AN ABSTRACT OF THE THESIS OF

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in Agricultural and Resource Economics presented on June 27, 1980

Title: The Feasibility of Establishing a Futures Delivery Point for Pacific Northwest Feeder Cattle

Abstract approved: Carl W. O'Connor

The commodity futures market represents a relatively new and innovative marketing technique for the cattle industry. It symbolizes a new era in livestock marketing, an era when producers can ultimately determine the final price received for their product. However, being a new marketing tool, it is not without its problems. One of the dilemmas relates to the existence and severity of location basis variability in areas that are without a nearby delivery point. If the problem is severe, producers attempting to hedge their production will find their hedging potential to be significantly different than what they should expect.

This thesis addresses the problem of location basis variability as it applies to Pacific Northwest feeder cattle hedges. Means and variances for regional cash markets and simulated hedging revenues are examined. The optimal price discount for a hypothetical Pacific Northwest nonpar delivery point is also examined in detail. Finally, hedging is analyzed to determine its value to feeder cattle producers in reducing exposure to price risk.

The major findings of this research show that the Pacific Northwest feeder cattle market is part of the national feeder market implying that

the same fundamental supply and demand relationships exist in both markets. The research also produced results indicating the presence of spatial market separation operating within the bounds of effective arbitrage.

No evidence was produced to support the assumption of location basis variability in Pacific Northwest feeder cattle hedges. This infers that livestock producers in the Pacific Northwest have the same potential to use the CME feeder cattle contract as producers in markets with delivery points. However, Pacific Northwest producers are severely penalized in the marketplace if they do elect to deliver. The results then are inconclusive from an economic standpoint. One could argue that since the nonpar delivery point will not affect the price relationships existing between the markets and thus will not correct any basis problems, it is not needed. On the other hand, this could be viewed as evidence to support the establishment of a delivery point, since it would not affect the fundamental price relationships and would result in increased usage of the futures market by producers in the local area. This argument and the research does not consider the implications to the long side of the futures contract.

The best estimate of a price discount for a hypothetical Pacific Northwest futures delivery point was approximately $2/cwt. for Choice 500-700 Pound feeder steers. At this discount level, equivalent delivery incentives will be generated for both the par and nonpar delivery points.

Finally it is shown that basis risk for all markets is significantly less than cash price risk. Producers who hedge can effectively reduce their risk by accepting the basis risk and transferring the cash price risk to speculators.

The Feasibility of Establishing a Futures Delivery Point for Pacific Northwest Feeder Cattle

by

John Teller Carpenter

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

Completed June 1980

Commencement June 1981

APPROVED:

Associate Professor of Agricultural and Resource Economics
in charge of major

Head, Agricultural and Resource Economics

Dean of the Graduate School

Date thesis is presented June 27, 1980

Thesis typed by Dodi Snippen for John Teller Carpenter

ACKNOWLEDGEMENTS

I am indebted to many for their contribution to this effort. In particular I am grateful to:

Dr. Carl W. O'Connor, major professor, for his many hours of counsel and guidance in conducting this research.

Dr. Mike Martin, for his constructive criticism and unending humor.

Dr. Frank Conklin, a true friend and confident, whose support during a crisis made possible the completion of this research.

Dr. Richard Towey, the economic theory core representative on my committee.

My fellow graduate students, for their unselfish encouragement and helpful suggestions.

Angela and my two children, Candace and Jinky, for their support and patience in the early stages of this thesis.

And finally, to my parents, John and Roseann Carpenter, who provided greatly needed support during a crucial time in the writing of this thesis, a time when all the previously completed work could have gone to no avail. This thesis is dedicated to them with love.

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CHAPTER I

INTRODUCTION

Livestock hedging in the Pacific Northwest has come under fire, especially from feeder cattle producers, as being impractical due to basis variability and difficulty in making deliveries. Producers feel this condition stems from the lack of an effective, nearby futures delivery point, which preempts the threat of delivery in the Pacific Northwest. As a result, it is alleged that the local cash market for feeder cattle apparently does not synchronize with the futures market as the delivery month approaches. Many producers feel that the futures basis, defined as the difference between the closest futures contract price and the actual cash market, exhibits a larger mean and variance than a comparable basis of a market annexed to a delivery point. If the condition is as perceived, price risk, a common measure of the effectiveness of hedging, will actually be increased rather than decreased.

This perceived problem surfaced at an Oregon State University extension presentation to the Oregon Cattleman's Association. It was evident by the discussion that the producers felt the efficiency of hedging in the Pacific Northwest was questionable, particularly if producers decided to deliver the cattle onto the market. Various factors including wide basis variation, distance to delivery points, management policies at the delivery points, and typical weight conditions of Pacific Northwest cattle were discussed. Several producers conveyed their experiences with

attempting to deliver cattle from the Pacific Northwest. One producer explained in detail how he suffered a substantial loss on his cattle as a result of delivery.[1/] Other producers also documented similar losses and circumstances.

The effects of wide basis swings and these reported delivery attempts have created a confidence crisis towards the futures market. Many Pacific Northwest producers believe that without an effective delivery point, the threat of delivery will be of no consequence in this region. There will exist no economic incentive for the two markets to close, and as a result, hedging Pacific Northwest cattle on the CME futures market will be ineffective.

Two problems seem to exist. They are; (1) the consequences of location basis variability [1] and (2) the presence of an ineffective delivery option. This research will specifically deal with the first problem, and will provide a framework of analysis that will clarify this issue for both livestock producers and Chicago Mercantile Exchange personnel. The second problem, although important, is primarily an individual firm management problem and need not be addressed by industry-wide research.

Background

The future market developed in the 1800's from a need to manage the price risk involved in shipping grain from production to processing areas. During this time, grain shipments were subject to considerable risk

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1/ The loss was attributable mainly to transportation costs, delivery discounts, intransit weight loss, and mismanagement of the cattle by the delivery yards after arrival. According to the producer, the cattle were forced to stay on the truck for 12 hours until pen space was available. In addition, they were not weighed until the next morning.

arising from inadequate transportation facilities, undependable communication systems, and weather conditions. The risk was greatest to the shipper during the fall and winter months when ice and snow closed the shipping canals and rail systems.

The primary function of the first futures exchange was to manage this price risk. This was accomplished by the introduction of competitive bidding on outstanding commodity contracts destined to arrive at the processing centers at a future date [8]. The exchange provided a central meeting place where buyers and sellers could assimilate all available market information and competitively bid on the "To Arrive" contracts.

A need to standardize the commodity contracts soon became apparent. Conflicts arose within the exchange from delivery of varying qualities of grain in fulfillment of contract commitments. The exchange authority shouldered the responsibility of developing a standardized contract on which bidding could occur. The exchange also provided an internal means of moderating and resolving disputes among traders. From these beginnings, the exchanges grew into several complex marketing organizations, one of which is now known as the Chicago Mercantile Exchange.

Speculation also played a large part in helping the futures market to grow. Speculators were attracted to the market by the financial leverage offered with the contracts. For a small amount of cash they could command a commodity contract valued at least ten times the amount of their initial investment; and while participating in the market, they performed numerous valuable services. As Dale Francis explains, "Americans do not go from a feast to famine cycle from harvest time to mid-winter, in large part, because of price speculators" [7]. Speculation on the price creates profit incentives for farmers to store their production

rather than selling it on the spot market. The profit motives of the farmers will have thus been harnessed to allocate the supply of foodstuffs smoothly over time.

Speculators also help allocate resources to geographic locations by carrying inventories to sell to the highest bidder. The liquidity of the market is also aided by speculators. In the absence of speculators, hedgers may have to accept substantial price discounts in the short run if they wish to enter or exit the futures market. Their mere presence increases the probabilities of having someone who is willing to take the offsetting position on the contract.

Friedman [6] also presents a strong argument for speculator interest in the futures market. He maintains that if a Federal bureaucracy were established to perform the same marketing functions as the futures, its costs of mediation would be staggering. The speculative market performs this function with no cost other than perhaps price destabilization.

The cash-futures price relationships exhibited by storable commodities such as wheat and corn are well understood, have been empirically tested, and are generally acknowledged by students of the future market. This is not so for future contracts of nonstorable commodities. Leuthold [9] has pointed out two main reasons for this. The first encompasses the changing form of the commodity over time. Futures contracts for perishables are exchanged on the presumption that the commodity will be available at a future date and not on the premise that the commodity exists in the specified form at the present time. Since live beef cattle cannot be held as inventory, there exists no meaningful relationship between prices and deferred delivery.

Another argument concerns the relatively short history of the market.

Live beef cattle futures have only existed since 1964. Previous to the late 1970's there existed little data from which to draw. Only now are professional articles dealing with livestock futures emerging.

Hedging is defined as the simultaneous offsetting of a spot market position with a commitment in the futures market. It is initiated through the buying or selling of a futures contract on standard forms from an established commodity exchange and on the presumption that, at a later date, an offsetting futures position will be substituted for the original commitment. Hedging is contrasted with forward cash contracting in the intent to deliver. A futures contract is usually purchased with the intent not to engage in the physical transaction of the product on the future market, but as a temporary substitute for a merchandising transaction which may be made at a later date. If the original futures contract was purchased with the intent to deliver, the result is not a hedge. The transaction is, in essence, no different from a simple forward cash contract. The use of the futures market in this manner is not generally desirable since the market's use of a highly specialized contract usually limits its applicability to the typical producer [18].

The economic incentives to hedge are based on the hedger's opportunity to influence the final price he receives or pays for a commodity. They include: (1) the ability of the producer, processor, or other marketing system participant to reduce exposure to cash price fluctuations, (2) the flexibility for the hedger to ignore absolute cash price levels and concentrate mainly on relative cash prices in his decision analysis, (3) the opportunity of the hedger to engage in trade simply on his judgment that present spot prices are relatively divergent from anticipated prices, and (4) the ability of hedgers to digress from traditional market structures

where producers have been price-takers into market structures where they can influence the prices received for their product.

Other considerations are also important in the analysis of a hedge. One of the primary considerations is the movement of the cash-futures differential, or the basis. Early attempts to describe the live cattle basis were anchored on the thesis that the price of storage for storable commodities was identical to the values of feedlot services in the production of cattle. In 1967, Paul and Wesson [13] attempted to derive a feedlot service value based on the relationship between feeder and slaughter animals. They postulated that it was a function of feed costs and tested the hypothesis by calculating a live beef cattle feeding margin. When the feeding margin was plotted with placements in feedlots, a positively sloped supply response was noted. This suggested that feedlot operators were responding to the futures price through placements; i.e., a positive basis was conducive to increased placements and a negative basis or basis near zero was conducive to reduced placements.

Ehrich [5] pointed out three deficiencies in the Paul and Wesson article. First, the behavioral attributes of the basis were not examined. Second, the theoretical causal relationship between slaughter cattle prices, feed costs, and feeder cattle prices was ignored. And third, it was generally believed, at that time, that cash and futures prices for nonstorable commodities followed an independent random walk and could not be considered in the usual "returns to storage" context. Paul and Wesson did not address this issue.

Ehrich then went on to derive a competitive model of feeder cattle prices based on feeder costs and slaughter futures prices. The model was of the form:

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

where

P_s^* = current futures price of fat steers

P_f = current cash price of feeder steers

C = total cost of feeding/cwt of gain

W_s = finished weight of fat steers

W_f = beginning weight of feeder steers

Empirical results showed the fat basis to vary around the predicted equilibrium in a manner consistent with observed behavior of hedgers and of price adjustments in the market. From this, Ehrich concluded that futures prices were economically tied to cash prices via the cattle feeding services of the feedlot. He also presented a hypothesized causal relationship between fat cattle prices and inventories of available feeder cattle. Preliminary indications showed that feeder cattle prices adjusted to expected fat cattle prices. These findings concurred with previous studies which showed feeder cattle prices to be price inelastic.[2/]

Ehrich summarized by stressing the important contributions which the futures market could make on pricing efficiency of the cash market. Providing that proper regulation was implemented, the futures market could

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[2/] G.E. Brandow [2] found farm level price elasticities of -.68 for cattle and -1.08 for calves. This follows from the fact that marketing charges remain relatively fixed when prices vary. A price change at retail will be passed back through marketing channels to farmers in almost its entirety. Price changes will thus have a greater percentage effect on farm price than on retail price.

eliminate from price adjustments the discount of future market uncertainty with which it must now contend.

In 1976, Miller and Kenyon [11] also took issue with the analytic results of Paul and Wesson. Through econometric analysis, they derived a linear relationship between cash and futures prices. Although the function did not explain all of the variability of prices, it did lead support to the thesis that futures were having an effect on cash prices. Cash and futures prices were now considered independent expectations of ongoing supply and demand condition manifesting a convergent relationship from the threat of delivery.

As has been implied, many economists once considered the price of storage discovery mechanism of the futures market to be the primary motivation for its existence. According to Working [19], "it is through supplying a direct measure of the return to be expected from storage, and a means, through hedging, of assuring receipt of that return, that a futures market makes its most direct and powerful contribution to the economics distribution of supplies of a commodity over time". Studies by Miller and Kenyon, Ehrich, and Leuthold have altered this theory as it applies to nonstorable commodities. The theory now conforms more realistically to what has been documented empirically.

Leuthold [9] has pointed out two conditions relating to the basis that must exist for a successful perishable commodities hedge.

1. The basis, both during and immediately preceeding the delivery month, must be lcose to zero. This qualification emulates from the threat of delivery. A basis that is significantly different from zero will create economic pressure to deliver the commodity onto the futures market. Deliveries onto the market, expecially deliveries of nonstorable commodities, have undesirable effects on the process of market exchange. Futures markets are not designed to efficiently handle deliveries. Their function is

basically a "paper" exchange. Actual exchange of the commodities to relieve a contractual commitment in the futures market normally results in pricing inequalities either to the long or short side.

2. The variance in the basis must be less than the variance in the cash market. Producers will not participate in forward contracting unless the basis risk is less than the price risk. Implicit within this assumption lies the perceived value of hedging. Producers engage in hedging to reduce risk. If a hedge cannot effectively transfer price risk, then it is of little value. This condition also precludes the necessity of a predictable basis. Every hedger incorporates his expectations of basis in calculating the expected profit of the hedge. If his expectations are not realized, the value of the hedge is decreased in direct proportion to the difference between realized and expected basis.

Bobst, in his study on location basis variability in Kentucky, concluded that a predictable basis arises from perfect spatial competition. "It can be shown that in a perfectly competitive spatial market, with free trade, perfect knowledge, large numbers of buyers and sellers, and so on, price difference between any two points cannot exceed the transfer cost between them in the short run" [1, p. 6]. Given these assumptions, excessive regional price differences would imply the existence of location basis variability.

Hedging revenue variances which are unjustifiably high in markets distant to delivery points will also give a preliminary indication of location basis variability. Revenue variances are measured by summing the variances and covariances of cash and futures prices over time. Hedging revenue variances can be derived for numerous markets both in and distant from the same area. Comparisons of the markets are then possible. Any severe departures from the norm can be viewed as evidence of hedging inefficiencies.

Several attempts have also been made to describe the basis for non-storable commodities by the use of econometric analysis. Vollink and Raikes [17] derived a four-equation supply and demand model for fat cattle in the Midwest from daily cash price movements recorded, daily futures prices recorded, daily futures contracts sold, and daily cash contracts executed. They theorized that, in equilibrium, the basis would precisely equal transaction costs of executing and completing a futures contract, implying supply and demand equivalence between all executable contracts. Then, by varying prices of both cash and futures contracts, the effect on equilibrium, and hence the effect on the basis, could be determined.

Their results indicated that price expectations of speculators do have a measurable impact on delivery-period basis determination for live cattle. These expectations explained nearly 40 percent of the variance in the pooled data set.

They also concluded that the movement of the basis in the delivery-period was relatively constant with few oscillations about the mean. However, the hypothesized transactions cost of $.10/cwt was substantially below the basis mean value of $.36/cwt.

Leuthold [9] also employed econometric techniques in analyzing the live beef cattle basis in Illinois. His model was formulated on the theory of basis being a function of future quantities available to the market. The variables utilized included cattle on feed, slaughter levels, feedlot placements, cash and futures prices, and the beef-corn price ratio.

The empirical results of the model reinforced two important assumptions of this paper. The first pertains to risk and uncertainty. The variability of the basis was significantly less than the variability of

either the futures or cash price. This implies that hedgers can substantially reduce their exposure to price risk through hedging.

The second conclusion reached concerned the sign of the regression coefficients. The economic variables of current slaughter, number of cattle on feed, beef-corn price ratio, feeder futures prices, and feeder cash price all were significantly different from zero and had the "correct" signs. Thus, "a fairly high proportion of the variation of the basis anywhere from two to seven months prior to contract delivery can be explained by the factors which determine and shift the supply curve" [9, p. 16].

The implications of nonpar delivery points to the Chicago Mercantile Exchange have been addressed by Skadberg and Futrell [16] and by Crow, Riley, and Purcell [4].

Skadberg and Futrell argued that "to have economic merit, they (futures markets) must offer hedging potential or perform a valid pricing function", (hedging potential is defined as the relative merits of a hedge compared to its costs of implementation). They concluded that hedging potential would be increased by the establishment of nonpar delivery points if the result was an increase in hedging opportunities or a decrease in hedging costs.

Crow, Riley, and Purcell tended to agree with this finding. However, they went one step further and analyzed the delivery alternatives resulting from the establishment of the Guymon, Oklahoma nonpar delivery point. They pointed out that the Guymon delivery point was economically unjustified when the delivery discount was calculated using Omaha as the base-point for the pricing system. Furthermore, if the basing-point pricing system was used, these conclusions must be reached:

1. If the delivery discount at the nonpar delivery point is greater than "true" structural differences, delivery would never occur.

2. If the delivery discount at the nonpar delivery point is less than structural differences, delivery would be relatively more frequent than at par delivery points.

"Any nonpar delivery point which is established using the costs of moving the product to or from the par delivery point as a discount will be economically unsound if the implicitly assumed basing-price system does not prevail" [4]. If the goal of the futures exchange is to enhance hedging potential, then either separate contracts should be devised for the regional markets, or the discount should be calculated on the basis of established intermarket relationships.

Peck [14] disagrees with the findings of Crow, Riley, and Purcell. She maintains that if the discount is set at the true structural differences, the futures market will be indifferent towards closing with the prices of the par delivery point or the prices of the nonpar delivery point. She advocates high nonpar delivery point price discounts to avoid this possibility. This basic disagreement exemplifies areas of commodity futures theory that still need to be researched. Topics including the random walk hypothesis, and the implications on price destablization from market speculation all fall into this category.

Location Basis Variability in the Pacific Northwest

The research set forth in this proposal will investigate the significance of location basis variability as it applies to the feeder cattle market in the Pacific Northwest. The first step of the analysis will be to investigate the cash price relationships between production regions.

Since the futures market is a common variable between all regions, one must first determine that all regions are part of a national market. The CME feeder cattle futures contract is primarily based on Midwest cattle markets. If there exists no consistent and predictable price relationship between the Pacific Northwest cash market and the Midwest cash market, then there could exist no consistent and predictable price relationship between the futures market and the Pacific Northwest cash market. Pacific Northwest hedgers would be at a distinct disadvantage when ompared to hedgers in the Midwest since the markets would move independently from one another and the threat of delivery would be to no avail. Furthermore, the establishment of a futures delivery point in the region would compound trade problems for futures and cash contracts. The market could not adjust to the supply and demand conditions of both cash markets at once and a significant bias would thus be introduced. If, however, there proves to be no statistical difference between the cash prices of the regional markets, hedgers in both regions would be economically justified to participate in the futures market.

If there exists no statistical difference between markets, a hedging revenue function based on the linear combination of cash-to-futures price variances and covariances will be constructed for the following markets: Omaha, Nebraska; Billings, Montana; Shasta, California; and Moses Lake, Washington.

The variation induced in the regional hedging revenues is attributable, in part, to the futures prices. And since there is only one futures exchange trading live feeder cattle contracts, this induced variance will be common to all cash markets. Differences in regional price basis will therefore rise from cash price variances and covariances of futures-to-cash prices [1, p. 6]. If significant differences between hedging revenue

functions are observed, one can conclude that the hedgers of the regional markets using the futures exchange would be economically disadvantaged. There would exist a reduced foundation in their use of the market as a hedging tool.

Nonpar Delivery Point Price Discount

Historical data has consistently shown that equivalent feeder animals will sell at a premium in the Midwest when compared to the Pacific Northwest market. The futures market could not disrupt this basic relationship and still function. The price discount would have to match this relationship as closely as possible so as to not disrupt either the cash or future market.

Crow, Riley, and Purcell [4] determined that any price discount which does not reflect true market conditions but is instead justified by an implicitly assumed basing-price system will be economically unsound unless the local market is actually founded on the basing-price system. Their findings indicate that the discount should be constructed around the true regional market relationship. A price discount which is unrelated to cash market processes will force both the futures and cash markets to respond to pressures outside the realm of local circumstances. A delivery point with a price discount unrelfective of the interregional relationship could conceivably put hedgers at a worse disadvantage than with the absence of a delivery point.

The problem, then, is to estimate the discount that would lead to the best market performance, i.e., where neither the long nor short side of the contract would be at a comparative disadvantage. This will be done by calculating an economic incentive for delivery at each market. Obviously there exists no local economic delivery incentive in the Pacific

Northwest since there is no area delivery point. To circumvent this, a hypothetical nonpar delivery point will be created for the Pacific Northwest. This will permit the estimation of a Pacific Northwest delivery incentive. The resulting delivery incentive can be directly compared with the incentives of the other delivery points. The nonpar delivery point price discount structure which will create equal incentives to deliver at all delivery points can then be estimated. The derived structure will implicitly assume the existing cash market structure to be optimal.

Hedging and Risk Management

Leuthold [9] has pointed out the conditions that must exist for a successful hedge. They are (1) that the basis must approach zero as the contract matures and (2) that the variance of the basis must be less than the variance of the cash market. If condition (1) is violated, either the threat of delivery will create economic pressures to force the basis to approach zero or deliveries of the hedged commodity will actually occur. The latter instance is not conducive to efficient futures trading since the futures market is not designed to handle physical deliveries, except in extreme circumstances. When it does occur, it usually reflects unforeseen supply and demand conditions that were not considered prior to the delivery month. Producers should be aware of the relative frequency that delivery may be required when they are engaged in hedging. This is especially crucial to Pacific Northwest producers who incur extremely high delivery costs if they elect to deliver. If the basis is consistently more than they anticipated it to be, their exposure to price risk may not be reduced when they enter the hedge. In this case the value of

hedging may be highly questionable.

Comparisons of cash price and basis variances also give an indication as to the reduction in risk the producer may expect when he enters a hedge. If the futures basis is more erratic than cash prices, exposure to risk will be increased instead of decreased. All previous studies reviewed in this thesis have found the cash price variation to be more than the basis variation in their respective regions [9, 12, 17]. This same condition is anticipated for the Pacific Northwest. If producers in this region can significantly reduce their exposure to price risk, they would be justified in using the futures market to hedge. Of course, this presumes that the problem of location basis variability can be resolved and that a suitable nonpar delivery point price discount can be estimated.

Objectives

The objectives of this research are:

1. Evaluate the price relationships of feeder cattle between the identified regional markets.

2. Determine the existence and severity of location basis variability for Pacific Northwest feeder cattle.

3. Examine the theoretical framework for the calculation of a futures delivery point price discount.

4. Estimate the value of hedging in reducing Pacific Northwest feeder cattle producers' exposure to price risk.

CHAPTER II

THEORETICAL FRAMEWORK OF ANALYSIS

Measurement of Cash Price Variances

The relationship between the cash price and the futures price at the close of the futures contract ultimately determines the success or failure of a commodities hedge. The futures price minus the cash price during the time when the contract would normally be lifted, or simply the basis, must be predictable at the onset of a hedge if the hedger is to reduce his cash price risk. The basis does not necessarily have to be zero, especially in locations which are distant from delivery points. It must, however, be less than a monetary value that would give hedgers an economic incentive to deliver. If it is not, delivery will occur. In equilibrium, after adjusting for transportation and other arbitrage costs, there will exist no incentive to deliver. Producers would be indifferent towards liquidating their futures position by delivery on the futures market or by cancelling their commodity futures position with an offsetting sale.

At the present time there is only one commodities exchange, the Chicago Mercantile Exchange, which trades in feeder cattle contracts. This exchange has established its par delivery point at Omaha, Nebraska. Feeder futures prices will thus react to cash market conditions that exist at Omaha. There are, however, many cash markets spread throughout the country which are supported by local supply and demand conditions. If the conditions are significantly different between the areas, prices will differ. The implications on hedging within these locales is based upon the relationships of one national futures market and the local cash price.

The futures market's ability to adjust to more than one cash market depends on the relationship that exists between the cash markets. If arbitrage between the areas is efficient, hedging potential will be unaffected. The lack of effective arbitrage, however, will decrease the probabilities of a successful hedge. One can see, then, that the first step in measuring the hedging potential of a specific area is to analyze the cash price relationship between a specific area and other markets.

These relationships will be analyzed by two methods. The first method involves the use of Bartlett's test of homogeneity of variance. The mathematical formulation of the test is as follows:

$$\text{let} \quad M = (N - K) \ln S_p^2 - \Sigma[n_i - 1) \ln S_i^2]$$

where

N = number of total observations

K = number of markets to be tested

n = number of observations per market

S_i^2 = variance of the i^{th} market

$$S_p^2 = \frac{\Sigma(n_i - 1)S_i^2}{N - K}$$

$$A = \frac{1}{3(K - 1)} \left[\Sigma \left(\frac{1}{n_i - 1}\right) - \frac{1}{N - K}\right]$$

$$V_1 = K - 1$$

$$V_2 = \frac{K + 1}{A^2}$$

$$b = \frac{V_2}{1 - A = (2/V_2)}$$

It follows that the sampling distribution of $F = \frac{V_2 M}{V_1 (b - M)}$ is approximately $F(V_1, V_2)$.

The null hypothesis is that there is no significant difference between the variances of the different markets, or:

$$Ho: \quad \sigma^2_1 = \sigma^2_2 = \sigma^2_3 = \sigma^2_4$$

Any evidence indicating that the markets are responding to unrelated economic factors will result in culmination of the research project. If the markets are reacting to separate supply and demand conditions, hedging potential for Pacific Northwest producers cannot be calculated. Non-rejection of this hypothesis will allow the research to continue with the formulation and estimation of the hedging revenue functions.

If there is no significant difference between the variances at the 95 percent critical value, the mean values of the price of each market will be compared. This will be accomplished with a t-statistic. The test statistic is:

$$t = \frac{\bar{D}}{S_{\bar{D}}}$$

where

$$\bar{D} = u_i - u_t$$

and

$$S_{\bar{D}} = \frac{\Sigma D^2_i - (\Sigma D_i)^2 / n}{n - 1}$$

The null hypothesis to be tested is:

$$Ho: \quad u_1 = u_2$$

Nonrejection of this hypothesis will imply that the mean prices are equal and that spatial market separation does not exist.

It is anticipated that the mean difference between the markets will be greater than zero. This is so because of the market separation that exists between the areas. All regions presumably have local supply and demand conditions that the individual markets react to. Adjustments to these separate economic factors should create some difference in prices paid. However, the magnitude of the difference cannot be predicted a priori.

Measurement of Location Basis Variability

The estimation of individual heding revenue functions is the next step in determining the existence and severity of location basis variability in the Pacific Northwest. The hedging revenues can then be statistically compared with one another. If the hedging revenues are statistically similar (i.e., the variances are equal) the hypothesis of location basis variability can be rejected. If, however, the variability of the Pacific Northwest hedging revenues is significantly greater than the variability of hedging revenues in other areas, the hypothesis of location basis variability is plausible and the placement of a futures delivery point in the area should be explored.

A hedging revenue function will be estimated for four auctions and range markets: Northern California (Shasta), Montana (Billings),

Washington and Oregon Range Sales, and Nebraska (Omaha). It will be formulated as follows:

$$R_{ijmt} = P_{it} + S_{jm} - L_{mt}$$

where

R_{ijmt} = revenue per hundred weight in market i from a hedge placed j periods prior to the cash marketing date t in the contract maturing in month m.

P_{it} = price of feeder steers of deliverable grade and weight in market i of period t.

S_{jm} = price at which contract maturing in month m was sold j periods prior to the cash marketing date.

L_{mt} = price at which the contract maturing in month m was repurchased in period t.

The actual lengths of the hedges, which will be in 16, 20, 24, and 32 week intervals, originated from a cattle backgrounding study by Rutledge [7]. He determined these intervals to be the most common feeding periods to bring feeder animals up to the desired weights. If an animal is in a 20-week backgrounding program, the hedge would be placed 20 weeks prior to the expected sale date. For any given hedge length or cash marketing date, the variables S_{jm} and L_{mt} will be the same among all markets.

The variance of the hedged positions will be derived from the expansion of equation (1). If one can assume the variance of hedging revenue to be a linear combination of variances and covariances of a series of hedges over time, then it follows that:

$$\text{Var}(R_{ijm}) = \text{Var}(P_{it}) + \text{Var}(S_{jm}) + \text{Var}(L_{mt}) + 2[\text{Cov}(P_{it}, S_{jm}) - \text{Cov}(P_{it}, L_{mt}) - \text{Cov}(S_{jm}, L_{mt})]$$

$$t = 1, 2, \ldots, T_m$$

Differences in hedging revenue variance must arise from differences in local cash market conditions, since, for given hedge lengths, variances in futures prices will be identical among all markets. Thus, hedging revenue variance will be a combination of local cash price variances and futures-to-cash price covariances.

Statistical analyses will be on pooled within-contract variances as follows:

$$\text{Var}(R_{ij}) = \sum_{m}^{M} \text{Var}(R_{ijm}) \; / \; \sum_{m}^{M} T_m - M$$

$$m = 1, 2, \ldots, M$$

where

$\text{Var}(R_{ij})$ = pooled within-contract variance in market i for hedge length j.

m = number of contracts.

All other variables are as previously defined.

After the hedging revenue functions have been calculated from equations (1) and (2), Bartlett's methodology will be used to test for simultaneous homogeneity of variance between revenues of the same length and class. The formulation of the model is identical to the one presented earlier. This test will be the key determinant in the documentation of

location basis variability for the Pacific Northwest. As has been mentioned earlier, mean differences between the hedging revenue functions pose no real problems to hedgers in the Pacific Northwest. In fact, they are to be expected due to spatial market separation. The presence of differing revenue variances, however, is a good indication that a delivery point may create an atmostphere more conducive to hedging in that particular area.

Estimation of the Delivery Point Discount

As has been mentioned before, a Pacific Northwest futures delivery point is a political issue as well as an economic one. Research into the existence of location basis variability may not produce enough persuasive evidence to belay the cattleman's call for a western delivery point. As such, this research will go one step further and examine the theory and empirical evidence pertaining to the level of a delivery point price discount, whether the existence of location basis variability is established or not.

The theory of the futures market specifically dealing with the level of an appropriate nonpar delivery point price discount has not been extensively addressed in the literature. Basically, though, there exists two poles of thought on the issue. The first, expounded by Anne Peck and the Chicago Board of Trade [14] details the need for a price discount at a level considerably above existing interregional price differences. They maintain this is needed so the futures market will close towards the par delivery price as the contract matures. If the nonpar delivery point discount is not set at a level which is greater than the temporal relationship, the futures market will be indifferent towards closing with either

that market or the par delivery market. The desirability of a predictable basis, as described earlier, would then be unattainable. This could have the effect of negating the usefulness of hedging.

The second interpretation of futures theory as professed by Skadberg and Futrell []6] and by Crow, Riley, and Purcell [4], dismisses the need for a nonpar delivery point price discount which is calculated from an assumed basing-point pricing system. As they pointed out, "Any nonpar delivery point which is established using the costs of moving the product to or from the par delivery point as the price discount will be economically unsound if the implicitly assumed basing-price system does not prevail" [4]. They also maintained that if the delivery discount at the nonpar delivery point is greater than "true" structural differences, delivery would never occur. Likewise if the delivery discount at the nonpar delivery point is less than structural differences, delivery would be relatively more frequent than at par delivery points. Thus, only with a delivery discount set at the level of structural differences would delivery be equally likely among all points.

This research will proceed on the assumptions of Crow, Riley, and Purcell that the delivery point discount should be equated with structural differences which exist in the market. Although further research is needed to validate this theory, the issue will be avoided here mainly because it would add little to the central theme of this project, the analysis of location basis variability. The author considers the issue of a delivery point price discount to be a fringe area of the thesis and will treat it as such. It is recognized, however, that the issue is unresolved and should be pursued by future research.

The basic approach of the research will be to infer that a delivery point has existed in the Pacific Northwest for the nine years of data that is available. The price discount will be the mean difference between the cash prices for Pacific Northwest choice 500-600 pound feeder steers and the cash prices for Omaha choice 500-600 pound feeder steers. The mean will represent the assumed structural differences between the two markets. The objective of using this approach is to measure the economic incentive for delivery in the Pacific Northwest which can then be compared with the delivery incentive that has existed at Billings and Omaha during the same time period.

The delivery incentive will be calculated from equation (4) which is:

$$DI_i = F - C_i - DPD_i - ShR - WD \qquad (4)$$

where

DI_i = the economic incentive to delivery at market i

F = the nearby futures contract price

C_i = the local cash market price for market i

DPD_i = the nonpar delivery point price discount for market i

ShR = a constant shrink calculated at six percent

WD = the weight discount for overweight feeder cattle delivered onto the futures market.

The objective behind using equation (4) is to measure the delivery incentive that has existed in each of the four cash markets. The results

can then be analyzed to ascertain the price discount which will produce no more economic incentive or disincentive to deliver at the nonpar delivery points than is generated at Omaha.

It is hypothesized that the statistical mean difference when used as the price discount, will produce the same delivery incentive in the Pacific Northwest as has existed at Billings or Omaha from 1972-1979. The alternative hypothesis is that delivery incentive will be greater in the Pacific Northwest than at the other established delivery points if the true structural differences averaged for the nine years of available data is used as the specified price discount. A standardized T-test will be used for this hypothesis. The test will be constructed as follows:

$$\text{Ho: } DF_i - DI_j = 0 \qquad \text{and} \qquad DI_i - DI_k = 0$$

$$\text{Ha: } DI_i - DI_j > 0 \qquad \text{and} \qquad DI_i = DI_k > 0$$

where

DI_i = the mean of the economic incentive to deliver feeder cattle in the Pacific Northwest.

DI_j = the mean of the economic incentive to deliver feeder cattle in Billings.

DI_k = the mean of the economic incentive to deliver feeder cattle in Omaha.

The test statistics are:

$$t_1 = \frac{\overline{D}_1}{S_{\overline{D}_1}} \qquad \text{and} \qquad t_2 = \frac{\overline{D}_2}{S_{\overline{D}_2}}$$

where

$$\overline{D}_1 = DI_i - DI_j$$

$$\overline{D}_2 = DI_i - DI_k$$

and

$$S_{\overline{D}_1} = \frac{\Sigma D_1^2 - (\Sigma D_1)^2 / n}{n - 1}$$

$$S_{\overline{D}_2} = \frac{\Sigma D_2^2 - (\Sigma D_2)^2 / n}{n - 1}$$

If the null hypothesis is rejected in favor of the alternative hypothesis, the establishment of a fixed price discount would not be acceptable for a Pacific Northwest delivery point. In that case it may be feasible to implement an adjustable discount for the delivery point. Implicitly assumed within any price discount of this nature would be the postulate that the Pacific Northwest cattle market is a regional satellite of the Omaha market, i.e., a basing-point pricing system is the modus operandi of the area.

This hypothesis will be tested by subtracting the Pacific Northwest feeder cash price from the Omaha feeder cash price at yearly intervals. The generated values can then be regressed with a cost of transportation index presented by Martin and McNamee [10] for Pacific Northwest commodities.

The hypothesis then is that the cost of transportation between the Pacific Northwest and Omaha is equivalent to structural differences between the feeder cattle markets of the areas. Conversely the alternative hypothesis is that transportation costs are not equal to the structural market differences.

In mathematical notation the relationship is:

$$Y = B_X + B_1X + e_1$$

where

Y = the structural market difference measured yearly

X = the cost of transportation to Omaha from the Pacific Northwest.

The hypotheses to be tested are:

Ho: $B_0 = 0$ and $B_1 = 1$

Ha: $B_0 \neq 0$ and $B_1 \neq 1$

There are some statistical problems with inferring a delivery point upon Pacific Northwest historical price data. The most obvious problem is assuming that pricing conditions would have been the same with a delivery point as without. Certainly the presence of a delivery point would have altered the pricing mechanism somewhat. The magnitude of this, however, cannot be determined a priori.

The Value of Hedging in Reducing Price Risk

There are two basic axioms concerning the relationship between cash and futures prices which will determine the effectiveness of the hedging strategy. The assumptions are that (1) the basis must decrease to a level which will minimize the economic incentive to delivery and (2) the variance of the basis must be less than the variance of the cash prices. The violation of either assumption will preclude the efficiency of the hedge.

According to Leuthold [9], the basis must approach zero as the expiration month of the futures contract draws near if hedging is to be effective. During the contract month, he maintains that both the cash price and the futures price for a deliverable quantity and quality of product must be the same. If they are not, delivery upon the futures market will take place.

In the strictest sense, this assumption is untrue. For every futures contract delivery, there is an associated cost. That cost must be calculated into the expectations of profitability if the producer is to make a rational decision. Costs of delivery will vary between individual producers and between regions. The quantifiable factors such as transportation costs, weight and grade discounts, and delivery point discounts are easily calculated. However, there are also such unquantifiable factors as risk preferences, perceived management conditions at the delivery points, and attitudes on delivery in general which also enter into the decision. To say then that the basis must approach zero if deliveries are to be minimized is a rather naive assumption. A more apt criterion for delivery would be based on the perceived economic incentive to deliver. The delivery incentive, which would be a combination of both quantifiable and unquantifiable factors as well as basis, can be regarded as a proxy for the threat of delivery. If the delivery incentive is strong enough, delivery upon the futures market will take place and force the futures price and cash price to converge. In equilibrium, i.e., if the economic incentive to deliver is approximately zero, there will exist no threat of delivery. Producers will be indifferent towards liquidating their futures position by delivery on the future market or by cancelling their position with an offsetting purchase in the futures market.

Hedging will also be ineffective if the variance of the basis is greater than the variance of cash prices. The implicit assumption presented in this context concerns a fundamental, if not crucial, justification for hedging. Producers participate in the futures market to reduce price risk. This is accomplished by transferring cash price risk to other hedgers (packers for example) and speculators. If the basis risk is not substantially less than the price risk, the producer has gained little. The same can be said for the speculator on the opposite end of the contract. If his risk (and possible gain) has not been increased by participating in the futures market, he has gained little.

The first assumption on the magnitude of the delivery incentive has already been addressed in the context of delivery point price discounts. The remaining assumption will be analyzed here. It is postulated that for hedging to be effective, the basis risk, which will be calculated from the hedging revenue functions derived earlier, must be less than the cash price risk. The Hartley test for equality of variance will be employed to analyze the hypothesis.

In mathematical terms the hypothesis is:

$$\text{Ho: } \sigma_1^2 = \sigma_2^2$$

$$\text{Ha: } \sigma_1^2 < \sigma_2^2$$

where

σ_1^2 = the variance of the hedging revenue function

σ_2^2 = the variance of the cash prices for each market.

The test statistic is:

$$H = \frac{\max(s_j^2)}{\min(s_j^2)}$$

The appropriate decision rule will be:

If $H \leq H\ (1 - .95,\ 2,\ \infty)$ conclude Ho:

If $H > H\ (1 - .95,\ 2,\ \infty)$ conclude Ha.

where $H\ (1 = .95,\ 2,\ \infty)$ is the $(1 - a)\ 100$ percentile of the distribution of H when Ho holds, for two factor levels and sample sizes of infinity.

In summary, then, six hypotheses will be analyzed. The first applies to the cash price variances. It is postulated that there exists no significant differences in cash price variances among markets, thus anchoring the theory that distant markets are not economically separated from delivery point markets such as Omaha and Billings.

It is hypothesized that there exists a statistically significant difference between the means of the central market (Omaha) and the Pacific Northwest market. If this hypothesis is not rejected, spatial market separation will have been established.

It is hypothesized that location basis variability exists in the Pacific Northwest, i.e., that hedging revenue variability is significantly different in the Pacific Northwest than at delivery point markets. If the variance is significantly different, one can assume that Pacific Northwest feeder producers are at a disadvantage in comparison to producers close to delivery points when Pacific Nortwhest producers elect to hedge their production.

It is postulated that the best estimate of a delivery point price discount can be derived from the fundamental price relationships between the delivery point market and the central market. Furthermore, assuming

that there exists no statistical difference between cash price variances among markets, it is postulated that the best assessment of a proper discount is the mean difference in price between the two markets.

If, however, this null hypothesis is rejected, an alternative discount structure will be analyzed. For this analysis, it is postulated that the best estimate of a functional delivery point price discount will be a floating index based on the cost of transportation between the Pacific Northwest and the par delivery point.

The final hypothesis that will be tested pertains to hedging as a risk strategy. If hedging is to be effective, price risk transferred to the producer must be less than cash price risk. Therefore, it is postulated that hedging revenue variances are significantly lower than cash price variances.

CHAPTER III

DESCRIPTION OF THE DATA

The Pacific Northwest is an area rich in the resources needed to produce top quality feeder cattle. The native pastures provide an excellent forage base for livestock production. As a consequence, the average weights are usually higher than in other regions of the Western United States. This sometimes poses a problem for Pacific Northwest livestock producers that attempt to use the C.M.E. futures market in their hedging strategy. As the delivery conditions of the feeder cattle contract states, "a delivery unit averaging over 650 pounds and up to and including 800 pounds per animal, is deliverable at a discount of 1½ cents ($.015) per hundred weight for each pound, or fraction thereof, by which the average weight exceeds 650 pounds" [3]. Frequently Pacific Northwest feeder cattle are included in this category. Since the C.M.E. futures feeder cattle contract is not specifically designed to handle this, some problems with the basis and with the delivery option have been generated which are peculiar to this area.

Producers should be aware of the problems of hedging heavier weight cattle when they enter the hedge. This is especially crucial for Pacific Northwest producers who manage long yearling operations. Typically these producers will delay selling the yearlings until late fall when the pasture is gone. The result is usually a feeder that weighs an average 75-100 pounds heavier than the national norm. If a producer enters a hedge with the idea of producing and/or delivering this type of animal, he may well find market conditions significantly different at the close of the hedge than what he expected. It is for this reason that this research examines

three separate price categories. They include prices for 500-600 pound feeder steers, 600-700 pound feeder steers, and 700-800 pound feeder steers. Summary statistics for Good steers and Choice and Good heifers are also presented but they are omitted from the main content of the research because the futures contract now being used is not designed to effectively handle these types of animals.

Seven years of data were used in the analysis. Weekly observations for both cash and futures prices were obtained for each of the six markets involved in the analysis. The data were collected directly from the area offices of the Federal-State Market News Service. In all, 386 observations were collected for each market. The time period extended from January 8, 1972, to May 19, 1979, inclusive. The price observations were rounded to the second decimal where necessary.

The area market news services that were sampled for this research quoted a range of prices rather than a specific price as representative of the weekly trade. The published range was frequently $1.00-3.00/cwt. This range was averaged when used in the statistical analysis. This method of estimating a weekly price could conceivably introduce a statistical bias into the data since the high and low prices were given equal weight in the averaging process. There was no way of knowing if a more representative price was something other than the average of the high and low. For the purposes of this study, it was assumed to be the best estimate of the market.

There were numerous instances where the weekly price observations were missing. The problem occurred most frequently in the price data for Good grade feeder cattle. The markets in Moses Lake, Washington; Omaha, Nebraska; and Shasta, California, were without many of the Good grade mar-

ket quotations. Where this problem occurred, a market quotation was estimated or interpolated from evident price trends and adjoining price quotations. Here again, the method of estimation can be criticized as conceivably introducing a statistical bias. The effects of this induced bias would be minimal, however, when one considers the many observations that were used in the study.

Statistical Descriptions of the Data

A general statistical description of the data is presented in Tables 1 and 2. The tables include cash price means and variances for all types and weights of feeder cattle produced in the four areas under investigation. As the reader will note, there appears to be little difference between the cash prices in each of the markets. The prices received for Choice grade livestock in the Pacific Northwest and in Shasta, California, are quite similar. An average difference between these prices, calculated for all the choice weight groups, approximates $.50/cwt. The difference is somewhat greater between the Pacific Northwest market and the Omaha market. For all combined Choice weight groups, the average approaches $2.55/cwt. This difference should mirror the hypothesized interregional market relationship. Previous studies have indicated large numbers of feeder cattle are produced in the Pacific Northwest while feedlot facilities to absorb the production are inadequate. The oversupply causes a dampening of prices at the producer level. Producers are forced to sell their cattle at reduced price levels to offset transportation charges out of the area. And while the average price of $2.65 does not approximate transportation charges to the Omaha region (the costs are estimated at $6.00-7.00/cwt. for 1978), it does closely mirror average

Table 1. Statistical Description of Cash Markets by Weight Category, 1972-1979.

	Pacific Northwest	Shasta	Greeley	Omaha	Billings
Choice 400-500 Pound Steers	----------	----------	dollars/cwt.	----------	----------
Mean	47.63	49.49	53.25	50.22	50.60
Variance	256.23	282.50	287.62	246.78	288.27
Choice 500-600 Pound Steers					
Mean	46.23	47.22	49.80	48.06	47.39
Variance	214.71	219.54	286.70	196.79	213.41
Choice 600-700 Pound Steers					
Mean	44.33	45.21	47.09	46.28	45.47
Variance	168.70	165.45	212.72	163.46	165.82
Choice 700-800 Pound Steers					
Mean	43.28	43.44	45.61	44.42	43.78
Variance	139.87	136.72	173.74	134.73	142.03
Good 500-600 Pound Steers					
Mean	41.09	44.48	46.64	NA	42.61
Variance	193.38	177.04	254.51	NA	173.76

Table 1. Statistical Description of Cash Markets by Weight Category, 1972-1979 (continued).

	Pacific Northwest	Shasta	Greeley	Omaha	Billings
Good 600-700 Pound Steers	----------	----------	dollars/cwt.	----------	----------
Mean	39.54	42.69	44.24	NA	41.13
Variance	145.95	136.78	191.29	NA	141.57
Good 700-800 Pound Steers					
Mean	38.90	NA	NA	NA	39.71
Variance	136.74	NA	NA	NA	122.84
Choice 400-500 Pound Heifers					
Mean	40.85	40.60	45.74	43.78	43.73
Variance	211.17	236.92	320,91	204.57	264.22
Choice 500-600 Pound Heifers					
Mean	39.26	39.12	43.67	42.19	41.50
Variance	174.34	192.23	233.98	169.38	199.04
Choice 600-700 Pound Heifers					
Mean	38.29	38.03	42.53	40.76	40.11
Variance	141.64	156.77	180.58	138.11	159.66

Table 1. Statistical Description of Cash Markets by Weight Category, 1972-1979 (continued).

	Pacific Northwest	Shasta	Greeley	Omaha	Billings
Good 500-600 Pound Heifers	----------	----------	dollars/cwt.	----------	----------
Mean	35.35	31.74	40.86	NA	37.37
Variance	150.03	164.54	215.15	NA	160.05
Good 600-700 Pound Heifers					
Mean	34.45	35.71	39.47	NA	36.21
Variance	130.23	131.93	169.74	NA	134.78

Table 2. Statistical Description of Cash Markets by Weight Category, 1975-1979.

	Pacific Northwest	Shasta	Greeley	Omaha	Billings
C4S	----------	----------	dollars/cwt.	----------	----------
Mean	47.81	50.24	53.87	50.80	51.03
Variance	354.61	397.2	473.83	342.09	399.97
C5S					
Mean	47.16	48.04	50.54	48.96	48.04
Variance	300.53	305.45	356.51	272.78	394.40
C6S					
Mean	45.32	46.06	47.95	47.48	46.26
Variance	239.70	226.91	266.37	225.72	226.66
C7S					
Mean	44.52	44.41	46.53	45.88	44.86
Variance	192.71	185.05	217.24	184.59	197.93
G5S					
Mean	41.55	44.51	47.71	NA	42.28
Variance	273.71	238.58	316.14	NA	231.21
G6S					
Mean	40.02	42.90	45.31	NA	41.21
Variance	198.37	181.81	236.38	NA	190.25
G7S					
Mean	39.87	NA	NA	NA	40.14
Variance	190.71	NA	NA	NA	169.18

Table 2. Statistical Description of Cash Markets by Weight Category (continued).

	Pacific Northwest	Shasta	Greeley	Omaha	Billings
C4H	----------	----------	dollars/cwt.	----------	----------
Mean	40.52	40.65	49.84	44.18	43.84
Variance	299.81	338.69	400.92	284.76	379.62
C5H					
Mean	39.41	39.43	44.17	43.07	41.94
Variance	247.88	274.49	292.38	238.19	289.68
C6H					
Mean	38.81	38.78	43.15	42.01	40.78
Variance	199.24	222.14	224.85	192.21	227.54
G5H					
Mean	35.07	31.52	41.65	NA	36.87
Variance	212.69	229.72	271.14	NA	222.91
G6H					
Mean	34.51	35.88	40.39	NA	31.11
Variance	184.88	182.47	211.51	NA	189.79

C = Choice; G = Good, 4 = 400-500 Pound, 5 = 500-600 Pound, 6 = 600-700 Pound, 7 = 700-800 Pound, S = Steers, H = Heifers.

transportation charges to feeding areas such as Idaho and California.

The price volatility exhibited by the cattle market during the last eight years has been unprecedented in history. The 1970's have seen prices go from record highs in 1974 to dramatic lows in 1975-1976, and a return to unparalleled highs again in 1979-1980. Cash price variances were also affected. They increased an average 40 percent overall and were significantly higher than that for some markets. This feast or famine pattern, so typical of most agricultural production, forced hundreds of feedlots into bankruptcy. Many cow-calf producers were also affected by the price volatility. In many areas 10-20 percent of the producers were obligated to liquidate their assets, while many others needed to borrow heavily against their equity to meet operating expenses. The 1970's will long be remembered as an expensive lesson on the economic implications of the cattle cycle, the OPEC oil embargo, and President Nixon's wage and price controls.

Weekly observations were also calculated for each of the hedging revenue functions. The functions were calculated from price observations of both the cash and futures markets. The calculations were based on equations (1) and (2) presented earlier.

Equation (1) is reprinted here for clarity:

$$R_{ijmt} = P_{it} + S_{jm} - L_{mt}$$

where,

R_{ijmt} = Revenue per hundred weight in market i from a hedge placed j periods prior to the cash marketing date t in the contract maturing in month m.

P_{it} = Price of feeder steers of deliverable grade and weight in market i of period t.

S_{jm} = Price at which the contract maturing in month m was sold j periods prior to the cash marketing date.

L_{mt} = Price at which the contract maturing in month m was repurchased in period t.

An example will best illustrate how the data were managed to create the hedging revenue functions. Assume the date is March 15. The nearby contract for this date is the March futures contract. (The March contract expires on March 20. After March 20 the April contract would be used until April 20, followed by the May futures contract and so on.) Since the March futures contract is the nearby futures contract, the market price for that contract is extracted and used as the observation for L_{mt}. At the same time the cash price observation for March 15 is extracted and used for P_{it}.

As Rutledge [15] pointed out, most backgrounding operations employ either 16, 20, 24, or 32 week hedging strategies if they elect to forward contract their production. So, depending upon the specific length of hedge being derived, the price observation for S_{jm} will be the price of a March futures contract either 16, 20, 24, or 32 weeks prior to March 15. If equation (1) is being used to estimate the hedging revenue for a 16 week hedge using March 15 as the closing date, the price of the March futures contract on November 26 will be used as the value for S_{jm}. After all of the prices for the hedging revenue function have been extracted from the data base, R_{ijmt} can be calculated for March 15. The same method is used to calculate revenues for March 21, March 28, etc. This process is continued for each week of the years 1972-1979 inclusive. The generated hedging revenues are then statistically analyzed for significant differences. Covariances between the cash price, the opening futures price, and the closing futures price are calculated and used in equation (2) to determine the variance of the hedging revenue function. Hedging revenue means

are also estimated and a T-test is used to analyze statistical similarities. From these tests, it is possible to measure the effects of location biasis variability on the various cattle markets in the study.

Not all hedges have opening futures prices from which to draw. As is frequently the case with new methods of trade, the C.M.E. futures contract for feeder cattle has to establish itself as a viable marketing alternative. By the mid 1970's, it had accomplished this with great success. However, prior to the mid 1970's, observations for S_{jm} in 20, 24, and 32 week hedges were relatively infrequent. This is the reason for the fewer d.f. for the longer hedges.

The January futures contract was ignored in this research because of its very recent implementation by the Chicago Mercantile Exchange. The contract was not introduced until 1978 and has had limited use since. The March contract was used instead as representative of the nearby basis where applicable.

As the research progressed, there appeared to be significant problems with the data for Greeley, Colorado. Statistical descriptions of the data showed them to be considerably more erratic than data from the other markets. The means of the Greeley prices were also quite different from those of the other markets. From a theoretical construct this posed a problem, since there should exist little difference in prices between Greeley, Billings, and Omaha. These markets possess almost identical structural characteristics. They are all located in essentially the same production area. They all market approximately the same type, grade, and volume of livestock. They are all readily accessible by truck or on the rail. They all have market quotations that are published daily. They all have excellent facilities. All outward appearances would indi-

cate they should have generated roughly the same price levels for identical commodities. However, the data used in this research showed the price quotations to be quite different.

The recognition of this problem prompted a re-evaluation of the data gathering techniques of the Greeley Federal-State Market News Service. It was determined that the service arrived at its published market quotation by sampling seven separate quotations in the Greeley area, mostly on a daily basis. These daily observations were then merged into a combined range with the high and low price used as representative of the market test. The daily highs and lows were then compared to the daily highs and lows of the other weekdays and a representative range of prices was estimated. This estimate was then used as the market quotation published by the market news service.

The pooling of the data and the estimating of a range that included all of the individual auctions created an average $4.00-6.00/cwt. price spread from which to choose. It also combined a random price effect from seven separate markets into the price quotations. This induced randomness and the necessary interpolation from the price range made the quotations unusable for statistical analysis. Thus, after a re-consideration of all the factors, it was decided to delete the Greeley market from any further analysis. No special statistical problems were encountered or recognized in any of the other markets.

In all, 386 observations were collected for each of the markets. The price quotations were taken directly from the weekly average of prices published in the LS-214 form of the Federal-State Market News Service. An equivalent number of observations were taken from the Wall Street Journal's summary of futures prices for the Chicago Mercantile

Exchange. The Thursday closing or settlement price of each contract was used as representative of the weekly trade. Daily prices were not averaged since it was felt an added bias would be introduced. This research was more concerned with actual quoted cash and futures prices rather than averages. Hedgers depend upon actual quotations which generate actual basis values and are less concerned with an average of weekly basis values. Their realized hedging profits are not connected with average prices but actual prices.

CHAPTER IV

IMPLEMENTATION OF THE MODEL

The analysis of location basis variability for Pacific Northwest feeder cattle was accomplished in four steps. The steps consisted of estimating cash price variances for the individual markets, using Bartlett's methodology to test the variances for equality, generating hedging revenue variances for the individual markets, and then testing those results for equality. If Bartlett's test would have shown the cash price variances to be statistically not equivalent, the research would have been terminated. But, as the results presented later will show, cash price variances among all the markets were equal. This allowed the research to progress into the estimation and analysis of hedging revenue variances that are generated by typical hedges placed in the futures market for Pacific Northwest, Billings, Omaha, and Shasta feeder cattle.

Cash Market Price Relationships

Cash Price Variances

It is hypothesized that there exists no significant difference between cash prices variances among the four markets. For this test, Bartlett's methodology was used. Table 3 presents the results of the test. As the statistics indicate, all Choice steers and heifers in their respective weight categories were not significantly different from one another, with one exception. The exception was Choice 400-500 pound feeder heifers. However, this is of no great concern since few Choice 400-500 pound feeder heifers are marketed in this region. The statistics also show that Good grade feeder steer and heifer prices do vary signifi-

Table 3. Bartlett's Test of Homogeneity of Variance - Cash Price Variances - Pacific Northwest, Shasta, Omaha, and Billings.

	F Statistics		
	1972-1979 386 cases	1972-1974 156 cases	1975-1979 230 cases
Choice 400-500 Pound Feeder Steers	1.9313	.4054	.7159
Choice 500-600 Pound Feeder Steers	.7359	1.799	.2827
Choice 600-700 Pound Feeder Steers	.2192	.2793	.0469
Choice 700-800 Pound Feeder Steers	.4913	.303	.1299
Good 500-600 Pound Feeder Steers	8.7757	.7848	14.50
Good 600-700 Pound Feeder Steers	6.8298	.309	12.23
Good 700-800 Pound Feeder Steers	10.9305	.011	11.35
Choice 400-500 Pound Feeder Heifers	3.7996	.4327	1.91
Choice 500-600 Pound Feeder Heifers	1.8639	.2093	.826
Choice 600-700 Pound Feeder Heifers	1.8072	.5437	.767
Good 500-600 Pound Feeder Heifers	13.5273	1.5054	18.56
Good 600-700 Pound Feeder Heifers	15.2940		16.32

The critical value of $F_{.05}(3.00) = 2.60$

cantly from market to market. The test statistics were all greater than the acceptable F-value (2.60) at the 95 percent significance level.

One explanation for the apparent differences in the variances of regional Good grade prices lies within the terms of trade negotiated between buyers and sellers. It is generally agreed upon that buying and selling Good grade animals involves greater price risk. The method of handling this price risk would be distinctly different in the Pacific Northwest than in the Midwest. In the Pacific Northwest, cattlemen frequently sell their Choice cattle to the highest bidder and then are content with whatever they can get for the lower quality animals. Prices will thus vary greatly depending on the arbitrage abilities of the producers. A common practice is to keep the animals that the buyer separates from the herd and return them to pasture to resell at a later date. The typical Pacific Northwest cattle producer, although concerned with the price he receives for his Good grade animals, is much more aware of the market for Choice grade animals. Hence, prices received for Good grade animals are more a function of terms of trade and producer bargaining power than an actual representation of value of product.

The results also indicate that Good grade cattle were severely penalized in the market during the late 1970's. They indicate substantial increases in the F-statistics for observations during this period. This symbolizes a tendency for Good grade prices to be affected more severely than Choice grade prices during times of increased market volatility.

Having established that Choice 500-600 pound feeder steers and heifers, Choice 600-700 pound feeder steers and heifers, and Choice 700-800 pound feeder steers from each market are not statistically different from one another, the second hypothesis will be tested.

Cash Price Means

It is hypothesized that there exists a statistically significant difference between the means of the central market (Omaha) and the Pacific Northwest market. A paired T-test was used to test this hypothesis. The data were broken down into three groups of observations based on selected price patterns observed. They include the 1972-1974 period which saw rapidly escalating prices, the 1974-1979 period when many feedlots and cow-calf producers were forced into bankruptcy because of extreme price volatility, and the 1977-1979 period which reflects the price relationships for the most recent time period available in the data. The results of the paired T-test on each of these data groups are presented in Table 4.

The results tend to support the existence of regional cattle markets that are tied to a national cattle market but act independently in adjusting to local supply and demand conditions. Earlier it was shown that the Pacific Northwest cattle market was part of the national cattle market from testing and confirming the hypothesis of equality of cash price variances. Now it is evident that spatial market separation exists from the T-test results presented in Table 4. At the 99.5 percent critical level, the null hypothesis is accepted for all comparisons between Omaha and the Pacific Northwest. The results are not quite so strong in the tests between Billings and the Pacific Northwest and between Shasta and the Pacific Northwest. For example, the hypothesis is rejected in comparison of 1977-1979 prices for Choice 500-600 pound steers between Billings and the Pacific Northwest and between Shasta and the Pacific Northwest. The reader will also note other insignificant T-test results for Choice 600-700 pound feeder steers, Choice 700-800 pound feeder steers, and Choice 500-600 pound

Table 4. Comparisons of T-Statistics for Mean Cash Price Differences - Pacific Northwest, Shasta, Omaha, and Billings. 1972-1974, 1974-1979, 1977-1979*

	1972-1974 (157 lbs)			1974-1979 (229 lbs.)			1977-1979 (106 lbs.)		
	Billings	Omaha	Shasta	Billings	Omaha	Shasta	Billings	Omaha	Shasta
Choice: 500-600 # Steers -Pacific Northwest	-9.38	-9.93	-6.31	- 6.55	-10.75	-5.21	- 1.44**	- 4.42	-2.29**
Choice: 600-700 # Steers -Pacific Northwest	-8.41	-8.71	-6.69	- 7.85	-12.61	-4.87	- 3.40	- 6.64	-1.15**
Choice: 700-800 # Steers -Pacific Northwest	-4.22	-4.45	-3.73	- 5.33	- 8.79	1.04**	- 2.37**	- 4.11	3.43
Choice: 500-600 # Heifers -Pacific Northwest	-8.43	-8.08	2.39	-16.46	-21.39	- .18**	-13.20	-14.21	-2.33**
Choice: 600-700 # Heifers -Pacific Northwest	-8.50	-6.51	4.12	-14.41	-18.16	.17**	-13.29	-10.40	-3.15

Critical T Value: t(.005) = + 2.860.

* The t-test results indicate a strong difference between the mean of the Pacific Northwest and Omaha markets. This would tend to support the contention that the markets are separated although it says nothing about the variability of the markets. There seems to be less of an absolute price difference between Billings and the Pacific Northwest, although they are still significantly different from one another in all categories. Shasta prices seem to follow more closely the prices of the Pacific Northwest in most categories. There also exists no statistical difference between their means in many of the categories.

**Indicates statistically insignificant T values.

feeder heifers during this time period. So while there appears to be a strong difference in prices between Omaha and the Pacific Northwest, the price differences are less significant between the Pacific Northwest and the other markets.

Location Basis Variability

It is hypothesized that location basis variability exists in the Pacific Northwest. This hypothesis will be tested by using Bartlett's test in a similar manner as used previously. The specific test will determine if hedging revenue variances from each region are significantly different from one another. The test will be used to ascertain differences in hedging revenue variation between Choice 500-600 pound feeders, Choice 600-700 pound feeders, and Choice 700-800 pound feeders in the Omaha, Billings, Shasta, and Pacific Northwest cattle markets. Furthermore, the hedges will be broken down into 16, 20, 24, and 32 week hedges.

The first step in the analysis is to derive the hedging revenues based on equations (1) and (2). Hedging revenues are a function of opening futures contract prices, closing futures contract prices, and cash prices. Hedging revenue variances are a function of cash price variances, futures price variances, and cash-to-futures price covariances. The proof of that is as follows.

$$\text{Assume: } R_{ijmt} = P_{it} + S_{jm} - L_{mt} \qquad (1)$$

where

R_{ijmt} = revenue per cwt. in market i from a hedge placed j periods prior to the cash marketing date t in the contract maturing in month m.

P_{it} = price of feeder steers of deliverable grade and weight in market i of period t.

S_{jm} = price at which contract maturing in month m was sold j periods prior to the cash marketing date.

L_{mt} = price at which the contract maturing in month m was repurchased in period t.

Recall that:

$$\text{Var}(P_{it}) = E(P_{it})^2 - [E(P_{it})]^2$$

$$\text{Var}(S_{jm}) = E(S_{jm})^2 - [E(S_{jm})]^2$$

$$\text{Var}(L_{mt}) = E(L_{mt})^2 - [E(L_{mt})]^2$$

$$\text{Cov}(P_{it}, S_{jm}) = E(P_{it}, S_{jm}) - E(P_{it})E(S_{jm})$$

$$\text{Cov}(S_{jm}, L_{mt}) = E(S_{jm}, L_{mt}) - E(S_{jm})E(L_{mt})$$

$$\text{Cov}(P_{it}, L_{mt}) = E(P_{it}, L_{mt}) - E(P_{it})E(L_{mt})$$

$$V(R_{ijm}) = V(P_{it}, L_{mt}) = E(P_{it} + S_{jm} - L_{mt})^2 - [E(P_{it} + S_{jm} - L_{mt})]^2$$

$$= E(P_{it}^2 + P_{it}S_{jm} - P_{it}L_{mt} + S_{jm}L_{mt} + S_{jm}^2 - S_{jm}L_{mt} - L_{mt}P_{it} - L_{mt}S_{jm} + L_{mt}^2) - [E(P_{it})]^2 - [E(P_{it})E(S_{jm})] + E(P_{it})E(L_{mt}) - [E(S_{jm})]^2 - E(S_{jm})E(P_{it}) + E(S_{jm})E(L_{mt}) - [E(L_{mt})]^2 + E(L_{mt})E(P_{it}) + E(L_{mt})E(S_{jm})$$

$$= E(P_{it})^2 - [E(P_{it})]^2 + E(S_{jm})^2 - [E(S_{jm})]^2 + E(L_{mt})^2$$

$$- [E(L_{mt})]^2 + 2E(P_{it}, S_{jm}) - 2[E(P_{it})E(S_{jm})]$$

$$- 2E(P_{it}, L_{mt}) + 2[E(P_{it})E(L_{mt})] - 2E(L_{mt}, S_{jm})$$

$$+ 2[E(L_{mt})E(S_{jm})]$$

Thus:

$$V(R_{ijm}) = Var(P_{it}) + Var(S_{jm}) + Var(L_{mt}) + 2[Cov(P_{it}, S_{jm})$$

$$- Cov(P_{it}, L_{mt}) - Cov(S_{jm}, L_{mt})] \qquad (2)$$

The hedging revenue variances derived in the analysis from equation (2) are summarized in Table 5. As the reader will note, the variation in hedging revenue decreases as the weight of the feeder animal increases. For instance, a 16 week hedge for Choice 400-500 pound feeder steers has a variance of 145.22 while the same length of hedge for Choice 700-800 pound feeder steers has a variance of 81.59.

Hedging price risk also decreases as the length of the hedge increases. On the average for Choice 500-600 pound feeders, hedging revenue variance decreases 33.95 percent when changing from a 16 week hedging strategy to a 32 week strategy.

Table 6 presents the means of the hedging revenue functions and corresponding cash prices. The reader will note the slight difference in means between the various lengths of hedges and the cash market. The difference is approximately $2.08 for most cases with cash market prices being the higher. This tends to confirm accepted commodity futures theory which promotes the notion that normally hedged positions will provide less

Table 5. Estimated Hedging Revenue Variances for 16, 20, 24, and 32 Week Hedges by Weight Category - Pacific Northwest, Shasta, Omaha, and Billings.

	Pacific Northwest	Shasta	Omaha	Billings
Choice 500-600 Pound Steers	----------	variance	----------	
16 Week	147.83 (354)	145.22 (354)	136.94 (354)	145.23 (354)
20 Week	135.77 (328)	132.85 (328)	126.21 (328)	132.84 (328)
24 Week	127.62 (288)	124.53 (288)	118.54 (288)	124.55 (288)
32 Week	112.29 (214)	113.68 (214)	98.88 (214)	113.68 (214)
Cash Market*	229.56 (386)	227.15 (386)	208.12 (386)	227.15 (386)
Choice 600-700 Pound Steers				
16 Week	110.96 (354)	105.07 (354)	110.81 (354)	106.67 (354)
20 Week	99.42 (328)	96.08 (328)	101.16 (328)	95.667 (328)
24 Week	92.55 (288)	89.35 (288)	94.59 (288)	87.89 (288)
32 Week	81.31 (214)	77.62 (214)	79.95 (214)	77.68 (214)

Table 5. Estimated Hedging Revenue Variances for 16, 20, 24, and 32 Week Hedges by Weight Category - Pacific Northwest, Shasta, Omaha, and Billings (continued)

	Pacific Northwest	Shasta	Omaha	Billings
Cash Market*	179.73 (386)	175.27 (386)	171.98 (386)	175.56 (386)
Choice 700-800 Pound Steers				
16 Week	87.38 (354)	81.59 (354)	86.26 (354)	88.57 (354)
20 Week	76.64 (328)	73.33 (328)	78.77 (328)	79.34 (328)
24 Week	71.21 (288)	68.22 (288)	73.97 (288)	72.96 (288)
32 Week	62.62 (214)	61.88 (214)	62.27 (214)	66.24 (214)
Cash Market*	148.25 (386)	143.82 (386)	140.77 (386)	150.02 (386)
Choice 500-600 Pound Heifers				
16 Week	120.36 (354)	131.08 (354)	119.87 (354)	140.01 (354)
20 Week	110.85 (328)	125.24 (328)	110.42 (328)	129.11 (328)
24 Week	103.35 (288)	113.19 (288)	102.81 (288)	121.02 (288)

Table 5. Estimated Hedging Revenue Variances for 16, 20, 24, and 32 Week Hedges by Weight Category - Pacific Northwest, Shasta, Omaha, and Billings (continued)

	Pacific Northwest	Shasta	Omaha	Billings
32 Week	88.42 (214)	99.09 (214)	82.94 (214)	108.66 (214)
Cash Market *	186.65 (386)	205.09 (386)	179.76 (386)	212.54 (386)
Choice 600-700 Pound Heifers				
16 Week	92.48 (354)	102.12 (354)	93.92 (354)	107.98 (354)
20 Week	83.49 (328)	92.39 (328)	85.57 (328)	98.09 (328)
24 Week	75.71 (288)	87.39 (288)	80.07 (288)	90.89 (288)
32 Week	63.35 (214)	74.19 (214)	64.57 (214)	78.96 (214)
Cash Market *	151.28 (386)	166.57 (386)	146.11 (386)	170.13 (386)

* The variance of the respective cash market used in the calculation of the hedging revenue variance.

The numbers in parentheses indicate the number of observations generated for each of the hedging revenue function.

Table 6. Estimated Hedging Revenue Means for 16, 20, 24, and 32 Week Hedges by Weight Category - Pacific Northwest, Shasta, Omaha, and Billings.

	Pacific Northwest	Shasta	Omaha	Billings
Choice 500-600 Pound Steers	---dollars/cwt.---			
16 Week	44.44	45.69	46.36	45.69
20 Week	44.13	45.39	46.16	45.39
24 Week	43.99	45.27	46.13	45.27
32 Week	44.58	45.73	46.61	45.73
Cash Market	46.52	47.77	48.44	47.77
Choice 600-700 Pound Steers				
16 Week	42.57	43.45	44.62	43.81
20 Week	42.22	43.12	44.38	43.48
24 Week	41.93	42.84	33.20	43.27
32 Week	42.08	42.84	44.43	43.32
Cash Market	44.53	45.53	46.69	49.89
Choice 700-800 Pound Steers				
16 Week	41.58	41.75	42.81	42.14
20 Week	41.20	41.40	42.55	41.79
24 Week	40.85	41.03	42.33	41.48
32 Week	40.66	41.62	42.10	41.27
Cash Market	43.66	43.83	44.88	44.21
Choice 500-600 Pound Heifers				
16 Week	37.42	37.28	40.41	39.72
20 Week	37.04	36.95	40.14	39.37
24 Week	36.66	36.69	40.08	39.16
32 Week	36.72	36.95	40.46	39.57
Cash Market	39.50	39.36	42.48	41.80

Table 6. Estimated Hedging Revenue Means for 16, 20, 24, and 32 Week Hedges by Weight Category - Pacific Northwest, Shasta, Omaha, and Billings (continued)

	Pacific Northwest	Shasta	Omaha	Billings
Choice 600-700 Pound Heifers	dollars/cwt.			
16 Week	36.51	36.24	39.03	38.38
20 Week	36.16	35.90	38.76	38.01
24 Week	35.72	35.62	38.62	37.75
32 Week	35.50	35.61	38.66	37.85
Cash Market	38.59	38.32	41.11	40.45

income if employed continuously.

Table 7 shows the results of Bartlett's test of homogeneity of variance for the hedging revenues. All of the T-values are insignificant at the 95 percent significance level. This would indicate that location basis variability does not exist in the Pacific Northwest. This would also indicate that a delivery point would do little to alter the fundamental cash market relationships which exist between the Chicago Mercantile Exchange futures market, and the Pacific Northwest cash market.

Thus, it has been shown that Pacific Northwest cattle producers do not need a feeder cattle delivery point to make effective use of the commodity futures market. The basic price relationships between the two markets are sourd, stable, and predictable. Hedgers can expect their local cash prices to be at levels that will not discourage them from participation in the commodity futures exchange. But what if they want to deliver?

The Delivery Process

The delivery of a commodity futures contract will usually occur when the cash and futures prices fail to converge as the delivery date nears. If the futures price remains above the cash price by a significant margin, producers who have hedged their production may find it profitable to liquidate their position on the futures market by delivery. For Pacific Northwest hedgers, this margin usually has to be quite substantial, since delivery costs to points east of the Rockies are quite high. Nevertheless, the threat of delivery is an important part of the cash-to-futures price relationship. Without it, cash and futures prices would become independent of one another and hedging would become impractical.

Table 7. Comparisons of Hedging Revenue Variances for 16, 20, 24, and 32 Week Hedges by Weight Categories Using Bartlett's.

	16 Week Hedge	20 Week Hedge	24 Week Hedge	32 Week Hedge
Choice 500-600 Pound Steers	.58639 (354)	.46904 (328)	.41171 (288)	1.44639 (214)
Choice 600-700 Pound Steers	.39912	.35847	.47860	.16675
Choice 700-800 Pound Steers	.68283	.62161	.54074	.31895
Choice 500-600 Pound Heifers	2.96683	2.82167	2.66288	4.62853
Choice 600-700 Pound Heifers	2.82821	2.67344	2.95245	

Critical T Value: T(.95, 3) = 7.81.

Whenever a hedger enters into a hedged position, he incorporates into the strategy his expectations on the magnitude of the basis when the contract expires. For Pacific Northwest producers, the anticipated basis is approximately $2.00 for Choice 600-700 pound feeder steers. If the basis is greater than this there could exist an economic incentive to deliver providing the basis is large enough to offset transportation costs, arbitrage costs, weight discounts, delivery point discounts, and other costs associated with delivering. One can assume that if the profit incentive is large enough, delivery will occur.

The option to deliver also depends on the type and quality of cattle that the hedger has on hand. According to contract specifications, "A par delivery unit is 42,000 pounds of Choice feeder steers averaging between 550 and 660 pounds". In addition, "A delivery unit averaging over 650 pounds and up to and including 800 pounds per animal, is deliverable at a discount of 1½ cents ($.015) per hundredweight (computed for the entire delivery unit) for each pound, or fraction thereof, by which the average weight exceeds 650 pounds" [17]. For most cattle producers, these terms are quite difficult to adhere to. This is especially true for range operations where the cattle do not all have equal feed conditions and grow at different rates.

The weight and grade deviation clauses are also quite specific. "No unit will be acceptable for delivery if it contains any animals weighing in excess of 50 pounds more or 50 pounds less than the average weight of the unit. The judgment of the grader as to the presence of overweight or underweight animals in the delivery unit shall be final". Also, "Delivery units containing not more than ten U.S.D.A. Good grade steers beyond the 20 percent allowance for Good Grade animals in the par unit shall be de-

liverable at a discount of $4.00 per hundredweight, in addition to any other allowances" [17]. As the reader will note, these restrictions invoke severe price penalties on substandard feeder cattle. This could have a profound effect on a producer's incentive to deliver. Delivery of substandard cattle onto the futures market could be much more costly to the hedger than what he normally expects to incur through established marketing channels.

Nonpar Delivery Point Price Discounts

It is hypothesized that the mean statistical difference between Omaha and the Pacific Northwest, when used as the nonpar delivery point price discount, will produce the same delivery incentive at the Pacific Northwest delivery point as exists at the Omaha delivery point.

The first step in testing this hypothesis is to calculate arbitrage costs for delivery of feeder cattle to Billings, Omaha, and the Pacific Northwest. These are presented in Table 8 and are indexed to 1978 prices. Final calculations to deliver Choice 500-600 pound feeder steers resulted in an estimated cost of $3.60/cwt to Omaha, $4.35/cwt. to Billings, and $5.75/cwt. to a hypothetical Pacific Northwest delivery point. These figures represent the expected costs that a normal producer located close to the delivery point would incur as a result of delivery. Transportation costs were omitted since they would have been constant across all markets. The delivery point price discount for the hypothesized Pacific Northwest delivery point was set at the expected mean price differential between the region and the par delivery point cash market.

The next step is to derive a function that would closely approximate the economic incentive to deliver. This function is of the form:

Table 8. Costs of Delivery to Selected Delivery Points (calculated at $.60/lb. feeder prices and assumes no transportation costs)

	Billings	
	Choice 500-600 Pound Steers	Choice 700-800 Pound Steers
Delivery Point Price Discount	$ .75	$ .75
Weight Discount	.00	.00
Shrink @ 6%	3.60	3.60
	$4.35	$5.85

	Omaha	
	Choice 500-600 Pound Steers	Choice 700-800 Pound Steers
Delivery Point Price Discount	$ .00	$ .00
Weight Discount	.00	1.50
Shrink @ 6%	3.60	3.60
	$3.60	$5.10

	Pacific Northwest	
	Choice 500-600 Pound Steers	Choice 700-800 Pound Steers
Delivery Point Price Discount	$2.00	$2.00
Weight Discount	.00	1.50
Shrink @ 6%	3.60	3.60
	$5.60	$7.10

$$DI_i = Nearby_F - Cash_i - DPD_i - WD_i$$

where

DI_i = the resulting delivery incentive at the market i.

$Nearby_F$ = the price of the nearby futures contract

$Cash_i$ = the cash prices of the individual markets i

DPD_i = the delivery point discount at the market i

WD_i = the weight discount at the market i.

The raw data generated from this function are presented in the appendix, Tables A and B. A statistical description of the delivery incentives and the results of the T-tests are presented in Table 9. The reader will note from the figures in the table that there is little difference in economic incentives to deliver between the markets when the arbitrage costs presented in Table 8 are used in the incentive function. The results of the T-tests also produce no evidence to reject the null hypothesis at the 95 percent critical value. From this, it can be concluded that when the interregional price relationships are used as the best estimate of a proper discount, equal incentives to deliver will be generated for both regions.

A paired T-test was also utilized in analyzing the relationship between regional market bases. The descriptive statistics and T-test results for this procedure are presented in Table 10. As the reader will note, the T-statistics for Choice 500-600 pound steers and Choice 600-700 pound steers are below the 95 percent critical T-value. However, the T-statistics are above the acceptable limit for Choice 700-800 pound steers.

Table 9. Analysis of Delivery Incentive for Various Markets.

Descriptive Statistics

	Mean	Standard Deviation	Number of Observations
Pacific Northwest Choice			
500-600 Pound Steers	1.073	.914	23
600-700 Pound Steers	1.327	1.264	62
700-800 Pound Steers	1.887	1.855	60
Billings Choice			
500-600 Pound Steers	1.385	1.456	14
600-700 Pound Steers	1.453	1.759	46
700-800 Pound Steers	1.888	2.043	75
Omaha Choice			
500-600 Pound Steers	.708	.682	14
600-700 Pound Steers	1.509	1.193	59
700-800 Pound Steers	2.242	1.782	91

T-test Results

Choice 500-600 Pound Steers

	Pacific Northwest	Omaha
Omaha	1.28	
Billings	.8034	1.57

+(.95, 35) = 1.684

Choice 600-700 Pound Steers

	Pacific Northwest	Omaha
Omaha	.813	
Billings	.4333	.194

+(.95, 116) = 1.658

Choice 700-800 Pound Steers

	Pacific Northwest	Omaha
Omaha	1.17	
Billings	.002	1.18

+(.95, ∞) = 1.645

Table 10. Statistical Description of Regional Basis Estimates After Deducting Appropriate Nonpar Delivery Point Price Discounts (Price discounts are $2.00/cwt for hypothetical Pacific Northwest Delivery point and $.75/cwt for Billings).

Choice 500-600 Pound Steers

	Mean	Standard Deviation	Number of cases
Pacific Northwest	-1.61	2.65	386
Billings	-1.52	2.51	386
Omaha	-1.44	2.54	386

	T-statistic	Correlation
Pacific Northwest-Billings	- .84	.66
Pacific Northwest-Omaha	-1.32	.55
Omaha-Billings	- .61	.53

+(.95, 386) = 1.645

Choice 600-700 Pound Steers

	Mean	Standard Deviation	Number of cases
Pacific Northwest	.29	2.61	386
Billings	.40	2.43	386
Omaha	.33	2.71	386

	T-statistic	Correlation
Pacific Northwest-Billings	-1.17	.70
Pacific Northwest-Omaha	- .38	.55
Omaha-Billings	.65	.68

+(.95, 386) = 1.645

Choice 700-800 Pound Steers

	Mean	Standard Deviation	Number of cases
Pacific Northwest	- .16	3.19	386
Billings	.59	3.11	386
Omaha	.69	3.45	386

	T-statistic	Correlation
Pacific Northwest-Billings	-7.99	.83
Pacific Northwest-Omaha	-7.22	.75
Omaha-Billings	-1.10	.83

+(.95, 386) = 1.645

Thus, one cannot reject the null hypothesis that a nonpar delivery point price discount of $2.00/cwt. is within reason for Choice 500-600 pound steers and Choice 600-700 pound steers for Pacific Northwest delivery. The same hypothesis will be rejected at the 95 percent critical level for delivery of Choice 700-800 pound steers. This indicates that a delivery price discount of $2.00/cwt. for the heavier weight feeders produces excessive price discrimination in the market place. If the price discount is reduced to $1.40/cwt. for the heavier weight animals, the T-statistics for the paired test drop below the acceptable critical values. The T-statistics for this price discount are:

Choice 700-800 Pound Steers

	T-Statistic	Correlation
Pacific Northwest-Billings	-1.62	.82
Pacific Norhtwest-Omaha	-2.18	.85

At a price discount of $1.40/cwt., the T-statistics for Choice 500-600 pound steers and Choice 600-700 pound steers are above the critical level. So, depending on what the discount was set at, there will exist at least one weight category of feeders that will be discriminated against at the delivery point.

Nonpar Delivery Point Floating Discount

It is hypothesized that the best estimate of a functional delivery point price discount will be a floating index based on the cost of transportation between the Pacific Northwest and the par delivery point. Transportation charges used in the test of this hypothesis were estimated from an equation derived by Martin and McNamee [10]. The function was formulated through an econometric analysis of the Pacific Northwest

transportation sector. The results of the function, based on 1978 transportation freight rates, were indexed to 1972 levels. An estimated cost of transportation curve was then constructed and is presented in Figure 1.

The observations for basis were taken from the first week of August of every year between 1972-1979. The month of August was used simply because there exists a futures contract that closes during that month, although any other contract month would have sufficed for the regression model.

The results of the model indicate that transportation charges, when used as the sole explanatory variable, do little in explaining the variation in basis. They are presented below for clarity.

$$\text{Ho: } B_0 = 0 \quad \text{and} \quad B_1 = 1$$

$$\text{Ha: } B_0 \neq 0 \quad \text{and} \quad B_1 \neq 1$$

The estimated equation is:

$$Y = \underset{(3.24)}{2.78} + \underset{(3.52)}{.78X} \qquad R^2 = .154 \qquad F_{\text{overall}} = 26.4$$

where

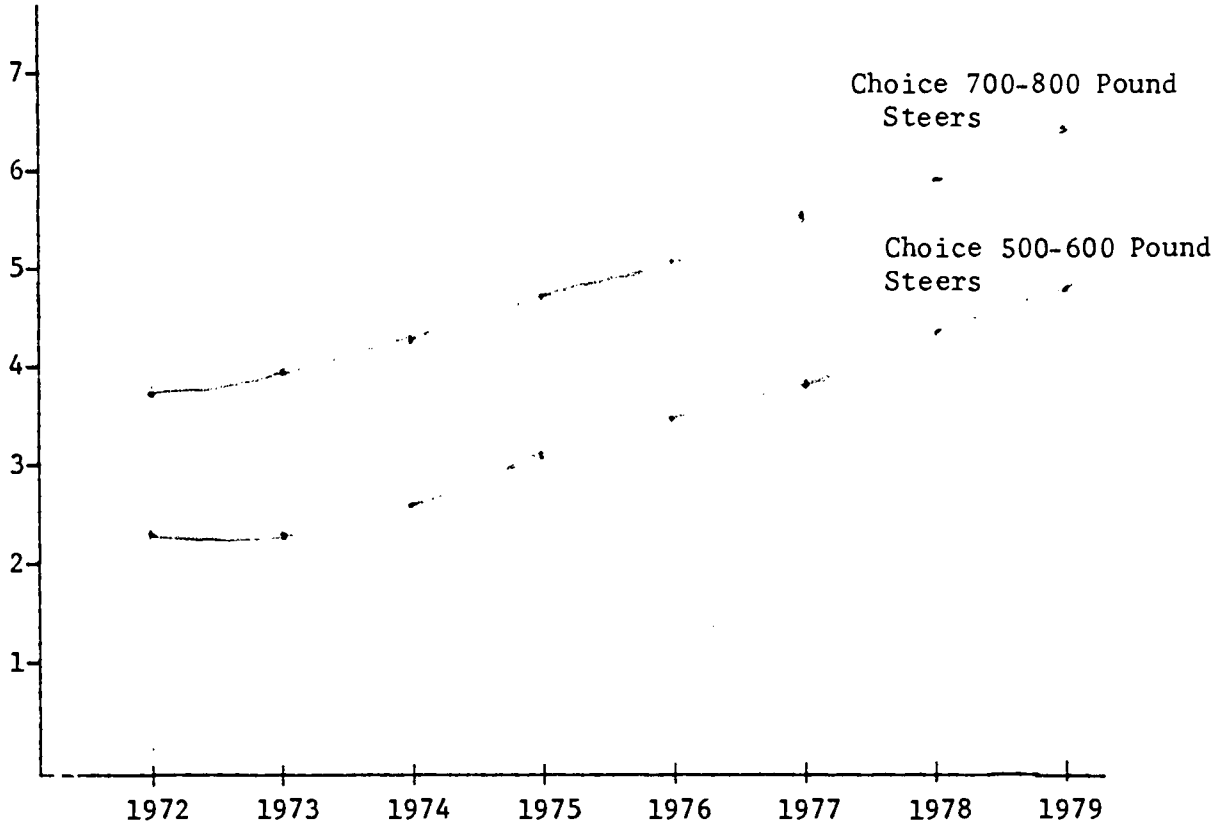
Y = nearby basis

X = estimated cost of transportation

$$\frac{b_0 - B_0}{S(b_0)} \simeq T(n-2) \quad \text{and} \quad \frac{b_1 - B_1}{S(b_1)} \simeq T(n-2)$$

$$\frac{2.78 - 0}{3.24} = .85 \qquad \frac{.78 - 1}{3.52} = -.062$$

$$t(.95, 7) = 1.895$$



Total Delivery Costs
PNW Feeder Steers to Billings, Montana

	Choice 500-600 Pound Steers	Choice 700-800 Pound Steers
1972	$2.15	$3.81
1973	2.25	3.91
1974	2.53	4.19
1975	3.00	4.66
1976	3.33	5.01
1977	3.74	5.40
1978	4.12	5.78
1979	4.56	6.22

Figure 1. Estimated Delivery Costs for Pacific Northwest Feeder Steers Delivered onto the Billings Futures Delivery Point.

The results indicate that the Beta values of the equation are statistically significant of the 95 percent critical T-value. However, the overall explanatory power of this model (R^2 = .154) was considered by the author to be of questionable value. The author does not consider a floating discount based on a cost of transportation index to be a feasible alternative to a fixed price discount for a Pacific Northwest delivery point. These conditions confirm earlier results that indicate the best estimate of the discount will be derived from the true interregional market relationships.

The Futures Market and Premium Cash Market

There is an additional, equally important consideration to address when analyzing a nonpar delivery point. That consideration involves the relationship between the futures market and the premium cash market. This research has uncovered an interesting pattern that evolves from comparisons of basis calculations across weight categories. The pattern, derived from delivery incentive calculations indicate that the futures market always follows the premium cash market. The reader will note from Table 11 that the interval between January, 1972, and August, 1974, saw little or no economic incentive to deliver Choice 500-600 pound steers. This was not true for Choice 700-800 pound steers. Economic incentives to deliver this weight group of cattle were quite high during the period. The incentive is especially pronounced in 1973 and early 1974. During the period from August, 1974, - December, 1976, there was a premium on deliveries of Choice 500-600 pound steers. Over the same time interval there was no economic incentive for delivery of Choice 700-800 pound steers. Once again in 1978, the incentive returned to delivery of Choice

Table 11. Profit Incentives to Deliver Feeder Cattle by Weight Category Formulated from the Delivery Point Basis - Hypothetical Pacific Northwest Delivery Point, 1972-1979 $/cwt.

Date	Choice 500-600 Pound Feeder Steers	Choice 600-700 Pound Feeder Steers	Choice 700-800 Pound Feeder Steers
1-20-73	----	.61	1.58
1-27-73	----	.62	----
2-03-73	----	.49	----
2-17-73	----	.11	.60
2-24-73	----	----	1.83
3-03-73	----	----	.26
3-10-73	----	.52	2.99
3-17-73	----	.01	1.47
7-21-73	----	----	.28
7-28-72	----	.06	1.21
8-04-73	----	1.03	3.77
8-11-73	----	1.11	4.12
8-18-73	----	----	.94
8-29-73	----	.65	----
10-03-73	----	.09	4.95
10-20-73	----	.81	3.73
10-27-73	----	1.05	----
11-24-73	----	.80	2.75
12-01-73	----	----	.36
12-15-73	----	1.58	1.14
12-22-73	----	.56	.12
1-05-74	----	1.31	----
1-12-74	----	.91	.47
1-19-74	----	1.33	2.48
10-12-74	.38	----	----
10-19-74	.09	----	----
11-23-74	2.63	1.56	----
11-30-74	2.31	.45	----
12-07-74	2.03	1.05	----
12-14-74	2.38	.76	----
12-21-74	.84	1.24	----
12-28-74	.48	.19	----
1-04-75	.43	----	----
2-08-75	.46	----	----
8-16-75	.37	----	----
8-30-75	.87	----	----
9-06-75	2.35	.50	----
9-13-75	1.98	.39	----
9-20-75	2.13	.53	----
9-27-75	.16	----	----
10-18-75	.02	----	----
11-08-75	2.11	1.65	----
11-15-75	1.17	----	----
10-09-76	----	.22	.10
10-16-76	.57	1.10	----
10-30-76	----	1.21	----

Table 11. Profit Incentives to Deliver Feeder Cattle by Weight Category Formulated from the Delivery Point Basis - Hypothetical Pacific Northwest Delivery Point, 1972-1979 $/cwt. (continued)

Date	Choice 500-600 Pound Feeder Steers	Choice 600-700 Pound Feeder Steers	Choice 700-800 Pound Feeder Steers
11-06-76	----	1.53	----
11-27-76	----	2.06	1.62
12-04-76	.48	2.47	1.23
12-11-76	.26	1.58	.35
12-18-76	----	3.33	1.43
12-25-76	----	2.36	.06
1-01-77	----	2.06	.03
1-08-77	----	.47	----
1-29-77	----	.63	----
9-24-77	----	3.21	2.24
7-15-78	----	.15	.77
7-22-78	----	2.45	2.28
7-29-78	----	.36	.05
8-19-78	----	----	.73
9-09-78	----	1.70	1.93
9-16-78	----	1.33	2.34
9-23-78	----	----	2.15
9-30-78	----	----	.30
10-07-78	----	----	.97
10-14-78	----	----	1.37
10-21-78	----	.12	.91
10-28-78	----	----	.97
11-04-78	----	----	3.08
11-11-78	----	.52	2.20
11-18-78	----	1.48	3.79
11-25-78	.23	6.59	8.80
12-02-78	----	4.65	7.48
12-09-78	----	4.82	6.23
12-11-78	----	3.57	5.33
12-23-78	----	3.24	4.00
12-30-78	----	----	.52
1-06-79	----	----	.85
2-24-79	----	----	.07
3-03-79	----	1.30	2.45
3-10-79	----	1.74	3.33
3-17-79	----	.42	.59
3-24-79	----	1.00	1.62
3-31-79	----	----	.12
4-07-79	----	2.41	.91
4-14-79	----	.74	2.50
4-21-79	----	----	.56
4-28-79	----	----	1.14
5-12-79	----	----	.77

---- No incentive to deliver.

700-800 pound steers. This relationship continued through May, 1979.

To understand this phenomenon, a close examination of livestock feeding profits is needed. Historically, feed grains have been a comparatively cheap feed source for utilization in the feedlot. This comparative relationship was altered in August, 1974, with the announcement of increased grain sales to the Union of Soviet Socialist Republics. The effect of this grain sale amounted to a tripling of domestic cash grain prices. The comparative advantage of using the relatively low priced feed grains in a relatively high proportion of the ration disappeared. A demand shift for feeder cattle ensued. The premium market changed from lightweight animals that take a considerable amount of time in fattening to heavyweight animals that require a shorter feeding interval. What effect did this have on the cash to futures price relationship?

The delivery incentive depicted in Table 11 indicates that the nearby futures price began to close with the cash prices for heavyweight feeders. This is portrayed by the delivery incentive for Choice 500-600 pound feeders which became significant during the period of relatively high cash grain prices. Then, when cash grain prices fell, the delivery incentive once again returned to the heavyweight feeders.

It can be seen then that the futures market closes with the premium cash market as the contract expiration date nears. If demand is greatest for lightweight cattle, the futures market will follow the price movements of lightweight cattle during the delivery month. Conversely, if demand is at a premium for heavyweight cattle, the futures market will follow the prices of heavyweight cattle in the delivery month. Therefore, depending on what type of cattle the producer has hedged, his economic incentive to deliver will be affected by industry supply and demand con-

ditions, in addition to delivery point price discounts, weight discounts, and transportation charges.

Hedging as a Risk Management Strategy

The final test to be performed relates to hedging as a risk strategy. The value of hedging is measured by its ability to reduce cash price risk incurred by the producer. When a producer enters a hedge, he transfers his risk from cash price variability to basis variability. Therefore, the variation in basis must be less than the variation in cash prices if the hedge is to be effective.

It is hypothesized that the variance of price in the cash markets is equal to the variance in the basis. The alternative hypothesis is that the variance of price in cash markets is greater than the variance on the basis. Table 12 presents the results of Hartley's test of equality for cash price and hedging revenue variances. At the 95 percent confidence level, the null hypothesis can be rejected in all of the markets for all the tested weight categories. Hedging revenue variances are significantly smaller than cash price variances when compared over the same time period. It would appear then that hedging is effective in reducing cash price risk by transferring it to others who are more willing to accept it.

Table 12. Comparison of Cash Market Versus Futures Market Basis Price Risk by Weight Category Using Hartley's Test of Homogeneity of Variance - Pacific Northwest, Shasta, Omaha, and Billings.

	Market	H-Statistic
Choice 500-600 Pound Steers	Shasta	1.564
	Pacific Northwest	1.553
	Omaha	1.519
	Billings	1.564
Choice 600-700 Pound Steers	Shasta	1.668
	Pacific Northwest	1.619
	Omaha	1.552
	Billings	1.646
Choice 700-800 Pound Steers	Shasta	1.763
	Pacific Northwest	1.696
	Omaha	1.632
	Billings	1.694
Choice 500-600 Pound Heifers	Shasta	1.565
	Pacific Northwest	1.55
	Omaha	1.499
	Billings	1.518
Choice 600-700 Pound Heifers	Shasta	1.631
	Pacific Northwest	1.636
	Omaha	1.555
	Billings	1.575

Critical Hartley Test Statistic: $H(1 - .95, 2, \infty) = 1.00$

CHAPTER V

LOCATION BASIS VARIABILITY

The research completed as part of this thesis has produced substantial evidence disproving the existence of location basis variability in the Pacific Northwest. Furthermore, it appears that producers of this region are in a better position to hedge their cattle than are producers of other regions, unless they are forced to deliver. A review of the findings of the research will confirm this.

First of all, it was shown that the Pacific Northwest feeder cattle market was part of the national cattle market. It responds to the same supply and demand conditions as the national cattle market. The variation exhibited by the Pacific Northwest market is statistically equivalent to the variations exhibited by the markets in Omaha and Billings. There is, however, a statistically significant difference between the average prices of the regions. This difference amounted to $2.00/cwt. for Pacific Northwest-Omaha prices and $1.25/cwt. for Pacific Northwest-Billings prices.

The derivation and analysis of the hedging revenue functions failed to indicate any significant difference between hedging revenue variances realized in the respective regions. It was hypothesized that the variances of the hedging revenue functions derived for Pacific Northwest markets would be significantly higher than comparable variances derived in other markets. This hypothesis was rejected. In fact, Pacific Northwest hedging revenue variances were found to be lower than the others. Hedging revenue averages for Pacific Northwest feeders were also found to be lower than other regions. However, one would expect this since

average prices received in the Pacific Northwest are lower than in Billings and Omaha. So while Pacific Northwest feeder cattle producers cannot sell their production in the cash market at price levels equal to producers in other regions, the basis risk they assume from the hedge is considerably less.

Delivery Point Price Discount

If a delivery point for feeder cattle is established in the Pacific Northwest, the optimal price discount for the market would approximate $2.00/cwt. This research has shown that a price discount set at this level would generate the same economic incentive to deliver at a hypothetical Pacific Northwest delivery point as exists now at Omaha. Any price discount that is significantly above or below $2.00/cwt. will either discriminate against delivery onto the market or will create unjustified profits when delivery is undertaken. These results support the findings of Crow, Riley, and Purcell that a nonpar delivery point price discount should be established at the interregional price relationships existing between the market areas. A price discount established at levels incongruous to this relationship will only result in rendering the new delivery point useless to hedgers.

Hedging and Risk Management

The results of this thesis have also shown that producers can successfully utilize the futures market to manage risk and uncertainty. Basis variation in all of the markets studied is considerably less than the cash price variation. A hedger who exchanges cash price risk for basis risk will be significantly reducing his exposure to uncertainty.

In many cases cash price risk coefficients (variances) can be reduced by one-half the original amount as a result of hedging.

Implications to Future Research

Given the rather limited theoretical and empirical research done in the futures market up to this date, it is not surprising to have uncovered, as part of this research, many pertinent issues encompassing commodity futures trading. Some of the more important issues are enumerated below.

As has been mentioned before, hedgers exchange cash price risk for basis risk when they buy or sell a contract in the futures market. The final outcome of the profitability of the hedge depends on the anticipated versus actual basis that is encountered when the hedge is lifted. If the anticipated basis equals the actual basis at the close of the contract, a perfect hedge is the result. If, however, the anticipated basis is different than the actual basis, an imperfect hedge is the eventual outcome. It can be seen that the ultimate value of hedging then rests with the predictability of the basis. A commodity contract with an unpredictable basis is certainly less valuable to the hedger than one with a predictable basis. If the value of the basis were known before purchasing a contract, hedging would be significantly more valuable to those risk adverse producers who are interested in reducing their exposure to risk as much as possible.

Following those lines, research should be started in two areas: (1) the estimation of an econometric basis model, and (2) the formulation of a basis contract. The estimation of an econometric basis model would give insight into the predictability of the basis. The ability to predict

basis at certain times of each contract's life would contribute greatly to the producer's ability to manage his exposure to risk. He could incorporate into his decision making process the anticipated values of basis and, as a result, could have more reliable expectations on the eventual profitability of the hedge.

Research into the formulation of a basis contract also needs to be initiated. There appears to be a need for such a contract. It would allow hedgers the option to select their total exposure to risk for any one contract or commodity. It would also allow them to "lock in" to a specific basis, thereby minimizing the problems of the imperfect hedge. Indirectly the contract already exists in the form of a spread position. As it stands now only speculators or day traders can participate in a spread. If a basis contract was created, all participants in the futures market could utilize it.

There also needs to be further research done on optimum hedging strategies. Typically, there are many decisions involved in formulating a hedging strategy. Questions involving which contracts should be used, what types of livestock should be hedged, how much of the total production should be hedged, and at what specific times the hedges should be placed all need further clarification. These decisions often are very complex and certain guidelines need to be established that will aid hedgers in determining the optimum strategy for their operation.

Certain changes also need to be initiated in the feeder futures contract. The most obvious relates to the weight discount clauses for delivery of overweight animals. According to the Chicago Mercantile Exchange Yearbook, "A delivery unit averaging over 650 pounds and up to and including 800 pounds per animal, is deliverable at a discount of 1½ cents

($.015) per hundredweight for each pound, or fraction thereof, by which the average weight exceed 650 pounds". This discount level may have been the industry norm at $30.00/cwt. feeder prices, but it falls short of matching the price structure that exists today at $70.00/cwt. feeder cattle prices. At $70.00/cwt. cattle there exists approximately a $3.00/cwt. discount for Choice 700-800 pound feeder steers. So while the cash market is discounting these animals $3.00/cwt. for the increased weight, the futures market is only discounting them $1.50/cwt. This pricing differential should be corrected.

Delivery conditions both pertaining to the actual type and quality of animal being delivered onto the market and to the physical handling of the delivered animals need to be more explicitly detailed and enforced in the contract. There have been complaints from both long and short contract holders on these issues. If the long side has to accept delivery of the commodity, he is entitled to the type and quality of livestock that are described in the contract. Frequently what he actually receives are cattle that are unable to meet the criteria. However, this is not always the fault of the short side. Complaints ranging from the mismanagement of arriving cattle to poor weighing and inspection conditions have been aired by this group. It appears as though an extensive upgrading of the process of delivery needs to be enacted, beginning with the way the contract is written and extending through a review of the physical capabilities that principal delivery points need to handle the large numbers of cattle that are delivered on occasion.

There are many other areas of interest that need research. They include:

1. The argument of Peck that implies a nonpar delivery point needs to have a larger delivery discount than exists in the regional cash market relationship versus the argument of Crow, Riley, and Purcell which states that a nonpar delivery point price discount should be set at the estimated intertemporal cash market relationship.

2. The role of basis in a changing transportation cost context.

3. The effect of changing transportation costs on established nonpar delivery point price discounts.

4. The value of pricing information that is passed to the producer as a result of price speculation in the futures market.

Any of these topics could provide interesting research material for students of economics who wanted to investigate the theory of commodity futures trading.

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APPENDIX A

ECONOMIC INCENTIVES TO DELIVER ONTO THE OMAHA DELIVERY POINT, 1972-1979

APPENDIX A

ECONOMIC INCENTIVES TO DELIVERY TO OMAHA

CASE-NO	DATE	DEL5	DEL6	DEL7
1	1152.	2.74	-999.00	-999.00
2	9092.	-999.00	-999.00	.25
3	9169.	-999.00	-999.00	.26
4	10029.	-999.00	-999.00	.09
5	12069.	-999.00	1.73	2.32
6	10145.	-999.00	-999.00	.25
7	12230.	-999.00	-999.00	.93
8	12302.	-999.00	.23	1.12
9	1063.	-999.00	-999.00	1.19
10	1133.	-999.00	-999.00	.38
11	1203.	-999.00	3.12	3.79
12	1273.	-999.00	1.96	2.60
13	2033.	-999.00	2.39	3.27
14	2103.	-999.00	1.50	1.86
15	2173.	-999.00	1.61	2.50
16	2243.	-999.00	2.42	3.73
17	3033.	-999.00	.47	1.35
18	3103.	-999.00	2.09	2.87
19	3173.	-999.00	.67	1.49
20	3243.	-999.00	-999.00	.18
21	4213.	-999.00	1.05	2.46
22	4283.	-999.00	.11	2.05
23	5053.	-999.00	-999.00	.89
24	5123.	-999.00	-999.00	.99
25	5193.	-999.00	-999.00	1.81
26	5263.	-999.00	-999.00	1.06
27	7143.	-999.00	-999.00	.38
28	7213.	-999.00	-999.00	.59
29	7283.	-999.00	1.87	3.13
30	8043.	-999.00	3.08	4.76
31	8113.	-999.00	3.54	5.22
32	8183.	-999.00	2.48	3.63
33	10033.	-999.00	-999.00	1.28
34	11173.	-999.00	-999.00	.40
35	11243.	-999.00	-999.00	.93
36	12153.	.35	2.89	4.57
37	12223.	.60	2.72	4.40
38	12293.	-999.00	1.00	3.21
39	1054.	1.35	4.10	6.21
40	1124.	.53	3.25	4.56
41	1194.	-999.00	-999.00	1.25
42	2024.	-999.00	.38	1.08
43	4134.	-999.00	-999.00	.93
44	4204.	-999.00	-999.00	.23
45	6294.	.96	3.61	3.70
46	7064.	-999.00	.27	.89
47	7274.	-999.00	.13	-999.00
48	12074.	.38	-999.00	-999.00
49	12144.	.80	.27	-999.00
50	12214.	.75	.48	-999.00
51	12284.	.49	.49	-999.00
52	12065.	.12	-999.00	-999.00
53	12186.	-999.00	.12	.21
54	1297.	-999.00	.27	.89
55	2057.	-999.00	-999.00	.21
56	3197.	-999.00	-999.00	.12
57	4167.	-999.00	.71	.53
58	4237.	.15	1.21	.51
59	9247.	-999.00	1.46	2.14
60	2156.	-999.00	.12	1.54
61	2256.	-999.00	-999.00	.76
62	3048.	-999.00	.31	1.28
63	3118.	.69	2.68	3.70
64	3188.	-999.00	1.11	2.15
65	3258.	-999.00	1.63	2.25
66	4016.	-999.00	.34	.43
67	4088.	-999.00	1.25	.94
68	4158.	-999.00	.71	.47
69	5136.	-999.00	.53	.36
70	5206.	-999.00	1.46	1.95
71	7158.	-999.00	-999.00	.81
72	7228.	-999.00	.37	2.05
73	7298.	-999.00	-999.00	1.15
74	8058.	-999.00	-999.00	.32
75	9168.	-999.00	-999.00	.14
76	11258.	-999.00	1.44	4.67
77	12028.	-999.00	1.51	4.25
78	12098.	.09	2.47	4.69
79	12168.	-999.00	1.22	4.39
80	12238.	-999.00	-999.00	3.66
81	12308.	-999.00	-999.00	3.21
82	1069.	-999.00	.01	4.87
83	1139.	-999.00	-999.00	2.87
84	1209.	-999.00	.03	2.59
85	1279.	-999.00	-999.00	2.14
86	2039.	-999.00	-999.00	1.50
87	2109.	-999.00	.62	2.83
88	2179.	-999.00	-999.00	2.72
89	2249.	-999.00	.81	4.83
90	3039.	-999.00	3.99	7.26
91	3109.	-999.00	4.34	7.66
92	3179.	-999.00	3.19	6.47
93	3249.	-999.00	2.44	4.92
94	3319.	-999.00	-999.00	1.49
95	4079.	-999.00	.70	2.81
96	4149.	-999.00	1.84	4.05
97	4219.	-999.00	-999.00	1.12

Variable Descriptions

Date = first two digits are months, next two digits are day, and last digiti is year

E.g., 10212 = October 21, 1972

Del5 = delivery incentive for Choice 500-600 pound feeder steers

Del6 = delivery incentive for Choice 600-700 pound feeder steers

Del7 = delivery incentive for Choice 700-800 pound feeder steers

APPENDIX B

ECONOMIC INCENTIVES TO DELIVER ONTO THE BILLINGS DELIVERY POINT, 1972-1979

APPENDIX B

ECONOMIC INCENTIVES TO DELIVER TO BILLINGS

All variables are as previously described in Appendix A.

CASE-NO	DATE	DEL5	DEL6	DEL7
1	10212.	-999.00	-999.00	.10
2	11252.	-999.00	-999.00	.85
3	12022.	-999.00	.50	1.97
4	12092.	-999.00	2.01	3.27
5	12162.	-999.00	-999.00	.71
6	1223.	-999.00	1.52	2.76
7	1273.	-999.00	-999.00	1.41
8	2033.	-999.00	-999.00	.67
9	2243.	-999.00	-999.00	.06
10	3103.	-999.00	-999.00	1.22
11	3173.	-999.00	.01	1.16
12	3243.	-999.00	-999.00	.75
13	3313.	-999.00	.30	1.02
14	4213.	-999.00	-999.00	.12
15	4283.	-999.00	-999.00	.24
16	7143.	-999.00	-999.00	1.01
17	7213.	-999.00	-999.00	1.56
18	7283.	-999.00	.99	3.86
19	8043.	-999.00	-999.00	3.06
20	8113.	-999.00	-999.00	1.82
21	10033.	-999.00	-999.00	1.24
22	11243.	-999.00	.89	1.77
23	12153.	-999.00	1.08	2.97
24	12223.	-999.00	-999.00	2.27
25	12293.	-999.00	-999.00	1.67
26	1054.	-999.00	2.19	3.87
27	1124.	-999.00	1.47	3.15
28	1194.	-999.00	.62	1.88
29	2024.	-999.00	-999.00	.60
30	4134.	-999.00	1.15	2.30
31	4204.	-999.00	.37	1.60
32	4274.	-999.00	-999.00	.10
33	11234.	2.23	1.27	-999.00
34	11304.	.80	-999.00	-999.00
35	12074.	.93	.61	-999.00
36	12144.	1.00	.47	-999.00
37	12254.	.27	-999.00	-999.00
38	1045.	.78	-999.00	-999.00
39	9205.	.09	-999.00	-999.00
40	8216.	-999.00	.44	-999.00
41	10096.	-999.00	-999.00	.13
42	10236.	-999.00	.89	.58
43	10306.	-999.00	1.16	.89
44	11064.	.29	1.08	.38
45	11274.	.69	2.98	2.98
46	12046.	-999.00	1.89	2.11
47	12116.	-999.00	.62	.81
48	12186.	-999.00	.76	.32
49	12256.	-999.00	.59	-999.00
50	1017.	-999.00	1.35	-999.00
51	1297.	-999.00	.05	.14
52	2197.	-999.00	-999.00	.14
53	3057.	-999.00	.21	-999.00
54	4237.	-999.00	.28	.37
55	9247.	1.35	3.11	3.36
56	3045.	-999.00	.09	-999.00
57	3115.	-999.00	.34	.83
58	4088.	-999.00	-999.00	1.07
59	4158.	-999.00	-999.00	1.11
60	5068.	-999.00	.28	1.43
61	5138.	-999.00	1.44	2.52
62	5208.	-999.00	1.14	1.50
63	5278.	2.38	4.95	5.57
64	7058.	-999.00	-999.00	.06
65	7128.	-999.00	.50	1.65
66	7208.	-999.00	.95	1.83
67	9108.	-999.00	-999.00	.42
68	9238.	-999.00	-999.00	.56
69	10288.	-999.00	-999.00	.92
70	11045.	-999.00	1.46	4.42
71	11113.	-999.00	1.00	4.00
72	11183.	.16	3.61	6.46
73	11258.	5.35	9.06	11.40
74	12098.	3.15	7.39	9.81
75	12098.	-999.00	2.12	4.59
76	12148.	-999.00	-999.00	.96
77	12238.	-999.00	-999.00	.77
78	12308.	-999.00	-999.00	.34
79	1069.	-999.00	-999.00	.94
80	9249.	-999.00	-999.00	.68
81	8032.	-999.00	-999.00	3.10
82	3109.	-999.00	1.47	3.82
83	3179.	-999.00	1.25	3.33
84	3249.	-999.00	-999.00	2.95
85	4079.	-999.00	-999.00	.90
86	4149.	-999.00	-999.00	.30
87	5269.	-999.00	-999.00	2.19