reality. This milestone in the history of the beef cattle industry was viewed with much divergence of opinion regarding the extent to which benefits of such futures were to be derived by beef cattle feeders and/or meat packers. At the close of the first day of trading, 191 trades had been made, and 141 contracts remained open [1]. From September 1969, at which time the total number of open contracts peaked at around 32,680,1/ there was a substantial decline in the number of open contracts of live beef cattle (see Figure 1). Following the September 1969 peak, the market witnessed a persistent decline in the total number of open contracts. This decline lasted until the following September. The total number of open contracts in live beef cattle bottomed out during September and October of 1970, and then began a brief rally which lasted until March of 1971. Since that time, the number of total open contracts have declined. Parallel occurences were also witnessed in the number of non-reporting total long and short commitments, reporting speculative total long commitments, and reporting hedging long and short commitments. Reporting speculating total short commitments did not follow the above pattern of movement. For the most part, reporting speculating total short

1/ Commencing with the August 1969 Futures contract, contract size was changed from 25,000 to 40,000 pounds.

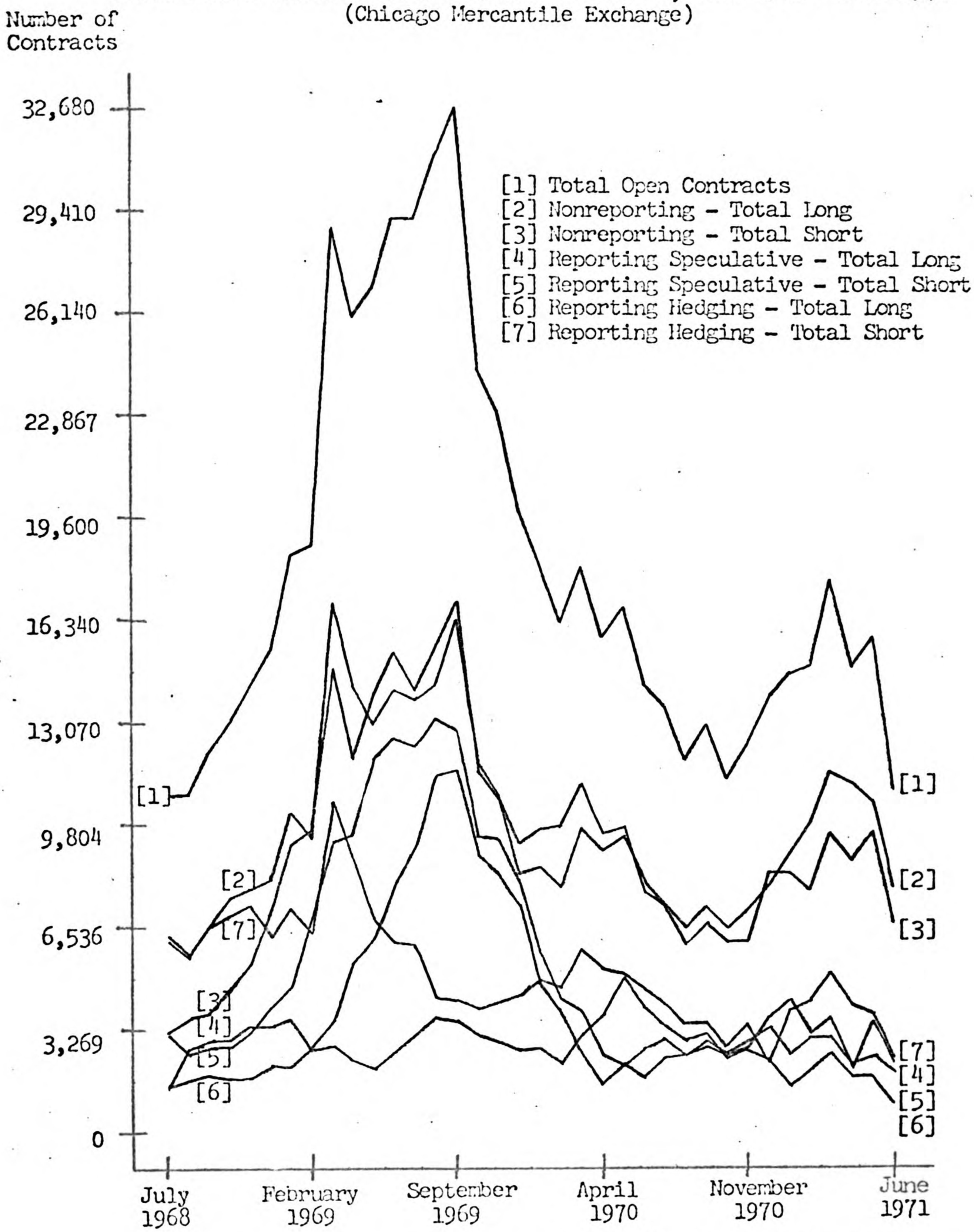
commitments varied relatively less throughout the entire period observed. In almost every case, the respective June 1971 level of number of open contracts is approximately equal to the July 1968 level [2].

The cause of the decline in total number of open contracts, and related positions and commitments is not readily assessable to any one particular class of traders and/or kind of commitment.

A relevent and immediately forthcoming question, given the forementioned observations is, does the failure of this market to continue to grow reflect a lack of hedging effectiveness throughout part, or all of the live beef cattle industry? That is, is the standard error of the estimate of the predicted cash-futures price differentials so large that subsequent accurate estimation of the derived cash market prices are not possible when employing the live cattle futures price as a base estimate; hence, effective hedging is not possible.

Obviously, to effectively evaluate hedging potential in each of hundreds of cattle feeding regions or areas would not only be extremely costly in terms of manhours and related research expenditures, but also the skill and insight required would be monumental. As a consequence, it is my intent in the following portions of this thesis to evaluate the heding effectiveness within each of ten major cattle feeding regions within the United States. The regions to be evaluated include Chicago, Kansas City, Omaha City, Sioux City, South Saint Paul, Detroit, California, Texas - New Mexico, Colorado, and Washington - Oregon.

MONTHEND LONG AND SHORT COMMITMENTS OF REPORTING AND NONREPORTING TRADERS: LIVE BEEF CATTLE FUTURES, JULY 1968 - JUNE 1971
(Chicago Mercantile Exchange)



Source: United Stated Department of Agriculture, Commodity Exchange Authority. <u>Commodity Futures Statistics.</u>

Figure 1.

Thesis Objectives

The primary objective is to evaluate the relative effectiveness of hedging live beef cattle in each of ten major beef cattle feeding regions of the United States. More specifically, the fundamental objectives of this thesis are as follows:

1. Determine previous cash-futures price differentials of 900 - 1100 pound choice steers, based on historical data, for all possible futures delivery intervals by each of ten major fed cattle markets.
2. Formulate a model for each fed cattle market which could be employed in predicting any given future live cattle cash-futures price differential.
3. Compare the degree of hedging effectiveness among ten major fed cattle markets, and make recommendations concerning the use, or nonuse of hedging as a marketing tool to minimize price risks.
4. Make recommendations regarding future research efforts on the prediction of cash-futures price differentials for live cattle.

Format of Material

The general order in which the objectives are to be met, hence the order in which related material will be organized, is according to the following format. Chapter II will contain a summary of the primary researched areas and relevant literature related to live beef cattle futures and the hedging of live beef cattle, their results and conclusions, and especially implications regarding hedging effectiveness. Included in Chapter III will be a brief summary of those forces affecting both cash and futures prices, and their interrelationships, followed by the determination of normal cash-futures price differentials for cash delivery interval by market. A review of available data and its qualities along with proposed methodology for empirically testing the foregoing hypotheses will also be included at this point. Empirical verification of these relationships will then follow. Presented in Chapter IV will be the formulation of a cash-futures price differential model and the application thereof to each of the forementioned fed cattle markets. Chapter V will deal exclusively with the findings of Chapter IV and the resulting implications. Chapter VI will encompase a relevant summary and conclusions, and recommendations as to worthwhile areas of research related to predicting live cattle cash-futures price differentials.

CHAPTER II

LITERATURE REVIEW

Overview

Published research and other scholarly works related to live beef cattle futures, and/or hedging of live beef cattle are apparently limited, not only in the number of literary works, but also, in scope and depth of analysis. A disproportionate share of the known literature has focused chiefly upon describing the emergence of live beef cattle futures, what it is, how it differs from traditional agriculture commodity futures such as corn, oats, and soybeans, how it works, its expected benefits, and how to employ it in a typical beef cattle feeding operation, or alternatively, within the context of a typical meat packing operation. The remaining related literature has focused primarily upon, (1) the theory and application of hedging live beef cattle, (2) factors influencing live beef cattle futures prices, (3) cash - future price relationships, and (4) hedging models. What is believed to be a fairly complete listing of published and unpublished research or literature which deals with live beef cattle futures and/or the hedging of live beef cattle and related literature is to be found in Appendix A.

From amongst the gamut of literature mentioned above, only the latter portion has relevance to the previously stated objectives of this thesis. Taking each of the five forementioned topics in their respective order, and briefly discussing the findings and conclusions of each, valuable insights into the determination of hedging effectiveness of live beef cattle can be obtained.

Theory of Hedging Live Beef Cattle

Claude L. Jones' "Theory of Hedging on the Beef Futures Market" is basically an exposition comparing the Keynes, Hicks, and Working theories of the existance and use of hedging as they apply to beef futures [3, pg. 1760].

According to Jones, Keynes hypothesized that given an assumed situation, referred to as "normal conditions", wherein supply and demand remain constant at some previously determined level, the future prices for one months' delivery would tend to be below the spot price now ruling. As a result, the basis which has frequently been referred to as normal backwardation, is the amount paid to the speculator by the hedger as compensation for assuming the price level risk [3, pg. 1761]. Hicks, according to Jones, asserts that the uncertainty of the future price level, and ones' desire to remain free to handle unexpected situations, is the main foundation upon which forward contracting, (and related price fixing schemes, such as futures markets and custom feeding) are based [3, pg. 1761]. In short, risk aversion of (adverse changes) in the price level is the primary influencing factor. Furthermore, by being able to establish a fed or finished price at the beginning of the production, and/or trading process, resource allocation decisions can be made with greater efficiency [3, pg. 1761].

Jones goes on to present Working's theory of hedging. According to Working, a (short) hedge would be executed only when the (cash) price is high in relation to expectations [3, pg. 1762]. Putting it another way, the behavior of hedgers suggests that a primary factor in determining whether to, or not to hedge, depends upon market price expectations and the relationship of the prevailing cash price, relative to the prevailing normal price for the comparable period of time [3, pg. 1762].

Relevant conclusions reached by Jones are, that in general, (1) "the use of the hedging tool as a risk remover is a valid generalization, but, (2) it (also) seems only logical to avoid hedging if the expected price movement is favorable, (i.e. upward) for the producers [3, pg. 1766]. This latter conclusion was also reached in an earlier work by Skadberg and Futrell, which will be noted shortly. Similar behavior is expected on the part of traders of live beef cattle.

What remains in question is the ability of individual producers, or traders to accurately anticipate price movements at various stages throughout the production or trading process.

Three relevant implications of the above conclusions are that (1) increased hedging activity would be expected on the upswing of the production cycle, (2) during periods of unusual price level uncertainty, attributable to either a market or non-market set of causal forces hedging activity would be expected to trend upward, (3) the effect of a particular hedge depends in part upon the hedgers ability to anticipate adverse or favorable changes in the cash market price for his specific commodity.

Factors Influencing Live Beef Futures Prices

Literature explicitly relating to the isolation of those factors influencing live beef cattle futures price, and how to analyze the movements thereof apparently number only two. They are, "Price Making Influences in the Cattle Futures Market" by George B. Parker [4], and "How to Analyze Live Beef Futures Price Movements" by Oppenheimer [5].

Only Parker's article attempts in any way to expand the rather traditional list of potential factors influencing beef cattle futures prices. The list of eight traditional theoretical influencing factors mentioned by both Parker and Oppenheimer include (1) cattle numbers, (2) type of animal on hand, (3) cost of feed, (4) the weather, (5) population growth, (6) level of consumer disposable income, (7) and the production of read meat substitutes. Also mentioned by both are (8) changing consumer tastes and preferences with respect to not only kind of cut and/or product, but also quality. Parker suggests that the daily run of cattle to major terminal markets and (2) the expected daily receipts are significant forces which generate changes in the daily level of futures prices [4, pg. 32]. Unfortunately, neither Parker or Oppenheimer attempt in any way to quantatively verify the relative importance of each of the above theoretical influencing factors.

There were no explicitly stated relevant implications or implications that be derived directly from either of these articles. Both articles, though, implicitly suggest that a futures price is essentially a forecasted price. Parker goes on to suggest that the daily futures prices are affected not only be actual daily receipts at the major terminals, but also by the expected receipts. A possible implication of this being that actual and expected receipts, above or below previously anticipated normal levels reflect appropriate adjustments in the expected volume of beef cattle to arrive at a future point in time.

Cash-Futures Price Relationships

In depth research focused primarily upon understanding, and predicting cash-futures price relationships, specifically relating to choice grade live beef cattle are limited to three. In addition, effort has been directed at interpreting the basis between feeder cattle at varying weights and live beef cattle futures. The intent of these latter works, "Pricing Feedlot Services Through Cattle Futures", by Allen Paul and William T. Wesson [6], and "Cash-Futures Price Relationships for Live Beef Cattle" by R. L. Ehrich [7], respectively, suggest and quantitatively verify that live beef cattle futures in conjunction with prevailing feeder cattle prices can be employed, to formulate a competitive charge for services rendered by live beef cattle feeding operators. A third article by Mark J. Powers, "Does Futures Trading Reduce Fluctuations in the Cash Markets?" [8] focuses upon, as is adequately reflected in the article's title, the impact of the existence of live beef cattle futures upon the random components of the corresponding cash markets.

Paul and Wesson employ graphic and tabular techniques of analysis. Ehrich, also employing tabular and graphic techniques of analysis, builds upon the earlier work of Paul and Wesson. This relationship is subsequently tested using weekly prices, and verified. Ehrich explicitly stated, as also does Paul and Wesson, but only in an implicit way, that ". . . Cash prices of feeder cattle are tied by economic forces to prices of futures contracts" [7, pg. 27]. However, nowhere in either article is the theoretical relationship, inclusive of specific variables and time lags, explicitly stated. Consequently, even in light of their apparent quantitatively verification, the degree of validity of their conclusions is questionable.

Powers' article focuses upon the impact of the existence pork bellies and live beef cattle futures upon the degree of variability in the random component of prices in these markets. The approach used is his analysis employs the variate difference method, applied to weekly data. He chooses to concentrate his analysis upon the random (error) component, rather than upon the systematic, or both random and systematic components. His alternative hypothesis was significant, at an alph level of 0.05, in both cash markets, past the introduction of each respective futures[8 pg. 463]. The validity of his results are enhanced given the fact of little, if any, change in information flows that occurred during the time periods under analysis [8, pg. 464].

Powers concludes by stating that ". . . part of the reduction in the variance in the random element can be attributed to the inception of futures trading in these commodities." The causal . . . "relationship between (these) reductions in random price fluctations and futures trading is explained in part by the improvement on the information flows fostered by futures trading" [8, pg. 464]. One relevant implication would be that futures prices are being employed in the production planning process as valid estimates of some live beef cattle and pork bellies price given a predetermined future date, such as during the delivery interval of a futures contract.

Relating specifically to live beef cattle cash - futures price relationships, four additional articles are outstandingly significant. They are "Futures Trading, Direct Marketing, and Efficiency of the Cattle Marketing System" by R. L. Ehrich [9], "An Economic Appraisal of Futures Trading in Livestock" written by Skadberg and Futrell [10], both were published during 1966, and Haverkamp's article, "Changing Role of Futures Markets: Potential Developments in Futures Markets of Significance to Agriculture and Related Industries" [11], and "An Evaluation of Futures Trading in Beef Cattle" by Turner [12].

One of the most interesting, concise, as well as relevant articles encountered, throughout my review of literature, was that by R. L. Ehrich entitled "Futures Trading, Direct Marketing, and Efficiency of the Cattle Marketing System". In a matter of only a few pages, he thoroughly covers, to mention but only a few topics, the characteristics of futures markets which contribute to more efficient pricing of live beef cattle, a limitation of futures markets with respect to increasing the coefficient of pricing efficiency, actual and expected futures price behavior, and the futures market as a source of price information.

In just as concise a form as the article was written, the conclusions he reaches include, (1) that an organized futures market in live cattle has by necessity enhanced pricing efficiency for cattle [9, pg. 5],

(2) since live cattle cannot be accurately graded, and that futures trading is done on a description, rather than an inspection basis, the potential level of improvement in the level pricing efficiency coefficient is limited [9, pg. 6], (3) that futures prices will be "unbiased predictions of future price levels, (and will) reflect the lowest quality cattle that meet the specifications of the (futures) contract; and tend to equal cash prices (of the lowest deliverable quality) during the delivery month" [9, pg. 7], (4) that futures prices will tend to reflect only broader cash price movements of the average quality within grade standards set forth in the cattle futures contract [9, pg. 9]

Ehrich conveyed in his article an attitude of optimism regarding the success of, and benefits derived from, beef cattle futures. Skadberg and Futrell, on the other hand left the impression of being pessimistic toward beef cattle futures being a significant marketing tool to be employed in the reduction of price level risk. The major premise of their, Skadberg and Futrell's, paper "is that futures markets per se are of no economic value to an industry . . . (unless they) . . . offer hedging potential or perform a valid pricing function" [11, pg. 1485].

Skadberg and Futrell approach their economic appraisal of livestock futures with a discussion and evaluation of futures prices as they relate to slaughter prices and quality. This is followed by reviews and conclusions regarding each of the following topic areas, the production-utilization pattern, basis, comparability of cash and futures market positions, hedging incentative and the role of the futures regarding pricing in the slaughter market.

Significant conclusions of relevance to our analysis reached regarding each of the forementioned topic areas, are as follows. First, the degree to which price level perfection is attainable with live beef cattle futures is limited to the extent that (1) the price range for USDA choice steers is typically wide and (2) that the price relationship between various weight-quality combinations within choice grade beef are characterized as highly variable [10, pg. 1486]. Second, "basis and basis change with respect to time periods, of key importance in most futures markets, do not appear to be relevant in the live cattle market" [10, pg. 1487]. They further conclude that, "there is no reason to expect consistent basis patterns, related to time periods, between the cash and futures markets. The exception, of course, is a contract maturity, at which time the two markets must be in close accord if substantial deliveries of production are to be avoided. At other times, cash prices might logically be above or below a particular futures contract, depending upon current conditions" [10, pg. 1487].

Regarding the degree of comparability of futures markets for live cattle, and comparable slaughter markets, Skadberg and Futrell reiterate that live beef cattle futures deviates from the traditional cash-futures markets relationship in that the commodity under consideration is continuously, rather than seasonally produced, as well as being relatively nonstorable. As a result, " . . . cash and futures market positions are not comparable except when the cattle achieve minimum prescribed weight and quality characteristics" [10, pg. 1488].

In addition to earlier comments regarding the pricing role futures markets perform, Futrell and Skadberg also state that, "Each (live beef cattle futures) contract should logically respond to factors effecting it individually with a low degree of interdependency between contracts a reasonable expectation" [10, pg. 1488].

The relevant contribution of Haverkamp's article to the topic at hand is minimal. He, though, does point out that attempts to explain cash-futures price spreads in terms of supply-of-services have not proven a satisfactory approach. As a consequence, in part, " . . . a void exists in the theory of cash-futures price spreads for nonstorable commodities" [11, pg. 842]. Haverkamp goes on to point out the observation that, ". . . In a substantial number of times it was impossible to execute a satisfactory short hedge" [11, pg. 842]. This observation, obviously has serious implications regarding the degree to which cattle feeders may shift his price level risk.

Turner's article, "An Evaluation of Futures Trading in Beef Cattle," presents many of the same arguments and reaches similar conclusions to those of Skadberg and Futrell, and Haverkamp. In addition, though, he suggests that the introduction of a futures market in live beef cattle was perhaps more strongly influenced by profit motives on the part of the commodity brokers than as a valid marketing tool to eliminate some of the price level risk faced by packers and feeders. The basis for his argument centers around the timing of the introduction of live beef cattle futures and the cyclic swings in fed beef cattle of choice grade steers within the 900 to 1300 price range. Why else would one introduce a marketing tool of which one of the primary objectives is that of offering hedging potential at a time when potential benefits from executing a hedge were likely to be negative [12, pg. 4].

One additional point noted by Turner concerns the relationship between open interest and price fluctuations. He states, "(in) general, the amount of open interest in contracts reflects the amount of speculation in the futures market, but more particularly, a big increase in open interest is accompanied by a large price fluctuation. It measures the amount of risk that is transferred from inventory holders to speculators. It also represents the volume of live cattle required to settle all contracts if trading were to cease" [12, pg. 7]. He continues by suggesting that, "(day) to day changes in volume of trading may be closely associated with price changes whereas open interests tend to build up as supplies move into hedgable positions and tend to diminish as the delivery date approaches" [12, pg. 8].

Unfortunately, none of the foregoing hypotheses were empirically tested and thus, verified. These hypotheses suggest implications regarding past, present and future hedging potential in live beef cattle futures. First, so long as the expected slaughter price of live beef cattle is favorable, short, and corresponding ultimate offsetting long positions, hedging activity will be at a minimum. Putting it another way, the incentive to employ cattle futures in a feeding operation is minimized since hedging potential is minimized. And second, speculative interest significantly increases only when some price change threshold has been exceeded. Consequently, significant changes in the degree of risk shifting from hedger to speculator is dependent upon significant changes in those factors affecting the market price for live beef cattle.

The fourth and final topic area of relevance to us concerns that of formulating the optimal ratio of hedged to unhedged inventory of a given commodity, which minimizes price level risk. Such a scheme is typically referred to as a hedging model of particular interest, therefore, are the articles written by Elder, and Ward and Fletcher entitled, "Risk, Uncertainty, and Futures Trading, Implications for Hedging Decisions of Beef Cattle Feeders," [13] and "From Hedging to Speculation" [14], respectively.

Elder's paper touches upon many aspects of futures trading. Of most importance to us herein are his comments regarding the proportion of hedged to unhedged beef cattle with respect ot risk minimization and profit maximization. The particular technique employed in determining this optimal proportion is a modified version of the Johnson-Stein formulation of the theory of hedging [13, pg. 24]. After much mathematical derivation and manipulation, he concludes that "(the) optimal proportion of expected output hedged thus depends on the degree of correlation between the finished weight of cattle and the price received for finished cattle . . . as well as the degree of correlation between the variable costs of production and the price received for finished cattle . . ." [13, pg. 44]. To put it another way, ". . . the smaller the correlation between production costs and output prices, and the smaller the variation in costs relative to prices, the larger will be the optimal proportion of expected output hedged" [13, pg. 44].

The Ward and Fletcher article, which apparently was formulated and written independently of Elder's paper approaches the problem in a similar manner, reaching essentially the same conclusions. Neither work deals explicitly with the timing of the hedge. Rather, both theoretically explore the problem of what proportion of "inventory" is to be hedged.

The one relevant implication derived from both of the foregoing works is that the effectiveness of a hedge, measured in terms of net returns, need not necessarily to be a one-to-one futures to cash position. As a matter of fact, it is very possible that by employing a one-to-one futures cash relationship, the hedging action may eliminate some potential profit. Hence, the traditional concept of taking a one-to-one, or as near as possible futures to cash position may not be necessarily valid for all commodities, more specifically for live beef cattle.

Conclusions

Numerous conclusions, most of which were theoretical, though a few were quantitatively verified, have been reached throughout the foregoing review of literature. Some of these conclusions contributed to the pool of knowledge regarding live beef cattle futures and hedging. Other conclusions were not expansive of our knowledge on this subject. A synopsis of the relevant foregoing conclusions is best presented by the following listing.

1. Theoretically, a particular live beef cattle futures price is the forecasted price of the minimal acceptable commodity weight-quality characteristics, during the closing interval

of a particular futures contract in Omaha post appropriate discount adjustments.[1/]

2. That live beef cattle futures prices are relatively unbiased, best estimates of future live beef cattle price.

3. Unlike traditional agricultural futures commodities, the concept of basis, and its relationship to the storage function, with the possible exception of the delivery interval of a particular live beef cattle contract, is null and void.

4. The traditional technique of establishing a one-to-one ratio between volume of futures and volume of commodity on hand, is not necessarily the optimal proportion with respect to minimizing risk levels, and/or maximizing net returns.

5. Criteria of a potentially effective hedge are two fold. First, (1) it must be possible to enact a successful position in the futures market and second, (2) the ability to foresee those factors which may cause unfavorable price movements within ones particular market, and also, predict the relevant cash-futures price differential.

6. The degree to which the live beef cattle futures market will be utilized in feeding and packing operations is dependent upon future price expectations and the level of variability of those expectations. Such expectations are likely to be related to the cyclic price trends for slaughtered beef cattle.

1/ Specific inventory months of interest at varying intervals throughout the production process were not stated. These were generated by the author and are included herein in Chapter III.

CHAPTER III

CASH AND FUTURES PRICES AND THEIR INTERRELATIONSHIPS

Inputs Useful in the Evaluation of a Potential Hedge

Consideration of the expected worth of even a single hedge could demand a significant amount of a commodity manager's time. The obvious reason being that price expectations were involved. To execute a short hedge during periods of a predictable price rise, or a long hedge during periods of a predictable price dealing may result in locking out profits. Conversely, not to place a short hedge during periods of a predictable price decline, or a long hedge during periods of a predictable price increase may result in substantial loss of revenue and consequently net profit.

Obviously, as was mentioned earlier in Chapter II, the individual abilities of both long and short hedgers to accurately predict future prices given all available relevant information has an enormous impact upon the relative worth, value, or potential of the proposed hedging activity.

At a minimum, the evaluation of the following three bits of information are critical: (1) current cash market prices for storable commodities, or in the case of non-storable commodities the expected total per unit production costs to bring the commodity to the prescribed market weight-grade specification, plus acceptable risk compensation, (2) the relevant prevailing futures market price, and (3) the relevant cash-futures price differential during the expected delivery interval. Elder [13] suggests that a fourth bit of information which should be taken into account is the difference in variability between relevant cash and futures prices.

Cash Market Prices

Traditionally, the prevailing cash market price for the commodity of interest were, and still are, first and foremost of concern to hedgers. Justification for this apparent limited focus lies in the fact that nearly all of the commodities which hedgers have been concerned with thus far are seasonally produced, storable commodities such as wheat, corn, oats, or soybeans. Hence, post harvest total supply is determined leaving domestic commodity and/or export demands as potentially significant variables. Consequently, incorporation of these cash prices into hedging schemes was not only logical but very appropriate.

With the introduction of non-storable commodity futures, a new era in hedging commenced. As is currently being realized, application of traditional hedging theory, which was based upon commodities possessing the characteristics of being seasonally produced and storable, to a continuously produced, non-storable commodity such as live beef cattle is inappropriate. A more appropriate set of cash market prices to employ or take into account when considering hedging non-storable agricultural commodities such as live cattle are: (1) the series of cash market prices generated from a specific price forecasting model, given the relevant market and anticipated delivery interval, and (2) the series of total average per unit production costs during the delivery interval, plus some minimal acceptable level of return for risk bearing. In as much as an adequate price forecasting model per region is not as yet available, the futures price plus or minus predicted cash-futures price differential will serve as an acceptable proxy. The determination of historically typical cash-futures price differentials by delivery interval and feeding market will be included under the section entitled cash-futures price differential in this chapter. Predicting this differential, methods employed and findings will encompas Chapter IV.

Futures Market Prices

Futures market prices, be it associated with any of the commodity characteristic combinations of continuously or seasonally produced, and storable or non-storable are essentially average aggregate future price estimates for a specific kind of commodity possessing prescribed futures market contrast characteristics at the effective delivery point(s) which have been appropriately discounted. Consequently, unless the relationships between the applicable forecasted slaughter market price for live cattle and the futures market price and known and monitored for deviations, hedging activities may prove to have a minimal impact, or quite possibly a negative effect.

Concerning those social and economic forces which would influence these futures prices, we must first segment our discussion on the basis of degree of commodity storability. With storable commodities the impact

Placement Intervals for Choice Steers 1,100 Pound Average Fed Weight Objective by Various Feeder Weights and Futures Delivery Intervals.

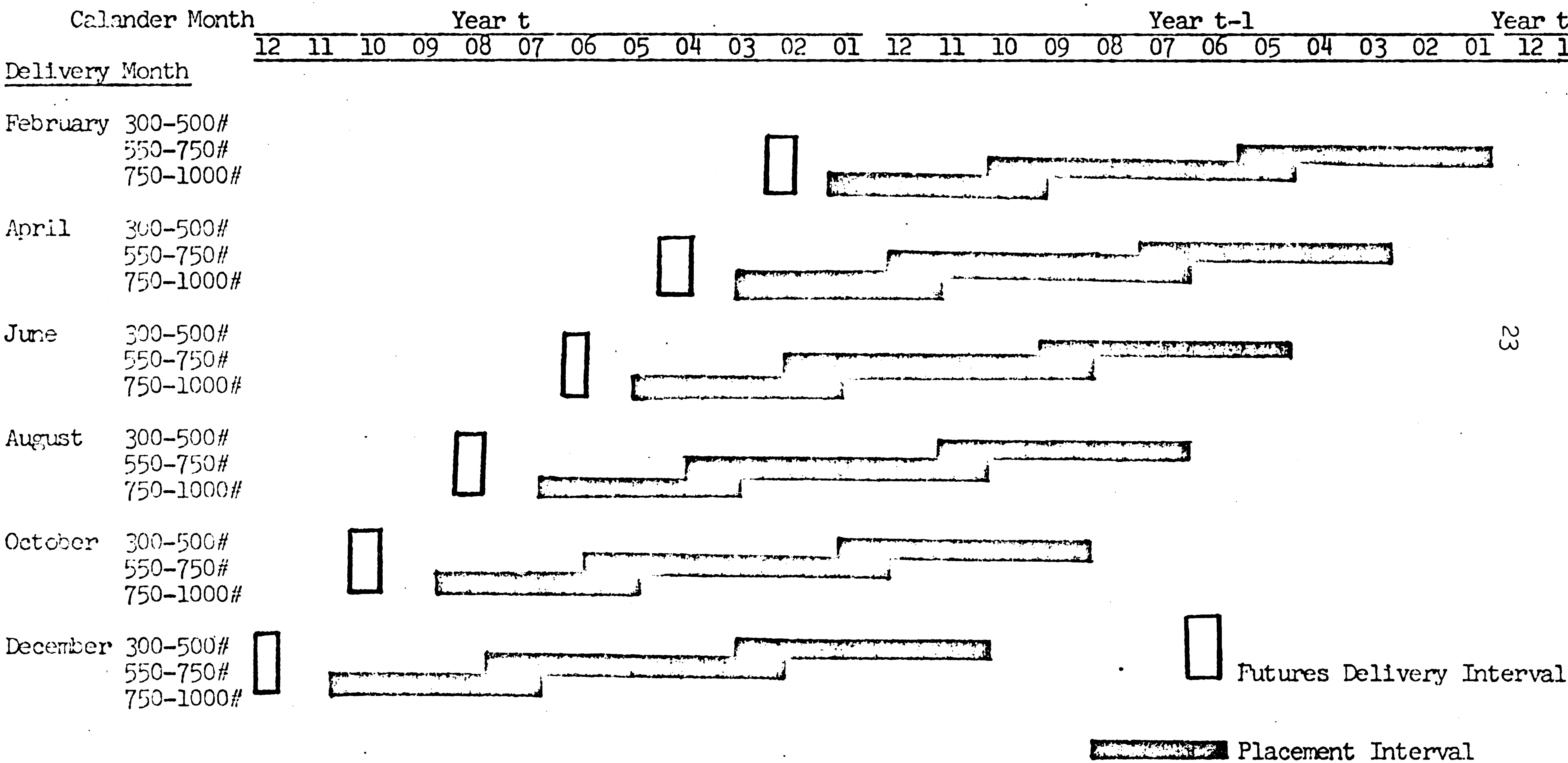


Figure 2.

of production upon price is buffered somewhat. Whereas with non-storable commodities, when commodity maturity is reached, it must be marketed for what it will bring or face the alternative outcome of gaining a nominal return. That is, given that storability is minimal, accurate determination of the particular supply and consumption influencing forces are critical. Of perhaps greater importance than kind of classification of influence is the specific determination or identification of which influences at what point in time are relevant. For live beef cattle which meet the minimum futures contract specifications the relevant supply intervals of significance are tabled in Figure 2 according to expected futures delivery month and current average feeder animal weights which could be brought to prescribed weight by the expected delivery interval.

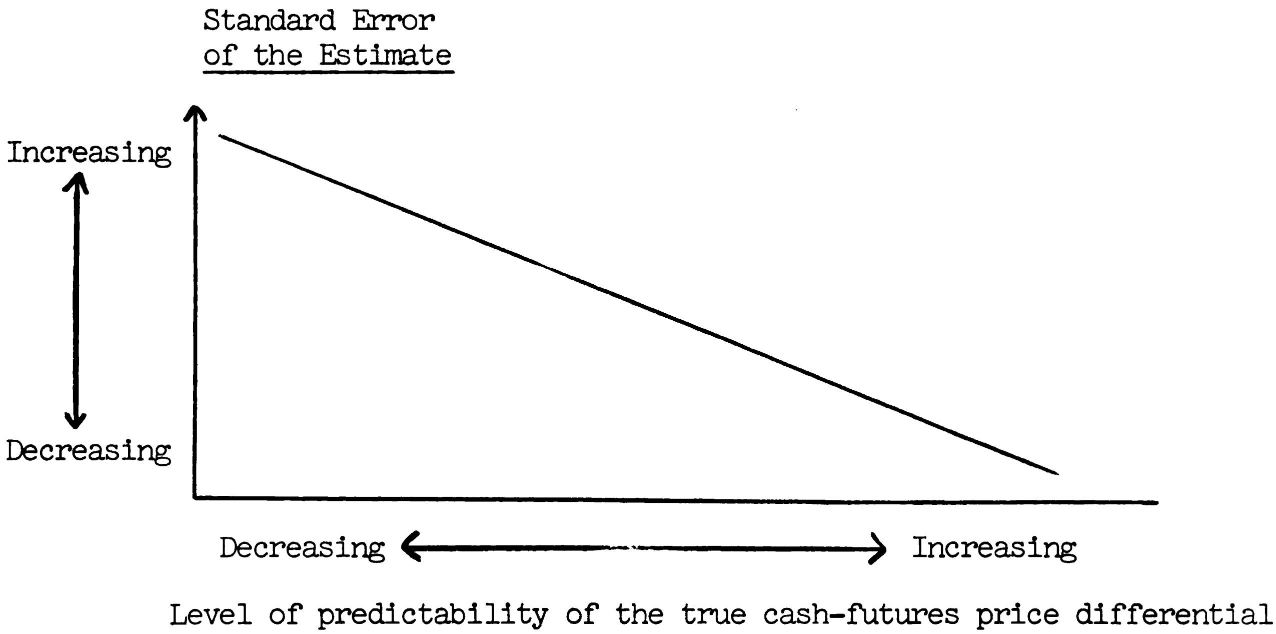
Cash-Futures Price Differential

The typical cash-futures price differential, its degree of variability, and the extent to which it can be predicted for a given commodity during individual futures market delivery intervals within individual cash markets is of major concern to the hedger. It is of concern, simply because the extent to which a given hedge is likely to be effective, i.e. afford price risk shifting qualities, is directly related to the accuracy with which the relevant future cash market price can be estimated. And, one approach to estimating the future cash market price in any one fed cattle market is to employ the live cattle futures price for the relevant delivery month as a base and make subsequent modifications thereupon by adding the appropriate estimated cash-futures price differential. Consequently the relative importance of the cash-futures price differential should be selfevident. Figure 3 and 3b best illustrates this direct relationship between accurate estimation of the cash-futures price differential and the effectiveness of estimating the futures cash market price, and subsequently the effectiveness of a particular hedge.

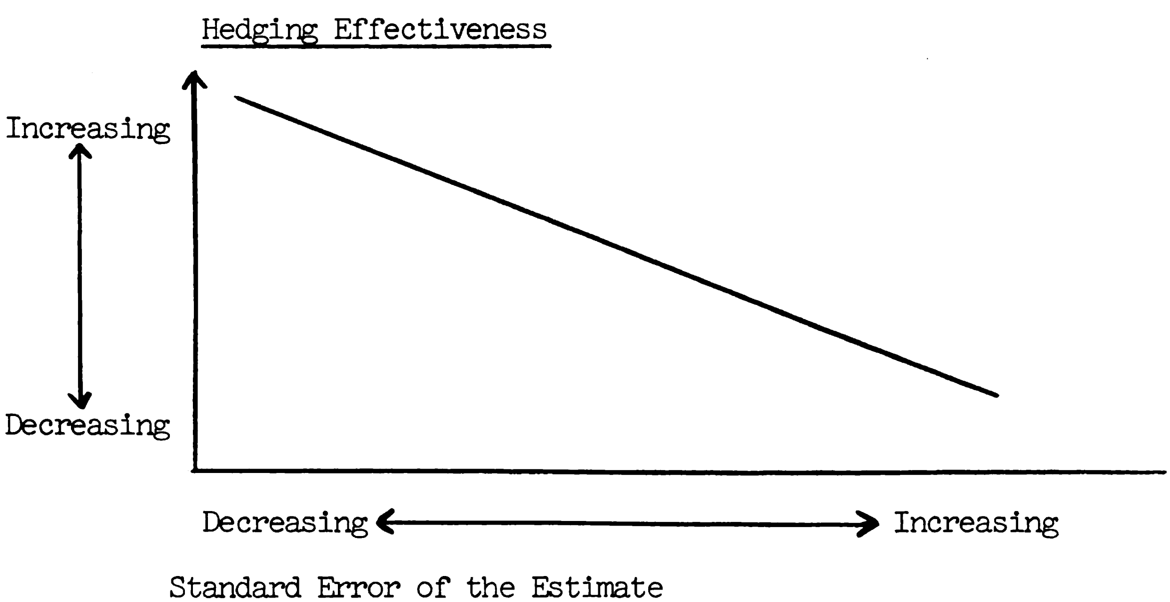
Determination of a future cash-futures price differential within any given market can be accomplished in one of three ways. First, by taking an average of all previous cash-futures price differentials during the allowable delivery intervals, over time, and computing corresponding upper and lower confidence bounds, given some alpha (α) level. To follow this approach would require two rather heroic assumptions. Those being, that (1) the conditions which influenced past cash-futures price differentials will continue to influence future cash-futures price differentials to the same extent, and (2) that the influences which effect previous cash-futures price differentials are equally influertial with respect to individual delivery intervals, within a given production period and between such periods. Obviously, both of these assumptions are too heroic to be employed as a part of this research.

Alternatively, average cash-futures price differentials for like delivery intervals all Februarys and all Aprils, etc., could be computed based on past, i.e. historic, data. This approach would eliminate the second (2) above objectionable assumptions, but not the first heroic assumption.

Illustration of the Relationship Between the Standard Error of the Estimate of the Predicted Cash-Futures Price Differential and the Derived Cash Market Price for Fed 900 - 1100 Pound Choice Steers.



a. Relationship between the standard error of the estimate and the level of predictability of the true cash-futures price differential.



b. Relationship between hedging effectiveness and the standard error of the estimate.

Figure 3.

Removal of the first forementioned assumption, i.e. that are conditions which influenced past cash-futures price differentials will continue to influence future price differentials to the same extent, can be accomplished by simply computing the price differentials for each allowable delivery interval and attempting to explain the variance thereof.

Determination of Average Cash-Futures Price Differentials During Allowable Delivery Intervals

Determination of the respective mean cash-futures price differential involves (1) the computation of the arithmetic mean for each delivery interval over time, and (2) verification of the adequacy with which the arithmetic mean is a valid representation of its respective population.

The sample arithmetic mean cash-futures price differential during live beef cattle futures delivery intervals, based upon weekly average prices for given choice steer weight and market combinations[1/], and weekly average live beef cattle futures prices on the Chicago Mercantile Exchange[2/] from February of 1965 through December of 1969, exhibit rather distinctive pattern, when these differentials are plotted against their allowable delivery intervals, over time. Figures 3 through 6 illustrate the degree of variability and pattern associated

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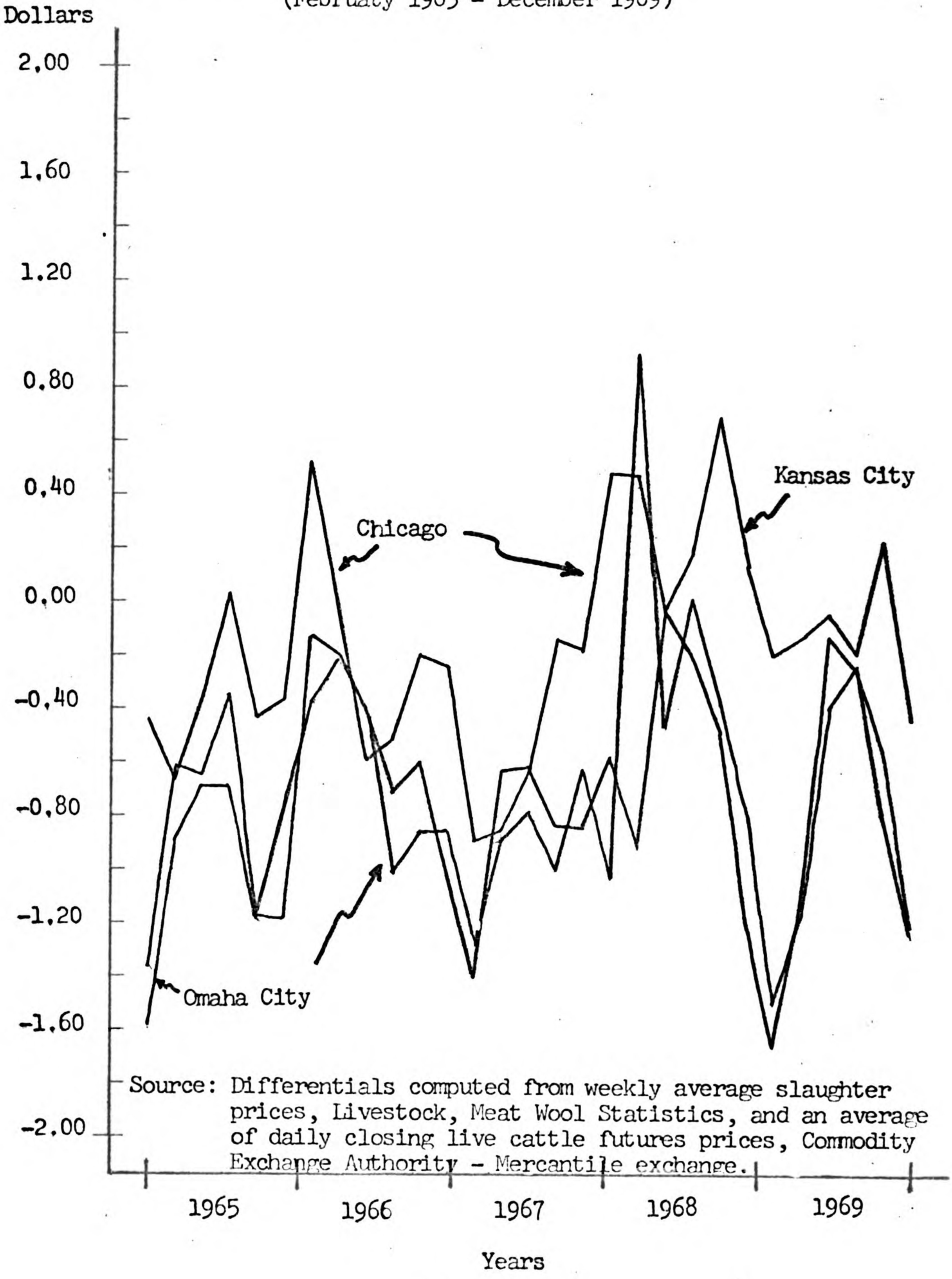
1/ Livestock, Meat, Wool Market News, U.S.D.A., Consumer Marketing Service.

2/ Annual Chicago Mercantile Exchange Year Book.

Sample Mean Cash-Futures Price Differentials During Delivery Intervals for Choice Steers, 900 - 1100 Pounds in the Chicago Omaha, and Kansas City Fed Cattle Markets.
(Februaty 1965 - December 1969)



Source: Differentials computed from weekly average slaughter prices, Livestock, Meat Wool Statistics, and an average of daily closing live cattle futures prices, Commodity Exchange Authority - Mercantile exchange.

Figure 4.

Sample Mean Cash-Futures Price Differentials During Delivery Intervals for Choice Steers, 900 - 1100 Pounds in the Detroit Sioux City, and South Saint Paul Markets.
(February 1965 - December 1969)

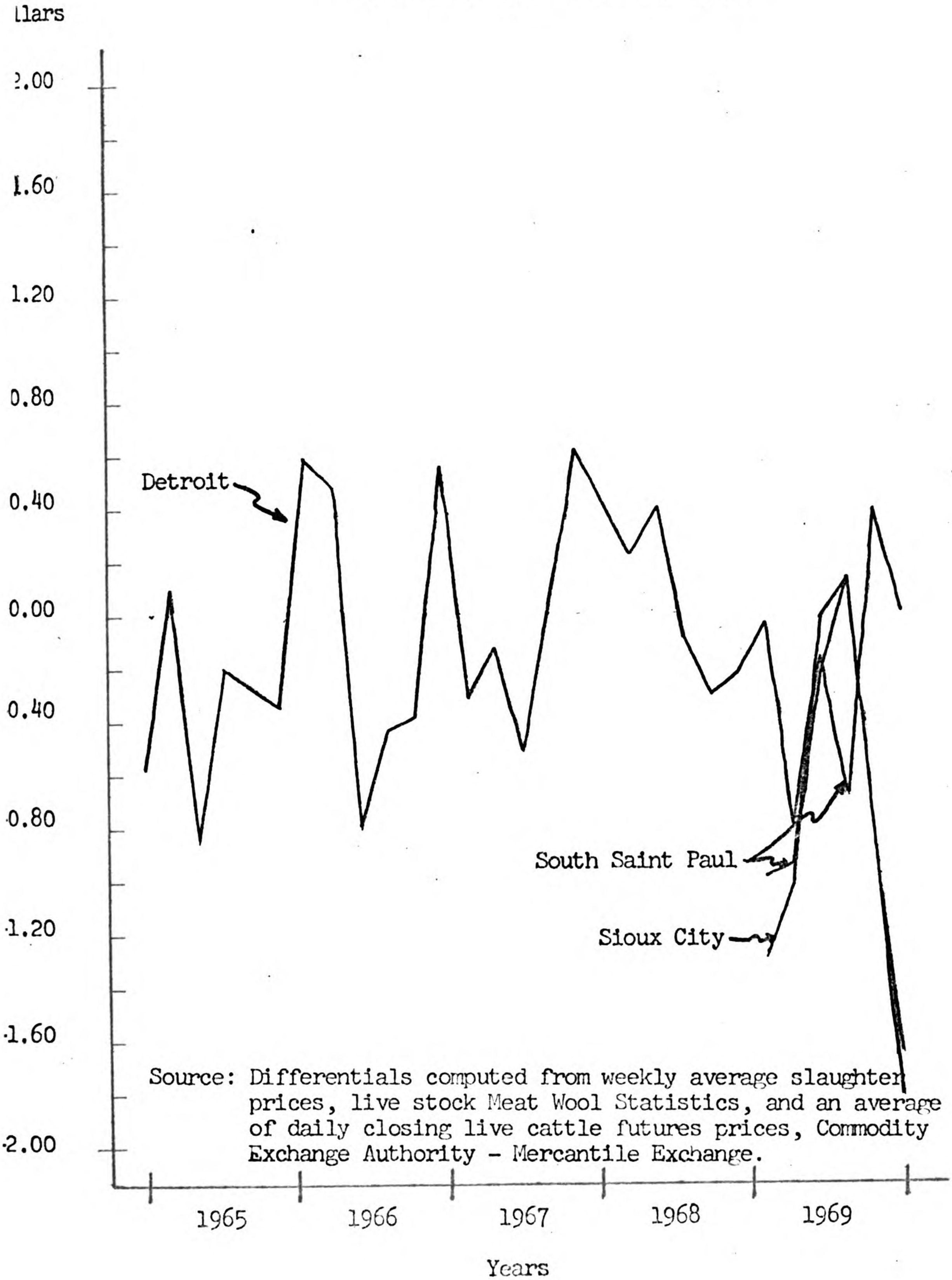


Figure 5.

Sample Mean Cash-Futures Price Differentials During Delivery Intervals for Choice Steers, 900-1100 Pounds in the Colorado, and Texas-New Mexico Fed Cattle Markets.
(February 1965 - December 1969)

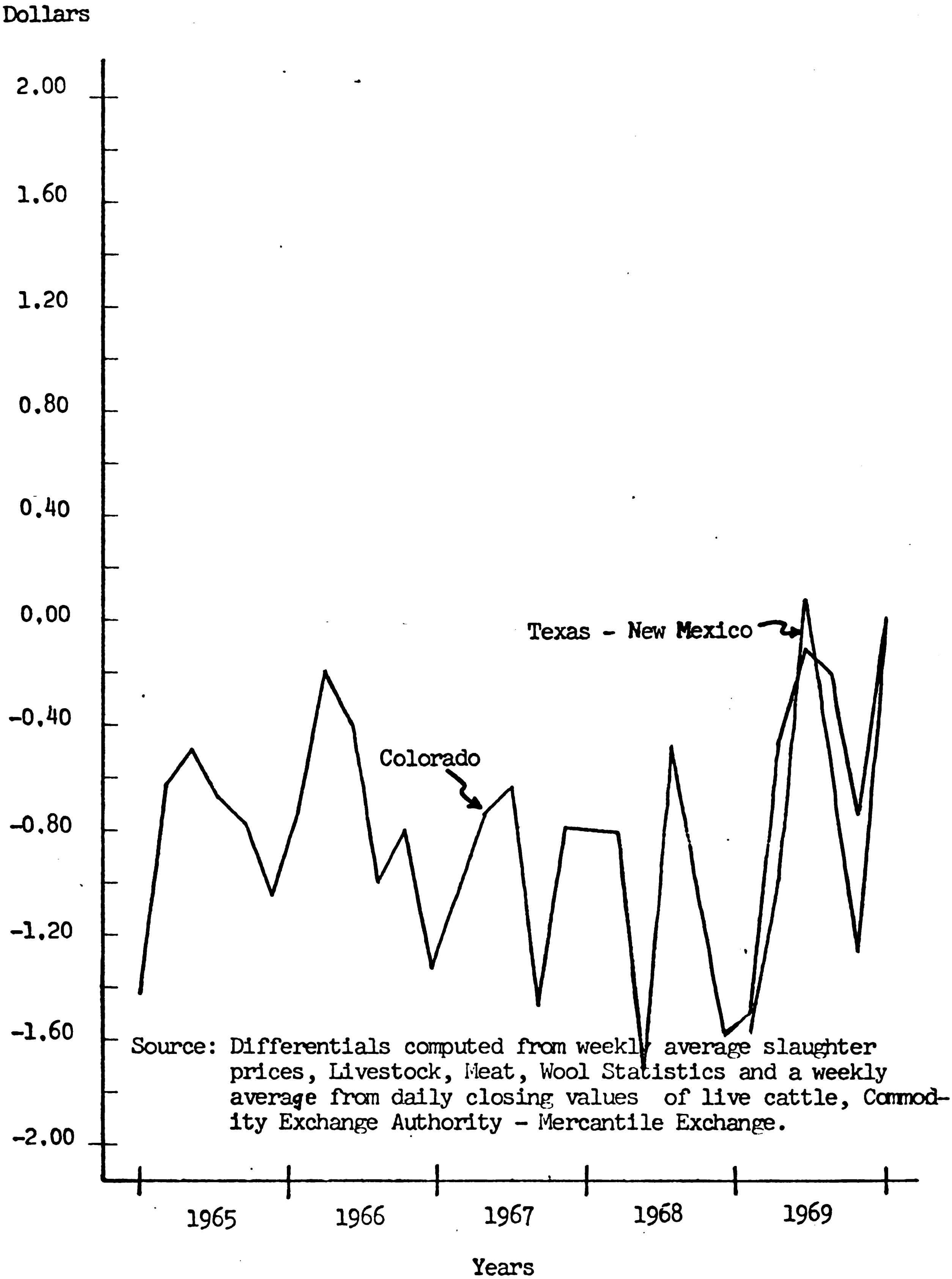
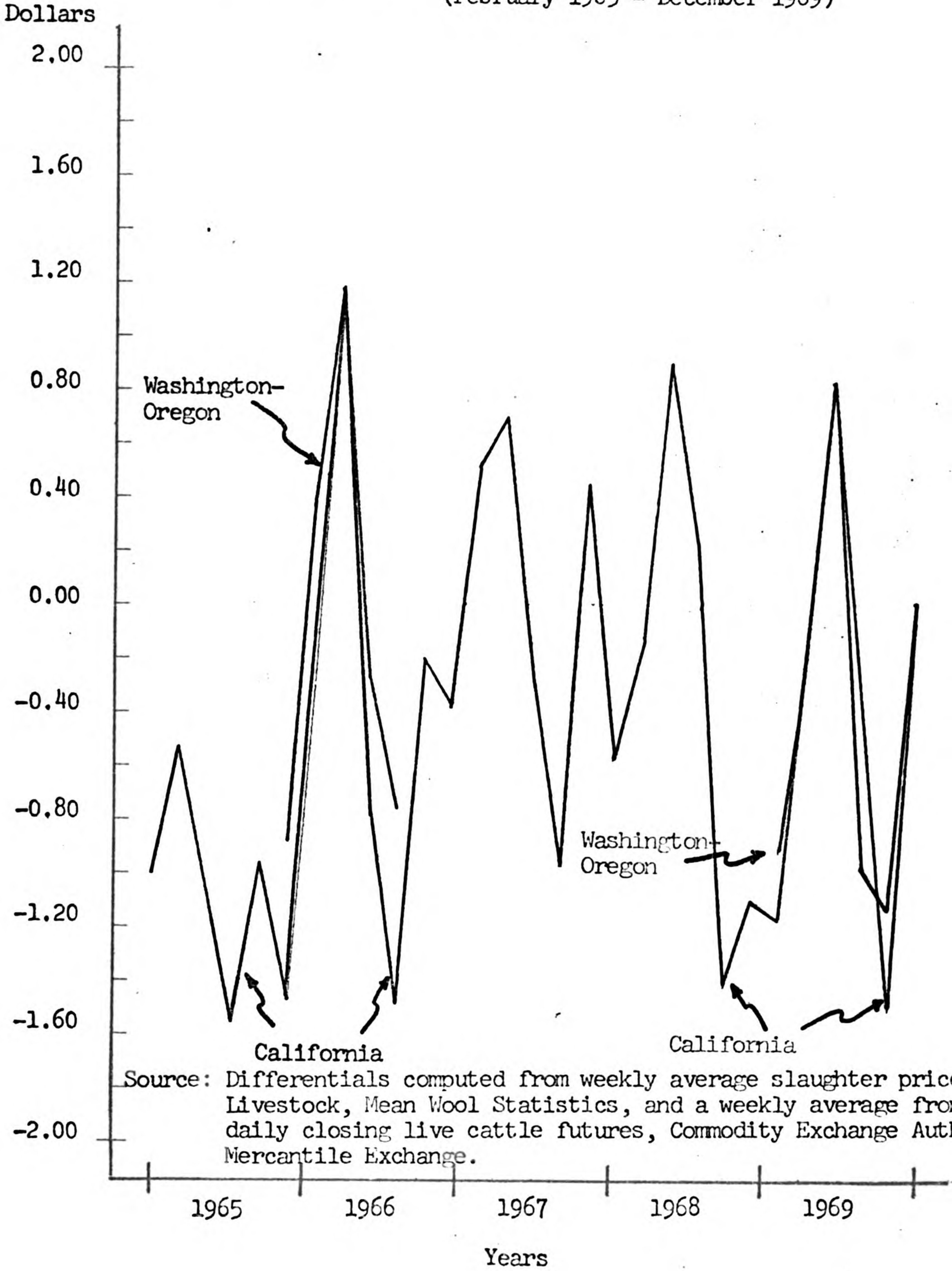


Figure 6.

Sample Mean Cash-Futures Price Differentials During Delivery Intervals for Choice Steers, 900 - 1100 Pounds in the California, and Washington-Oregon Fed Cattle Markets.
(February 1965 - December 1969)



Source: Differentials computed from weekly average slaughter prices, Livestock, Mean Wool Statistics, and a weekly average from daily closing live cattle futures, Commodity Exchange Authority, Mercantile Exchange.

Figure 7

with these cash-futures price differentials in the various fed cattle markets of concern herein.

The over all market and delivery period, arithmetic mean cash-futures price differential for choice steers within the 900 - 1100 pound weight range is -0.66 dollars. Whereas, the over all cash-futures price differential by market, and delivery period are -0.63, and -0.66 dollars, respectively, for 900 - 1100 pound choice steers. Individual cash-futures price average differentials during specific market delivery periods and/or markets and associated range values are posted in Tables 1 and 2, respectively. Evaluation, and subsequent analysis of these forementioned patterns will be covered in Chapter IV.

These individual average cash-futures price differential means are of a minimal value unless the degree of variation associated with each is known. The simplest measure of dispersion is that of the range. Ranges for the cash-futures price differentials covering the time interval of allowable futures delivery period by market, and delivery period are summarized in Table 2. Corresponding minimum and maximum values are tabled in Table 3 on the subsequent page.

Within the choice steer 900 - 1100 pound weight, the average over all market and delivery month range was 1.61 dollar. Over all average range and delivery period range values were computed to be 1.61 and 1.62 dollars, respectively. From these values alone, it would appear that there is little difference between the average range on a market basis, as compared to the delivery period basis, as compared to an over all basis. Nevertheless, there is a significant degree of

Table 1: Mean Cash-Futures Price Differentials During Delivery Intervals by Major Fed Cattle Markets and Live Beef Cattle Futures Delivery Intervals for Choice Steers, 900 - 1100 Pound Range. 1/
(February 1965 - December 1969)

Fed Cattle Markets	Contracts: February	April	June	August	October	December	Averages
Chicago	0.16	-0.09	-0.33	-0.26	-0.08	-0.22	-0.10
	(0.10)	(0.16)	(0.12)	(0.11)	(0.12)	(0.07)	(0.12)
Detroit	0.21	-0.17	0.02	-0.59	-0.13	0.18	-0.11
	(0.11)	(0.13)	(0.12)	(0.11)	(0.09)	(0.12)	(0.10)
South Saint Paul	-1.00	-0.98	-0.71	-0.30	-0.96	-1.25	-0.87
	(0.07)	(0.16)	(0.23)	(0.24)	(0.15)	(0.24)	(0.18)
Omaha	-1.02	-1.05	-0.64	-0.44	-0.86	-0.95	-0.83
	(0.10)	(0.12)	(0.09)	(0.08)	(0.08)	(0.09)	(0.10)
Sioux City	-1.30	-1.08	-0.53	-0.22	-0.99	-1.21	-0.89
	(0.11)	(0.17)	(0.26)	(0.20)	(0.10)	(0.21)	(0.18)
Kansas	-1.31	-1.02	-0.44	-0.51	-0.66	-0.95	-0.81
	(0.11)	(0.12)	(0.12)	(0.09)	(0.08)	(0.07)	(0.10)
Texas - New Mexico	-1.41	-1.19	-0.33	-0.99	-1.33	-0.42	-0.94
	(0.20)	(0.23)	(0.26)	(0.27)	(0.09)	(0.10)	(0.20)
Colorado	-1.45	-1.26	-0.57	-0.45	-1.06	-0.74	-0.92
	(0.15)	(0.19)	(0.20)	(0.08)	(0.10)	(0.14)	(0.15)
Washington - Oregon	-1.06	-0.57	0.55	-0.81	-0.92	-0.63	-0.57
	(0.14)	(0.14)	(0.23)	(0.14)	(0.18)	(0.37)	(0.17)
California	-0.82	-0.03	0.91	-0.35	-1.18	-0.08	-0.56
	(0.11)	(0.13)	(0.08)	(0.11)	(0.12)	(0.26)	(0.13)
Averages:	-0.87	-0.74	-0.39	-0.49	-0.82	-0.63	-0.66
	(0.12)	(0.16)	(0.17)	(0.14)	(0.11)	(0.17)	(0.09)

Source: Computed by author.

1/ The upper number of each pair of values is the mean cash-futures price differential, the lower value is the associated standard error of the mean.

Table 2: Ranges for Choice Steers Within the 900 - 1100 Pound Weight Classification by Delivery Interval and Major Fed Cattle Market (February 1965 - December 1969)

	Contracts						
Fed Cattle Markets	February	April	June	August	October	December	Averages
Chicago	1.05	2.00	1.81	1.31	1.39	2.10	1.61
Detroit	1.30	2.06	1.83	2.06	1.38	1.40	1.67
South Saint Paul	0.52	1.01	1.45	1.57	0.94	1.13	1.10
Sioux City	0.77	1.07	1.44	1.38	0.63	1.06	1.06
Omaha	1.48	1.84	1.38	1.21	1.39	1.37	1.44
Kansas City	1.65	2.00	2.07	1.29	1.52	1.32	1.64
Texas - New Mexico	1.28	1.48	1.18	1.57	0.63	0.59	1.12
Colorado	1.94	2.57	3.97	1.54	1.33	3.32	2.44
Washington - Oregon	0.99	1.32	2.41	1.80	2.24	4.07	2.14
California	1.58	1.93	1.15	1.46	1.54	3.77	1.90
Average	1.26	1.73	1.87	1.52	1.30	2.01	1.61

Source: Computed by author.

variability within a given market by delivery period, or within a given delivery period by market that cannot be readily ignored.

Relative measures of dispersion, in addition to the forementioned absolute measure of dispersion, which must be reviewed before interpretating the meaning of our computed arithmetic means, included the coefficients of skewness and kurtosis. Our interest in the value of the coefficient of skewness stems from two sources. First, for a given arithmetic mean[3/] to be a representative measure of some sample or population, the relevant frequency distribution of that sample should be symmetrical, or very nearly so. If such is not the case, employment of the arithmetic mean as a representative measure of our sample or population would be inappropriate and some other measure, such as the median, mode, and so forth, may be more appropriate. Secondly, if in fact our distribution of concern was significantly skewed, either positively or negatively, application of confidence intervals would not necessarily result in the probable inclusion of the true population arithmetic mean at a given level of probability.

With respect to the importance of knowing the respective values of the coefficients of kurtosis, our concern lies in knowing whether or not the area included within a portion of a frequency distribution is in fact accurately represented by the standard alpha levels and their corresponding areas under a normal frequency distribution. That is, if the coefficient of kurtosis is greater than 3, in this case, we know

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3/ Given data which possesses only positive values, the geometric mean would be more appropriate, reoresentative, than the arithmetic mean. That is, the standard error of the mean under these conditions would be smaller than those associated with the arithmetic mean.

that this particular distribution is some what more peaked than a standard normal distribution, i.e. liptokurtic. Hence, alpha levels and associated areas contained in the tails of the distribution would be an overestimate of the area under our particular frequency distribution.

Specific values of the coefficients of skewness and kurtosis associated with each frequency distribution of mean cash-futures price differential are presented in Table 3. As can be readily observed from this table, the ranges of the values of skewness and kurtosis are relatively narrow. The overall kurtosis and skewness values are 2.6264 and -0.1178, respectively. The overall average of these values by market are 2.634 and -0.1006, respectively. Corresponding overall average coefficient values by contract are 2.6188 and -0.1351.

Given that the computational technique employed to determine the value of the coefficient of skewness and kurtosis is such that no skewness is represented by a coefficient value of 0.0000, and when the mounding characteristics are of a normal nature, i.e. mesokurtic, the coefficient value is 3.0000. It should be readily apparent that there is no apparent significant deviation with respect to skewness and kurtosis from that of the characteristics possessed by a normal distribution. Consequently, the use of the arithmetic mean as a representative measure for our samples is appropriate. Furthermore, the confidence intervals imposed these arithmetic means will, given their respective degrees of freedom and standard deviation, contain the true population mean for some prescribed alpha level.

Table 3: Coefficients of Skewness and Kurtosis of the Mean Cash-Futures Price Differential Distributions of Choice Steers, 900 - 1100 Pound Range, for Major Fed Cattle Markets by Live Beef Cattle Futures Contract[1] (February 1965 - December 1969)

Fed Cattle Markets	Contracts						
	February	April	June	August	October	December	Average
California	-0.0924	-0.7257	-0.7581	0.2320	0.5222	-0.8039	-0.2710
	2.8203	3.5626	3.4329	2.5516	2.2218	2.3773	2.8278
Chicago	-0.0899	0.0144	-0.0467	0.7373	-0.0227	0.1425	0.1225
	1.5127	2.1177	2.3944	2.1041	1.6963	2.3445	2.0283
Colorado	-0.5622	0.0338	-1.1530	0.5734	-0.0038	-1.5134	-0.4375
	2.3415	1.7355	6.0856	3.8117	1.7667	7.0869	3.8046
Detroit	-0.1465	0.6632	0.2003	-0.5214	0.7992	-0.7953	0.3325
	1.8600	3.1674	2.3876	4.4365	3.5418	2.2481	2.9402
Kansas City	-0.3022	1.3225	0.0591	0.5194	-0.5147	0.4774	0.2602
	2.9813	4.5517	2.8915	2.2033	4.1042	3.5679	3.3833
Omaha	-1.4976	0.5779	0.1324	0.2863	-0.2863	-0.6539	-0.1771
	5.0575	2.8628	1.9220	1.9266	3.0575	2.5260	2.8921
Sioux City	-0.9365	0.1835	0.1482	0.3333	-1.3097	0.2084	-0.2288
	2.6856	2.0155	1.2493	1.9735	3.1466	1.3187	2.2149
South Saint Paul	-0.5549	0.2708	0.0467	0.1643	-1.3097	-0.3220	-0.2841
	2.6010	1.9140	1.5673	1.58545	3.1466	1.2809	2.0607
Texas - New Mexico	-0.0443	0.3609	-0.2237	0.6572	-1.4251	-0.2808	-0.1600
	1.6786	1.8154	1.2295	1.5826	3.5275	1.4408	1.8791
Washington - Oregon	0.1074	-0.2380	-0.7787	0.2611	0.0424	-0.3721	-0.1630
	1.3511	2.7707	2.2966	2.6006	2.6444	2.1749	2.3064

Source: Computed by author.

[1] The upper number of each pair of values is the coefficient of skewness, 0.000 is nonskewed, and the lower value is the coefficient of kurtosis, a 3.0000 value is a normal distribution.

Table 4: Sample Mean Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers Within the California Fed Cattle Market by Major Live Beef Cattle Futures Delivery Interval. (February 1965 - December 1969)

Futures Contract	Mean Differential	Standard Deviation	Sample Size	Confidence Interval Limits	
				Lower	Upper
February	-0.82	0.422	15	-1.06	-0.59
April	-0.03	0.502	15	-0.25	0.31
June	0.91	0.311	15	0.74	1.08
August	-0.35	0.409	15	-0.58	-0.12
October	-1.18	0.481	15	-1.44	-0.91
December	-0.08	1.124	18	-0.64	0.48

Source: Computed by the author.

Table 5: Sample Mean Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers Within the Chicago Fed Cattle Markey by Major Live Beef Cattle Futures Delivery Interval (February 1965 - December 1969)

Futures Contract	Mean Differential	Standard Deviation	Sample Size	Confidence Interval Limits	
				Lower	Upper
February	0.16	0.370	14	-0.11	0.32
April	-0.09	0.620	16	-0.42	0.24
June	-0.33	0.487	16	-0.59	-0.07
August	-0.26	0.427	16	-0.49	-0.03
October	-0.08	0.471	15	-0.34	0.18
December	-0.22	0.322	19	-0.38	-0.06

Source: Computed by the author.

Table 6: Sample Mean Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers Within the Colorado Fed Cattle Market by Major Live Beef Cattle Futures Delivery Interval (February 1965 - December 1969)

Futures Contract	Mean Differential	Standard Deviation	Sample Size	Confidence Interval Limits Lower	Confidence Interval Limits Upper
February	-1.45	0.600	15	-1.79	-1.12
April	-1.26	0.796	18	-1.66	-0.86
June	-0.57	0.839	18	-0.98	-0.15
August	-0.45	0.347	18	-0.63	-0.28
October	-1.06	0.431	17	-1.22	0.84
December	-0.74	0.644	21	-1.03	-0.45

Source: Computed by the author.

Table 7: Sample Mean Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers Within the Detroit Fed Cattle Market by Major Live Beef Cattle Futures Delivery Interval (February 1965 - December 1969)

Futures Contract	Mean Differential	Standard Deviation	Sample Size	Confidence Interval Limits Lower	Confidence Interval Limits Upper
February	0.21	0.425	14	-0.03	0.46
April	-0.17	0.533	18	-0.44	0.10
June	0.02	0.494	17	-0.23	0.27
August	-0.59	0.445	17	-0.90	-0.27
October	-0.13	0.356	15	-0.32	0.07
December	-0.18	0.475	16	-0.43	0.07

Source: Computed by author.

Table 8: Sample Mean Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers Within the Kansas City Fed Cattle Market by Major Live Beef Cattle Futures Delivery Interval (February 1965 - December 1969)

Futures Contract	Mean Differential	Standard Deviation	Sample Size	Confidence Interval Limits Lower	Upper
February	-1.31	0.412	15	-1.54	1.08
April	-1.02	0.496	18	-1.27	-0.77
June	-0.44	0.508	18	-0.69	-0.19
August	-0.51	0.362	18	-0.69	-0.33
October	-0.66	0.344	18	-0.83	-0.49
December	-0.95	0.303	20	-1.09	-0.81

Source: Computed by the author.

Table 9: Sample Mean Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers Within the Omaha Fed Cattle Market by Major Live Beef Cattle Futures Delivery Interval (February 1965 - December 1969)

Futures Contract	Mean Differential	Standard Deviation	Sample Size	Confidence Interval Limits Lower	Confidence Interval Limits Upper
February	-1.02	0.371	15	-1.22	-0.81
April	-1.05	0.492	18	-1.30	-0.80
June	-0.64	0.398	18	-0.84	-0.44
August	-0.44	0.354	18	-0.62	-0.27
October	-0.86	0.345	18	-1.03	0.69
December	-0.95	0.397	20	-1.14	-0.76

Source: Computed by the author.

Table 10: Sample Mean Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers Within the Sioux City Fed Cattle Market by Major Live Beef Cattle Futures Delivery Interval (February 1965 - December 1969)

Futures Contract	Mean Differential	Standard Deviation	Sample Size	Confidence Interval Limits Lower	Confidence Interval Limits Upper
February	-1.30	0.279	6	-1.60	-1.01
April	-1.08	0.450	6	-1.32	-0.84
June	-0.53	0.634	6	-1.19	0.14
August	-0.22	0.497	6	-0.74	0.30
October	-0.99	0.236	6	-1.22	-0.75
December	-1.21	0.480	5	-1.81	-0.62

Source: Computed by the author.

Table 11: Sample Mean Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers Within the South Saint Paul Fed Cattle Market by Major Live Beef Cattle Futures Delivery Interval (February 1965 - December 1969)

Futures Contract	Mean Differential	Standard Deviation	Sample Size	Confidence Interval Limits Lower	Upper
February	-1.00	0.177	6	-1.19	-0.82
April	-0.98	0.384	6	-1.38	-0.58
June	-0.71	0.566	6	-1.31	-0.12
August	-0.30	0.582	6	-0.91	0.31
October	-0.96	0.364	6	-1.33	-0.60
December	-1.25	0.535	5	-1.91	-0.59

Source: Computed by the author.

Table 12: Sample Mean Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers Within the Texas - New Mexico Fed Cattle Market by Major Live Beef Cattle Futures Delivery Interval (February 1965 - December 1969)

Futures Contract	Mean Differential	Standard Deviation	Sample Size	Confidence Interval Limits Lower	Confidence Interval Limits Upper
February	-1.41	0.483	6	-1.92	-0.90
April	-1.19	0.552	6	-1.77	-0.61
June	-0.33	0.587	5	-1.06	0.40
August	-0.99	0.665	6	-1.69	-0.29
October	-1.33	0.229	6	-1.55	-1.10
December	-0.42	0.256	6	-0.69	-0.15

Source: Computed by the author.

Table 13: Sample Mean Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers Within the Washington - Oregon Fed Cattle Market by Major Live Beef Cattle Futures Delivery Interval (February 1965 - December 1969)

Futures Contract	Mean Differential	Standard Deviation	Sample Size	Confidence Interval Limits Lower	Upper
February	-1.06	0.406	9	-1.37	-0.74
April	-0.57	0.483	12	-0.88	-0.26
June	-0.55	0.790	12	0.05	1.06
August	-0.81	0.497	12	-1.13	-0.50
October	-0.92	0.632	12	-1.32	-0.52
December	-0.63	1.281	12	-1.44	0.48

Source: Computed by the author.

Table 14: Sample Mean February Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers by Major Fed Cattle Market (February 1965 - December 1969)

Fed Cattle Market	Mean Differential	Standard Deviation	Sample Size	Confidence Limits Lower	Confidence Limits Upper
Chicago	0.16	0.370	14	-0.11	0.32
Detroit	0.21	0.425	14	-0.03	0.46
So. St. Paul	-1.00	0.177	6	-1.19	-0.82
Omaha	-1.02	0.371	15	-1.22	-0.81
Sioux City	-1.30	0.279	6	-1.60	-1.01
Kansas City	-1.31	0.412	15	-1.54	-1.08
Texas - New Mexico	-1.41	-.483	6	-1.92	-0.90
Colorado	-1.45	0.600	15	-1.79	-1.12
Washington - Oregon	-1.06	0.406	9	-1.37	-0.74
California	-0.82	0.422	15	-1.06	-0.59

Source: Computed by the author.

Table 15: Sample Mean April Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers by Major Fed Cattle Market (February 1965 - December 1969)

Fed Cattle Market	Mean Differential	Standard Deviation	Sample Size	Confidence Limits Lower	Confidence Limits Upper
Chicago	-0.09	0.620	16	-0.42	0.24
Detroit	-0.17	0.533	18	-0.44	0.10
So. St. Paul	-0.98	0.384	6	-1.38	-0.58
Omaha	-1.05	0.492	18	-1.30	-0.80
Sioux City	-1.08	0.405	6	-1.32	-0.84
Kansas City	-1.02	0.496	18	-1.27	-0.77
Texas - New Mexico	-1.19	0.552	6	-1.77	-0.61
Colorado	-1.26	0.796	18	-1.66	-0.86
Washington - Oregon	-0.57	0.483	12	-0.88	-0.26
California	-0.03	0.502	15	-0.25	0.31

Source: Computed by the author.

Table 16: Sample Mean June Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers by Major Fed Cattle Market (February 1965 - December 1969)

Fed Cattle Market	Mean Differential	Standard Deviation	Sample Size	Confidence Limits Lower	Confidence Limits Upper
Chicago	-0.33	0.487	16	-0.59	-0.07
Detroit	0.02	0.494	17	-0.23	0.27
So. St. Paul	-0.71	0.566	6	-1.31	-0.12
Omaha	-0.64	0.398	18	-0.84	-0.44
Sioux City	-0.53	0.634	6	-1.19	0.14
Kansas City	-0.44	0.508	18	-0.69	-0.19
Texas - New Mexico	-0.33	0.587	5	-1.06	0.40
Colorado	-0.57	0.839	18	-0.98	0.15
Washington - Oregon	0.55	0.790	12	0.05	1.06
California	0.91	0.311	15	0.74	1.08

Source: Computed by the author.

Table 17: Sample Mean August Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers by Major Fed Cattle Market (February 1965 - December 1969)

Fed Cattle Market	Mean Differential	Standard Deviation	Sample Size	Confidence Limits Lower	Confidence Limits Upper
Chicago	-0.26	0.427	16	-0.49	-0.03
Detroit	-0.59	0.445	17	-0.90	-0.27
So. St. Paul	-0.30	0.582	6	-0.91	0.31
Omaha	-0.44	0.354	18	-0.62	-0.27
Sioux City	-0.22	0.497	6	-0.74	0.30
Kansas City	-0.51	0.362	18	-0.69	-0.33
Texas - New Mexico	-0.99	0.665	6	-1.69	-0.29
Colorado	-0.45	0.347	18	-0.63	-0.28
Washington - Oregon	-0.81	0.497	12	-1.13	-0.50
California	-0.35	0.409	15	-0.58	-0.12

Source: Computed by the author.

Table 18: Sample Mean October Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers by Major Fed Cattle Market (February 1965 - December 1969)

Fed Cattle Market	Mean Differential	Standard Deviation	Sample Size	Confidence Limits Lower	Confidence Limits Upper
Chicago	-0.08	0.471	15	-0.34	0.18
Detroit	-0.13	0.356	15	-0.32	0.07
So. St. Paul	-0.96	0.364	6	-1.33	-0.60
Omaha	-0.86	0.345	18	-1.03	0.69
Sioux City	-0.99	0.236	6	-1.22	-0.75
Kansas City	-0.66	0.344	18	-0.83	-0.49
Texas - New Mexico	-1.33	0.229	6	-1.55	-1.10
Colorado	-1.06	0.431	17	-1.22	-0.84
Washington - Oregon	-0.92	0.632	12	-1.32	-0.52
California	-1.18	0.481	15	-1.44	-0.91

Source: Computed by the author.

Table 19: Sample Mean December Cash-Futures Price Differentials and Related Statistics for 900 - 1100 Pound Choice Steers by Major Fed Cattle Market (February 1965 - December 1969)

Fed Cattle Market	Mean Differential	Standard Deviation	Sample Size	Confidence Limits Lower	Confidence Limits Upper
Chicago	-0.22	0.322	19	-0.38	-0.06
Detroit	0.18	0.475	19	0.07	0.43
So. St. Paul	-1.25	0.535	5	-1.91	-0.59
Omaha	-0.95	0.397	20	-1.14	-0.76
Sioux City	-1.21	0.480	5	-1.81	-0.61
Kansas City	-0.95	0.303	20	-1.09	-0.81
Texas - New Mexico	-0.42	0.256	6	-0.69	-0.15
Colorado	-0.74	0.644	21	-1.03	-0.45
Washington - Oregon	-0.63	1.281	12	-1.44	0.18
California	-0.08	1.124	18	-0.64	0.48

Source: Computed by the author.

Table 4 through 13 presents by major feeding region the arithmetic mean cash-futures price differential for each of the live beef futures delivery periods and the corresponding lower and upper confidence limits, given alpha set at the 0.05 level, and related statistics. In Table 14 through 19, these same values are presented but on a by contract basis instead. The alpha level is held the same throughout Tables 4 and 5.

Obviously, as the graphs and tables which were presented earlier in this chapter illustrate, markets which can be grouped together based upon commonality of observed pattern of behavior and variance are the Omaha and Kansas City markets, the Sioux City, South Saint Paul and the Chicago markets, Colorado and Texas-New Mexico, and the Washington-Oregon and California market. It would appear that homogeniety of supply and demand influencing forces provides for a sufficient explanation of this grouping phenomenon.

CHAPTER IV

PREDICTING THE CASH-FUTURES PRICE DIFFERENTIAL

Generalization of Findings

Attempts at identifying those variables, especially exogenous ones, which would be useful in explaining the observed variability in price differential, and subsequent prediction thereof, within each of the forementioned fed cattle markets was met with only moderate success. Those explanatory variables which were selected and subsequently subjected to tests of significance were, (1) the cash-futures price differentials within fed cattle markets other than the specific market under analysis, (2) the prevailing market price for choice steers of the 900 - 1100 pound weight range in each of the major fed cattle markets, (3) a 12-month moving average of the number of pounds of choice steers sold out of first hands for slaughter within the respective markets and in other domestic markets for which data were readily available, (4) the ratio of number of pounds of choice steers sold out of first hands for slaughter within the relevant market of interest to the effective futures market delivery point, Omaha, for live cattle, (5) the direction of cash market prices, both within the relevant market and within all others, and finally, (6) the allowable delivery months for live cattle futures, i.e. February, April, June, August, October, and December.

Selection of these six kinds of potential explanatory variables, from the set of all possible explanatory variables, was based on the assumption that variations in the close out cash-futures price differentials over time within a given market is attributable primarily to supply influences affecting the relevant market. Inclusion of any one of these potential explanatory variables into a given regression equation is based upon the significance of that variable's F statistic at each step in the addition and/or deletion process of potential explanatory variables.

The general result being that, of these six potential kinds of variables, only (1) the prices for 900 - 1100 choice steers in other markets and (2) within the relevant market, (3) and the allowable delivery months were generally significant at an alpha level of 0.05 or less. Upon occasion the direction of the price change for choice steers, 900 - 1100 pound weight group in Chicago was apparently a statistical significant factor.

The reliability of even these generalizations is greatly constrained by the limited number of observations from which the individual effect of the various variables could be derived. Furthermore, given that the computational technique of ordinary least squares was employed to measure the effect attributable to each of the hypothesed variables and subsequent tests of significance, fulfillment of the assumptions of nonexistance of a significant degree of serial correlation, non independent-independent variables, multicollinearity and heteroscadisticy, and the expected mean of the error term being zero, were required. Such was, initially, assumed to be the case. At the close of this chapter, verification of these assumptions will be noted.

Findings by Fed Cattle Market

Findings within each of the individual major fed cattle markets, taken in alphabetical order, are as follows.

California:

Of the variables which were considered as possible explanations of the California cash-futures price differential, X_{31}, the cash market price in the Detroit cash market for live cattle, choice steers 900 - 1100 pound weight range, X_{34}, interestingly enough was significant, as was also the corresponding price in the California market, X_{35}, the Detroit cash-futures price differential, X_{30} and the delivery month of October, X_{11}. Obviously there is no readily apparent cause-effect relationship between the Detroit and California markets. Yet, for some reason the two markets possess parallel price movements. Such leads me to believe that there is a third factor common to both for which the Detroit market is serving as a proxy.

The values of the partial correlation coefficients for the first three explanatory variables, price in Detroit, price in California, and the Detroit cash-futures price differential, are -0.949, 0.954, and 0.922, respectively. October's partial correlation coefficient was estimated to be only -0.584. The regression equation which these four variables comprise is listed below.

$$X_{31} = -0.102 + (-0.871)(X_{34}) + 0.875(X_{35}) + 0.919(X_{30}) + (-0.393)(X_{11})$$
$$\quad (0.066) \qquad (0.063) \qquad (0.095) \qquad (0.125)$$

Overall measures of the worth and significance of this predicting equation or model if you prefer are:

Number of Observations	Standard Error of the Estimate	$\overline{R}$	Significance of the F of the Equation
24	0.193	0.971	<0.0005

Chicago:

Significant explanatory variables within the Chicago fed cattle market include (1) the cash-futures price differential within the Omaha fed cattle market, X_3, (2) the June, X_9, and (3) August, X_{10}, delivery months. The values of the partial correlation coefficients are -0.694, for the Omaha differential, -0.469 for the delivery month of June, and -0.548 for August. Inclusion of these variables into an ordinary least square regression equation results in the following alpha and beta coefficients and corresponding standard errors.

$$X_1 = 1.313 + 0.526(X_3) + (-0.369)(X_9) + (-0.470)(X_{10})$$
$$\quad (0.111) \qquad (0.142) \qquad (0.146)$$

General measures of statistical significance for this equation are given by the standard error of the estimate, the significance of the F of the regression equation, and $\overline{R}$. The values of these general measures are:

Number of Observations	Standard Error of the Estimate	$\overline{R}$	Significance of the F of the Equation
29	0.274	0.737	<0.0005

Colorado:

Explanatory variables which appear to be of significance in explaining the Colorado fed cattle cash-futures price differential, X_6, are (1) the futures delivery month of February, X_7, (2) the prevailing cash market price for fed choice steers in the 900 - 1100 pound weight range within the Colorado market itself, X_{21}, and (3) the Chicato market, X_{18}. The relative importance of each of these independent variables, as measured by the partial correlation coefficient are -0.465, 0.739, and -0.514, respectively. Upon regressing of these three variables upon the observed cash-futures price differential within this market, the following regression equation evolves.

$$X_6 = -2.836 + \underset{(0.187)}{(-0.491)(X_7)} + \underset{(0.057)}{0.315(X_{21})} + \underset{(0.064)}{(-0.231)(X_{18})}$$

Statistical significance of this equation is indicated by the following overall statistical measures.

Number of Observations	Standard Error of the Estimate	$\bar{R}$	Significance of the F of the Equation
29	0.338	0.802	<0.0005

Detroit:

Significant explanatory variables in explaining the Detroit cash-futures price differential are two. The August month of futures delivery of live cattle, X_{10}, and the Kansas market cash-futures price differential, X_2. Corresponding contributions to the equation which they form, as a whole, as measured by the partial correlation coefficients are, respectively, -0.605, and 0.426. The resulting regression equation is:

$$X_{30} = 0.294 + (-0.719)(X_{10}) + 0.392(X_2)$$
$$\qquad\qquad (0.186) \qquad\qquad (0.163)$$

The relative worth of the equation taken as a whole in predicting the Detroit cash-futures price differential is given by the explained variation, adjusted for the number of regressors employed, and the standard error of the estimate of the regression equation. These values are:

Number of Observations	Standard Error of the Estimate	$\bar{R}$	Significance of the F of the Equation
29	0.358	0.585	0.002

Kansas:

The Kansas cash-futures price differential, X_2, appears to be explainable in part by the changes associated with the cash-futures price differential in the Omaha fed cattle market, X_3, and the futures delivery months of June, X_9, (3) August, X_{10}, and October, X_{11}. Respective partial correlation coefficients are 0.559, 0.636, 0.498, 0.495. The regression equation and relevant coefficient values are as follows.

$$X_2 = -0.705 + 0.369(X_3) + 0.597(X_9) + 0.430(X_{10}) + 0.402(X_{11})$$
$$\qquad (0.112) \qquad (0.148) \qquad (0.153) \qquad (0.144)$$

Values of overall measures of significance for this equation are:

Number of Observations	Standard Error of the estimate	$\bar{R}$	Significance of the F of the Equation
29	0.276	0.775	<0.0005

Omaha:

Variations in the Omaha cash-futures price differential, X_3, explained in part by variations in the Chicago cash-futures price differential, X_1, (2) variations in the prevailing price of choice steers of the 900 - 1100 pound weight group in the Chicago fed cattle market, X_{18}, and (3) variations is the Omaha price for 900 - 1100 pound choice steers. The prediction equation which these variables form is given below.

$$X_3 = -0.592 + \underset{(0.277)}{0.934}(X_1) + (\underset{(0.246)}{-0.617})(X_{18}) + \underset{(0.253)}{0.634}(X_{20})$$

The values of the standard error of the estimate, and other overall measures of statistical significance of this prediction equation are:

Number of Observations	Standard Error of the Estimate	$\bar{R}$	Significance of the F of the Equation
29	0.356	0.706	<0.0005

The net association between each individual independent variable and the dependent variable, as measured by the coefficient of partial correlation, are 0.567 for the Chicago cash-futures price differential, -0.456 for the price of 900 - 1100 pound choice steers in Chicago, and 0.456 for the price of choice steers in the 900 - 1100 pound weight range in Omaha itself.

Sioux City:

Based on a very limited number of observations, which occurred between February 1968 and December 1969, there are seven explanatory variables which were statistically significant at an alpha level of

0.05 or less, in explaining the Sioux City cash-futures price differential, X_4. They included, (1) the price for 900 - 1100 pound choice steers in Sioux City, X_{22}, (2) Colorado, X_{21}, (3) Chicago, X_{18}, (4) Kansas, X_{19}, and in (5) Omaha, X_{20}. Other variables of significance were the futures delivery months of February, X_7, and December, X_{12}.

The values of the partial correlation coefficients for these variables are 0.999, 0.994, 0.954, 0.988, and -0.997 for the prices in Sioux City, Colorado, Chicago, Kansas City, and Omaha, respectively. Estimates of the net association attributable to the delivery months of February and December are 0.994 and 0.974.

The prediction equation for the Sioux City cash-futures price differential and associated alpha and beta coefficient values are as follows.

$$X_4 = -8.208 + \underset{(0.057)}{(-1.263)(X_{21})} + \underset{(0.037)}{0.473(X_7)} + \underset{(0.034)}{1.564(X_{22})} + \underset{(0.087)}{0.530(X_{12})} +$$

$$\underset{(0.064)}{0.288(X_{18})} + \underset{(0.015)}{0.357(X_{19})} + \underset{(0.038)}{(-0.691)(X_{20})}$$

Overall measures of relative worth of this equation are as follows:

Number of Observations	Standard Error of the Estimate	$\bar{R}$	Significance of the Regression F Statistic
10	0.018	0.999	0.001

South Saint Paul:

Variables which are of statistical significance in explaining the observed variation in the South Saint Paul cash-futures price differential, X_5, during the years of 1968 and 1969 are eight in number. They include (1) the South Saint Paul prevailing prices for choice steers, 900 - 1100 pound weight range, X_{23}, and (2) comparable prices in the Sioux City market, X_4, (3) Chicago market, X_{18}, (4) Kansas City market, X_{19}, (5) Omaha market, X_{20}, and (6) Colorado, X_{21}. Also of significance are the delivery months of (7) February, X_7, and (8) December, X_{12}.

Coefficients of partial correlation between the explanatory variable, February and the dependent variable, South Saint Paul cash-futures price differential, is estimated to be approximately, 0.998. The corresponding value of the delivery month of December is 0.998 as well. Coefficients of partial correlation between the dependent variable and the prevailing price for 900 - 1100 pound choice steers in Sioux City, South Saint Paul, Chicago and Kansas are 0.999, 0.999, 0.992, and 0.999, respectively. Related values for corresponding price series in Omaha and Colorado are both -0.999.

The prediction equation which comprises these explanatory variables and the relevant alpha and beta coefficients is presented as follows.

$$X_5 = -5.396 + \underset{(0.020)}{0.445(X_4)} + \underset{(0.019)}{0.311(X_7)} + \underset{(0.032)}{0.863(X_{23})} + \underset{(0.052)}{0.806(X_{12})}$$

$$+ \underset{(0.033)}{0.263(X_{18})} + \underset{(0.010)}{0.217(X_{19})} + \underset{(0.021)}{(-0.414)(X_{20})} + \underset{(0.038)}{(-0.761)(X_{21})}$$

Overall measures of significance of this prediction equation are:

Number of Observations	Standard Error of the Estimate	$\bar{R}$	Significance of the F of the Equation
10	0.009	1.000	0.013

Washington - Oregon:

Variation in the Washington - Oregon cash-futures price differential, X_{33}, were significantly related to variations in the price for choice steers of the 900 - 1100 pound weight range (1), X_{20}, and (2) in Kansas, X_{19}. The (3) direction of price change of choice steers, 900 - 1100 pounds, in Chicago is significant. Delivery months of (4) February and (5) October, X_7, and X_{11}, respectively, further contribute to an explanation of the Washington - Oregon cash-futures price differential. The resulting prediction equation along with the corresponding standard errors of the regression coefficients is as follows.

$$
\begin{aligned}
X_{33} = -6.149 &+ \underset{(0.377)}{5.654(X_7)} + \underset{(0.092)}{(-1.355)(X_{20})} + \underset{(0.0274)}{0.372(X_{24})} \\
&+ \underset{(0.063)}{(-0.201)(X_{11})} + \underset{(0.093)}{1.540(X_{19})}
\end{aligned}
$$

The values of the partial correlation coefficients for the variables, February, the price direction of change in Chicago, and price in Kansas were all 0.99. Corresponding values for the price of Omaha 900 - 1100 pounds choice steers and the delivery month of October were -0.989 and -0.821, respectively. Overall measures of the relative worth of this particular prediction equation are given as follows.

Number of Observations	Standard Error of the Estimate	$\bar{R}$	Significance of the F of the Equation
11	0.065	0.995	<0.0005

Verification of the Required Ordinary Least Squares Assumptions

The validity of the earlier assumptions made regarding the non existance of significant serial correlation, the use of non independent-independent variables and multicollinearity, and the expected mean of the error term being equal to zero, are essentially valid for most cases. In every case, the computed Durbin Watson statistic, which is an indirect measure of serial correlation, was greater than the appropriate critical value, given an alpha (α) of 0.05. Thus, the hypothesis of zero serial correlation can be accepted. Hence, the estimates of alpha, (α), and beta, (β), remain, at least with respect to this source of problems, efficient as well as unbiased. The extent to which one explanatory variable within a specified equation is correlated with others in the same equation, the problem if multicollinearity, is significant at least one time, in six of the nine possible equations. Fortunately, the impact of the existence of this kind of problem is one of increased difficulty in isolating or separating out the effect of individual explanatory variables, and not one of causing the estimates of alpha and beta to become biased, inefficient, and/or inconsistent.

In addition to the forementioned findings regarding the validity of the required assumptions, i.e. those assumptions which must hold valid when employing the ordinary least squares computational approach in estimating the regression alpha and betas in order that they will possess the characteristics of being unbiased, efficient, and/or consistent, the expected value of the error term, as measured by the arithmetic mean of the error terms, was exactly zero in every case. Table 1 and appendix C shows the specific values of the Durbin Watson statistic, and simple correlations used in determining the existence or nonexistence of non independent-independent variables, and multicollinearity.

CHAPTER V

INTERPRETATION AND EVALUATION OF FINDINGS

Interpretation of the Changes in the Cash-Futures Price Differential

The cash-futures price differential is in effect the net result of price changes in both the cash, and futures markets. Consequently, it is conceivable that observed variations in this differential between allowable delivery intervals, over time, may be attributable to one of the following changes:

1. Changes in the relevant cash market price, the futures market price remaining constant.

2. Changes in the Omaha market which in turn influences the futures market, all other cash markets remaining constant.

3. Both the cash and the futures market prices moving in the same direction.

4. Cash and futures market prices moving in diverse directions.

Furthermore, given the way in which the cash-futures price differential was computed, i.e. the price differential is equal to the cash market price minus the futures market price, we also know that there is a direct relationship between the price differential and the cash market price. The relationship between the futures price and the differential, obviously, is an inverse one.

As a matter of clarity, it is perhaps appropriate to call attention to the fact that an increasing cash-futures price differential means that the differential is becoming less negative. Whereas, a declining or decreasing differential implies that it is becoming more negative.

The Observed Monthly Effect

The inclusion of an effect attributable to specific calendar months into the cash-futures price differential predicting equations for various fed cattle markets appears to coincide with the peaks and troughs of the relevant normal seasonal pattern of distribution of the proportion of the total number of cattle marketed. In the 12 north central states the percent of the annual average of fed cattle marketed is lowest during the first and the fourth calendar quarters, and largest during second and third calendar quarters, the months of April through June. Whereas, in the western fed cattle markets, the first calendar quarter months are typically the largest percentage wise.[1/] Table 6 illustrates which calendar months in particular were significant and their relative impacts upon the various market price differentials.

Twelve month moving average of the number of pounds of choice steers, all weights, sold out of first hands for slaughter, was also subjected to a test of significance. Interestingly enough it was concluded that at an alpha level of 0.10 or less, this particular variable was not a significant influence upon the cash-futures price differential.

There are two possible explanations for this phenomenan. One being, that the magnitude of fluctuation normally observed with the number

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1/ Livestock and Meat Situation, LMS 179, E.R.S./U.S.D.A., May 1971, pgs. 26-27.

of head of cattle marketed was reduced when converted into number of pounds marketed, which takes into account the counter seasonal fluctuation associated with the average weight of choice steers marketed during the summer months. A second alternative explanation of this phenomenan is that the 12-month moving average takes into account only normally reoccurring events on the supply side. Whereas, dummy variables representing monthly effects allow for regularly occurring events which occur on either/or the supply or demand side.

The signs of the estimated beta coefficients associated with the significant months are generally consistent with the impact of seasonal influence of supply rather than a demand influence. Or at least, the impact of the seasonal influence attributable to the supply side, significantly outweighs that of any existing seasonal influence on the demand side. Again note Figure 6.

The observed exception being in the Kansas fed cattle market. The signs for the estimated betas associated with significant monthly effects are all positive. Thus indicating that with the onset of these months, the cash-futures price differential is expected to expand, i.e. become less negative.

Observed Significant Price Effects

Two price effects were statistically significant at a prescribed alpha level of 0.05. The first being the price effect of the respective market cash price. Obviously, the fact that this particular variable is significant, or even that the sign of the associated beta coefficient is

Table 20: Estimated Beta Values Associated with Significant Months by Months and Major Fed Market.

Major Fed Cattle Markets	Live Cattle Futures Delivery Interval (Month)					
	February	April	June	August	October	December
California					-0.393	
Chicago			-0.369	-0.470		
Colorado	-0.491					
Detroit				-0.719		
Kansas City			0.597	0.430	0.402	
Omaha						
Sioux City	0.473					0.530
South Saint Paul	0.311					0.806
Washington-Oregon	5.654					-0.201

positive should not be surprising. What is of interest, though, is the fact that these estimated values range from approximately +0.3 in Colorado to +1.6 in the Sioux City fed cattle market. Note Table 7.

The second price effect which was statistically significant at a 0.05 level of alpha, was that of cash market prices in markets other than the one for which the differential is being analyzed. In reality, I suspect that these price effects are only influential to the extent to which they affect the cash market price of the market for which the price differential is being analyzed. Hence, the prices in neighboring markets are only cluttering up the model.

Cash-Futures Price Differential Effect

Interestingly enough, upon three occasions, cash-futures price differentials in another market was statistically significant with respect to explaining some of the observed variation in the differential under analysis. These three instances were in the Chicago, Omaha and California fed cattle markets. The Omaha differential was a significant explanatory variable for the Chicago cash-futures price differential, and vice versa. And, the Detroit differential, as was noted earlier, a significant explanatory variable for the California fed cattle market. A hypothesized explanation of this would simply be that, since the effect of changes in the futures price was not subjected to a test of significance, and other cash-futures price differentials were, the effect which should have been attributed to the futures price was captured indirectly by the differential itself.

Table 21: Extimated Beta Values Associated With Significant Fed Cattle Cash Markets

	Fed Cattle Cash Markets								
Fed Market Differential	California	Chicago	Colorado	Detroit	Kansas City	Omaha	Sioux City	South Saint Paul	Washington - Oregon
California	0.875			-0.871					
Chicago									
Colorado		-0.231	0.315						
Detroit									
Kansas City									
Omaha		-0.617				0.634			
Sioux City		0.288	-1.263		0.357	-0.691	1.564		
South Saint Paul		0.263	-0.761		0.217	-0.414	0.445		
Washington - Oregon					1.540	-1.355			

That is, in both the Chicago and Omaha fed cattle markets, the futures price itself may be a significant influence. Perhaps the cause effect relationship being the impact of the inter and intrarelationship of the futures price upon the Chicago and Omaha fed market cash price, and the Omaha cash market price for fed cattle upon the live cattle futures prices.

Interpretation of Findings as Relating to Effective Hedging

The interpretation of these findings in terms of the prospects for effective hedging, on the average, focuses upon the degree of accuracy with which the fed cattle market cash price for 900 - 1100 pound choice steers can be measured. In theory to hedge effectively is to simultaneously reduce price change risk and not lock out cash market profits. Hence, accurate fulfillment of cash market price expectation is critical.

Determination of these cash price estimates can, with relative ease, be accomplished by employing the relevant prevailing futures price as the best estimate of the price most likely to prevail during the appropriate delivery intervals for the country as a whole, and then adjusting this value with an estimate of the value of the relevant cash-futures price differential. It should be readily apparent, then, that reliable price forecasts weigh heavily upon (1) the reliability with which the futures price if formulated, and (2) the degree of accuracy with which the adjustment factor, i.e. cash-futures price differential if you prefer, can be estimated. For purposes of simplification we will assume that the standard error of any one futures price is not significantly different from zero. Thus, limiting our attention to the standard errors of the estimate of the individual cash-futures price differentials.

Estimates of the standard error of the estimate for each regression performed, i.e. in this case the dollar value above and below predicted value of the cash-futures price differential line, are given below in Table 22.

Table 22. Standard Error of the Estimate of the Predicted Cash-Futures Price Differentials by Fed Cattle Market

Fed Cattle Market	Standard Error of the Estimate
California	0.193
Chicago	0.274
Colorado	0.338
Detroit	0.358
Kansas City	0.276
Omaha	0.356
Sioux City	0.018
South Saint Paul	0.009
Washington - Oregon	0.065

As one can readily observe, the range in these standard errors, for markets with like number of observations is not substantial. In fact, the differences are quite minimal. Such was also the case with the standard error of the estimate of the means which were noted in chapter III.

CHAPTER VI

SUMMARY AND CONCLUSIONS, AND RESEARCH RECOMMENDATIONS

Summary and Conclusions

The objectives, which were set forth in Chapter I, of (1) determining, historically, the normal cash-futures price differential, and the formulation of a model which could be employed in the prediction thereof in each of the ten major fed cattle markets, during the live cattle futures delivery interval, have been met at varying levels of fulfillment depending upon the individual fed cattle market in reference.

Initial limiting factors to be a higher level of fulfillment of the objectives included an insufficient number of observations, which resulted in the dropping of the Texas - New Mexico fed cattle market from our analysis. Furthermore, this limited number of observations greatly constrained the degree of observed variability in the Sioux City, South Saint Paul and Washington - Oregon fed cattle markets. Second, the extent to which data was useful and readily accessable further limited the scope of our analysis by limiting the number of viable potential explanatory variables which could be subjected to tests of significance in explaining the observed cash futures price differentials.

Nevertheless, the arithmetic means of the respective cash-futures price differentials by allowable delivery interval were computed, as were also, predicting equations for each market's cash-futures price differential.

The observed pattern of change of these price differentials during the delivery intervals suggested exploring the significance of variables which possessed seasonal influences. From this set of potentially viable variables which might explain some, or even all, of the variability in the observed cash-futures price differentials, two variables in particular were significant. They were (1) the coded or dummy variables measuring the effects attributable to live cattle futures delivery intervals, and (2) the within cash market prices of the respective fed cattle markets. Inclusion of these variables where appropriate resulted in, based upon an evaluation of the computed standard errors of the estimate for each markets moderately successful estimates of the cash-futures price differentials, overall.

With respect to the interpretation of the standard errors of the estimate into terms of effectiveness of hedging, it is sufficient to say that the accuracy on the average with which the cash price in each of the various markets can be predicted, given the futures price for the appropriate delivery month, with widely varying degrees of accuracy. That is, the Colorado, Detroit and Omaha fed cattle markets can be predicted to within a range of approximately $1.36, at an alpha level of 0.05. The Chicago and Kansas City fed cattle markets are predictable to within a range of approximately $1.08, alpha set at 0.05. Whereas, the remaining markets, California, Sioux City, South Saint Paul, and Washington-Oregon, are predictable to within an average of 14 cents, at the same alpha level.

The reliability of the arithmetic means employed in Chapter III as a representative measure of the distribution of cash-futures price differentials during the delivery intervals within given fed cattle markets.

was verified to be valid through a brief study of the respective distribution properties of skewness and Kurtosis. Adequacy of the alpha and beta estimates with respect to being best, linear unbiased and consistent estimates was also confirmed by examination of the Durbin Watson statistic for serial correlation and appropriate simple correlation matrics for non independent-independent variables and multicollinearity.

Related Research Recommendations

Based upon the foregoing research, and related observations, several comments concerning further research into the area of analysis and prediction of the cash-futures price differentials during the futures contract delivery intervals for live cattle are appropriate.

The first recommendation being that any similar research on markets other than Omaha, or possibly west coast markets, be halted. Secondly, that the resources which would have been directed to understanding the cash-futures price differentials in all other markets be directed at understanding the behavior of the Omaha market. The primary reason being, simply, that it appears that the Omaha market is the key to understanding the entire behavior pattern of this price differential in cattle. Appropriate objectives of such a study might include at a minimum:

1. Understanding the futures price determining mechanism.
2. Determination of the price formulation mechanism within the Omaha live or fed cattle market and the influences outside fed cattle markets play upon Omaha and vice versa.
3. Where necessary, modify the existing data collection and dissemination process.

Perhaps, the most appropriate technique to employ to meet these objectives would be that of a system approach. As a part of this process, permit me to further suggest that the cattle cycle and the ascending and descending influences there of, be examined as a possible significant influence upon the cash-futures price differentials in each market.

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APPENDICES

APPENDIX A

APPENDIX A

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APPENDIX B

Statistical Indications of Serial Correlation, Non Independent-Independent Variables and Multicollinearity by Fed Cattle Market

Fed Cattle Market	Serial Correlation	Multicollinearity	Non Independent-Independent Variables
California: (X_{35})			
		Simple r Matrix	Simple r Matrix
Observations=24	Durbin Watson=2.148		

Multicollinearity — Simple r Matrix:

	X_{11}	X_{30}	X_{34}	X_{35}
X_{11}	1.000			
X_{30}	-0.012	1.000		
X_{34}	-0.107	-0.023	1.000	
X_{35}	-0.271	-0.224	0.942	1.000

Non Independent-Independent Variables — Simple r Matrix:

	e
X_{11}	0.001
X_{30}	-0.000
X_{34}	0.216
X_{35}	-0.000

Fed Cattle Market	Serial Correlation	Multicollinearity	Non Independent-Independent Variables
Chicago: (X_1)			
		Simple r Matrix	Simple r Matrix
Observations=29	Durbin Watson=2.184		

Multicollinearity — Simple r Matrix:

	X_3	X_9	X_{10}
X_3	1.000		
X_9	0.145	1.000	
X_{10}	0.293	-0.208	1.000

Non Independent-Independent Variables — Simple r Matrix:

	e
X_1	0.625
X_3	-0.002
X_9	-0.003
X_{10}	0.001

Figure B1

Fed Cattle Market	Serial Correlation	Multicollinearity	Non Independent-Independent Variables
Colorado: (X_6)			
		Simple r Matrix	Simple r Matrix
Observations=29	Durbin Watson=2.427	$\begin{array}{c|ccc} X_7 & 1.000 & & \\ X_{18} & -0.007 & 1.000 & \\ X_{21} & -0.111 & 0.885 & 1.000 \\ \hline & X_7 & X_{18} & X_{21} \end{array}$	$\begin{array}{c|c} X_6 & 0.558 \\ X_7 & -0.008 \\ X_{18} & -0.027 \\ X_{21} & -0.020 \\ \hline & e \end{array}$

Fed Cattle Market	Serial Correlation	Multicollinearity	Non Independent-Independent Variables
Detroit: (X_{30})			
		Simple r Matrix	Simple r Matrix
Observations=29	Durbin Watson=1.676	$\begin{array}{c|cc} X_2 & 1.000 & \\ X_{10} & 0.320 & 1.000 \\ \hline & X_2 & X_{10} \end{array}$	$\begin{array}{c|c} X_2 & -0.000 \\ X_{10} & -0.002 \\ X_{30} & 0.783 \\ \hline & e \end{array}$

Figure B1 (cont.)

Fed Cattle Market	Serial Correlation	Multicollinearity	Non Independent-Independent Variables
Kansas City: (X_2)			
Observations=29	Durbin Watson=2.407	Simple r Matrix	Simple r Matrix

Multicollinearity, Kansas City — Simple r Matrix:

	X_3	X_9	X_{10}	X_{11}
X_3	1.000			
X_9	0.115	1.000		
X_{10}	0.293	-0.208	1.000	
X_{11}	-0.038	-0.208	-0.208	1.000

Non Independent-Independent Variables, Kansas City — Simple r Matrix:

	e
X_2	0.587
X_3	0.003
X_9	0.002
X_{10}	-0.002
X_{11}	0.002

Fed Cattle Market	Serial Correlation	Multicollinearity	Non Independent-Independent Variables
Omaha City: (X_3)		Simple r Matrix	Simple r Matrix

Multicollinearity, Omaha City — Simple r Matrix:

	X_1	X_{18}	X_{20}
X_1	1.000		
X_{18}	0.385	1.000	
X_{20}	0.297	0.974	1.000

Non Independent-Independent Variables, Omaha City — Simple r Matrix:

	e
X_1	-0.001
X_3	0.657
X_{18}	-0.000
X_{20}	0.000

Figure B1 (cont.)

Fed Cattle Market	Serial Correlation	Multicollinearity	Non Independent-Independent Variables
Sioux City: (X_4)		Simple r Matrix	Simple r Matrix
Observations=10	Durbin Watson=2.359		

	X_7	X_{12}	X_{18}	X_{19}	X_{20}	X_{21}
X_7	1.000					
X_{12}	0.028	1.000				
X_{18}	0.075	0.146	1.000			
X_{19}	0.386	0.020	0.699	1.000		
X_{20}	0.177	0.169	0.951	0.766	1.000	
X_{21}	0.152	0.024	0.927	0.832	0.888	1.000
X_{22}	0.164	0.116	0.962	0.766	0.983	0.925

	e
X_4	0.000
X_7	0.000
X_{12}	0.000
X_{18}	0.000
X_{19}	0.000
X_{20}	0.000
X_{21}	0.000
X_{22}	0.000

Fed Cattle Market	Serial Correlation	Multicollinearity	Non Independent-Independent Variables
South Saint Paul: (X_5)		Simple r Matrix	Simple r Matrix
Observations=10	Durbin Watsin=2.926		

	X_4	X_7	X_{12}	X_{18}	X_{19}	X_{20}
X_4	1.000					
X_7	0.155	1.000				
X_{12}	0.251	0.028	1.000			
X_{18}	0.446	0.075	0.146	1.000		
X_{19}	0.410	0.386	0.020	0.699	1.000	
X_{20}	0.553	0.177	0.169	0.951	0.766	1.000
X_{23}	0.590	0.104	0.212	0.967	0.690	0.980

	e
X_4	0.000
X_5	0.000
X_7	0.000
X_{12}	0.000
X_{18}	0.000
X_{19}	0.000
X_{20}	0.000
X_{23}	0.000

Figure B1 (cont.)

Fed Cattle Market	Serial Correlation	Multicollinearity	Non Independent-Independent Variables
Washington-Oregon: (X_{33})		Simple r Matrix	Simple r Matrix

Multicollinearity — Simple r Matrix

X_7	1.000				
X_{11}	-0.149	1.000			
X_{19}	-0.424	-0.125	1.000		
X_{20}	-0.02	-0.209	0.910	1.000	
X_{24}	0.289	-0.516	-0.064	0.910	1.000
	X_7	X_{11}	X_{19}	X_{20}	X_{24}

Non Independent-Independent Variables — Simple r Matrix

X_7	0.000
X_{11}	-0.123
X_{19}	-0.001
X_{20}	-0.000
X_{24}	0.004
X_{33}	0.069
	e

Figure B1 (cont.)