# Hedging as a Marketing Tool For Western Cattle Feeders

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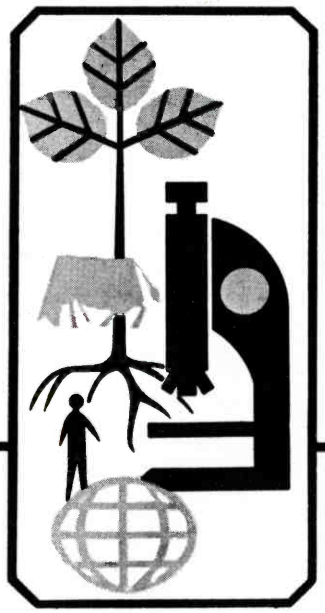

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# HEDGING AS A MARKETING TOOL FOR WESTERN CATTLE FEEDERS*

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## I. Introduction

### Development of the Live Cattle Futures Market

Futures trading in live cattle was initiated on the floor of the Chicago Mercantile Exchange, November 30, 1964. Although futures trading in grain had been available for over 100 years, this was the first live commodity to be traded on a futures market since 1935, when live hogs were traded briefly and discontinued. The live cattle contract was actively traded from its beginning and had the third largest number of contracts traded on the Exchange by the end of 1965.

At the end of the first year of live cattle futures trading the Chicago Mercantile Exchange opened a Western Live Cattle Futures Contract with delivery at Los Angeles. Unlike the Chicago contract, it was never traded actively. A new Western live cattle contract was written in April of 1967, in an effort to increase the trading in this market. Although this new contract fit the type of cattle being marketed in Arizona and California better than the first contract, it did little to increase the trading activity on the Western market. Since that time, the Western contract has been closed out while the Chicago contract has continued to increase in volume.

Although the live cattle futures market has been traded actively for several years, there continues to be disagreement concerning its economic value to the cattle industry. "To have economic merit, a futures market must offer hedging potential or perform a valid pricing function. Without this potential, futures markets are simply a game in which income is transferred between winning and losing players, i.e., speculators" [10, p. 1485]. A major hypothesis of this study is that the live cattle futures market has provided opportunity for successful hedging for Midwest cattle feeders. Benefits from hedging are assumed to accrue as a result of minimizing risk, and/or providing an alternative in buying and selling which results in either increased or stabilized profit margins.

The hedging potential for Arizona-California cattle feeders might be limited using the Midwest market because of the distance from the market and because of the quality of cattle to which the futures contract applies. If this is the case, Arizona-California feeders would be at a competitive disadvantage to the Midwest feeder, assuming opportunities for successful hedging are available to the latter group and that hedging performs a useful function.

If Western feeders are at a disadvantage in attempting to hedge on the Chicago market, why was the Western Live Cattle Futures Contract an unsuccessful venture? It would appear that Arizona-California feeders would best be served by a contract which applied to the quality of cattle being produced in that area, and a delivery point at or near the location at which the cattle are being marketed.

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*This study is part of Arizona's contribution to Western Regional Marketing Project, WM-62, entitled, "Technological and Structural Changes in the Marketing of Beef."

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## Objectives

The purpose of this study was to examine the hypotheses relative to the live cattle futures market and attempt to determine why the Western Live Cattle Futures Contract failed. More specifically, the major objectives were to answer the following questions:

1. Has the live cattle futures market provided any advantages?
2. If advantages do exist, are Arizona-California cattle feeders at a disadvantage with respect to Midwest feeders with nearby delivery points?
3. What caused the Western contract to fail?

## Procedures

The method used to accomplish the first two objectives involved a statistical decision model. In this model, representative feedlots were simulated for both the Midwest and the Arizona-California regions. These feedlots were assumed to be feeding cattle on a year-round basis. The model developed returns based on four different strategies with respect to fat cattle marketing. Total revenue received from the sale of slaughter cattle, less feeder cattle and hedging costs, was used as the basis for judging the relative merits of each strategy.

In the first decision strategy, cattle were assumed to be placed on feed each week and an equal number sold for slaughter. They were not hedged. This strategy was used as a basis of comparison for the other strategies which included hedging. The second decision strategy used involved a complete hedge, i.e., when cattle were bought and placed on feed, they were hedged. The third strategy incorporated a selective hedge based on a breakeven price. When the futures market price was equal to or above the breakeven price, a hedge was executed. If the futures market price was below the breakeven price, the cattle were placed on feed unhedged. The fourth decision strategy also involved a selective hedge using monthly price indexes to predict slaughter cattle prices in future months. If the futures market price was equal to or above the estimated price, in the month cattle were to be sold, the cattle were automatically hedged but, if the futures market price was below the estimated slaughter price, the cattle were placed on feed but not hedged.[1]

The alternative of not feeding, when market conditions were unfavorable, was included for cattle feeders not involved in feedlot ownership. Using the futures price on a projected delivery date, estimates of revenues, over costs including feeding, were made. Whenever returns were estimated to exceed costs of feeding, including the purchase of feeders, by a minimum of $10.25 per animal,[2] cattle were placed on feed and hedged. If the conditions were not met, no action was taken. Results for both the hedge and a non-hedge strategy were determined.

A mailed questionnaire to Arizona-California cattle feeders was used to help determine which important variables might have caused the Western Live Cattle Futures Contract to be inactively traded. The questionnaire was used in an attempt to determine characteristics of cattle feeders in Arizona and California which might give some indication of why they have been reluctant to use the futures market for hedging.

# II. Theory and Operation of a Live Cattle Futures Market

## General Theory

The traditional theory of futures trading gives two reasons for participating in futures markets. In one case, the trader expects to gain from changes in the price of futures contracts by speculating. In the second case, the trader expects to eliminate or to reduce risk from price changes in the physical commodity by hedging. Hedging is defined as performing equal and opposite transactions in the futures and cash market at the same point in time.

Hedging has traditionally been classified as either short- or long-term. Short-term hedging is used when the physical commodity is to be held for only a short period of time, such as one or two weeks, and the hedger intends to protect himself against price variability in the cash market. This type of hedging assumes that the basis will be unchanged or at least the basis variability will be less than the variability of cash price for the period of time the hedger holds the physical commodity.[3] When the hedger buys the physical commodity, he sells futures contracts of an equal quantity; therefore, if the cash price

1. IF A FUTURES CONTRACT FOR THE MONTH IN WHICH THE CATTLE WERE TO BE SOLD WAS NOT AVAILABLE, THE NEAREST CONTRACT FOLLOWING THAT MONTH WAS USED.

2. THE ADDITIONAL CHARGE OF $10.25 PER ANIMAL WAS INCLUDED TO ELIMINATE MOST OF THE RISK OF LOSS ASSOCIATED WITH A POSSIBLE ADVERSE BASIS DIFFERENTIAL.

3. BASIS IS DEFINED AS THE DIFFERENCE BETWEEN THE CASH AND THE FUTURES PRICE AT A POINT IN TIME, FOR A GIVEN QUALITY OF PRODUCT AND LOCATION.

changes the futures price will theoretically change by an equal amount in the same direction. When he sells the physical commodity on the cash market, he simultaneously buys back the futures contract, thus making his profit on the merchandising of the commodity and neither gaining nor losing by changes in the general level of prices of the commodity.

Long-term hedging is used when the physical commodity is to be held for longer time periods. In this situation, the hedger expects to insure a reasonable return for storing the commodity. This type of hedging is based on the theory that as the contract month is approached, the basis will narrow and the cash price and futures price will become equal at the close of the contract. At the time the hedge is placed, the futures price should be higher than the price paid for the commodity, unless the hedger has already incurred a loss and is hedging to eliminate the possibility of a larger loss. Examples of three typical hedges involving live cattle futures are shown in Table 1.

In a study by Paul and Wesson, an attempt was made to show analogy between carrying charges and cattle feeding services [10]. As the difference between the spot price and the futures price for grain is the cost of storage, the differences between feeder cattle prices plus the cost of feed and the futures price were defined as the cost of feedlot services. If this were the case, the futures price would always be at a premium to the price of feeder cattle plus the cost of feeding. Historically, however, the live cattle futures price has, at times, been at a discount to the price of feeders plus the cost of feed. Hence, under this theory, the feedlot operator would be paying someone to accept his services.

Commercial feedlots with large fixed investments attempt to maintain capacity so long as variable costs are being met. Therefore, there is a tendency to place cattle on feed even when total costs are not expected to be met. Additionally, there is a tendency to discount the futures price as a true indicator of the price. Feeders, like farmers in general, tend to act with optimism, and assume market conditions will be better in the future.

Table 1. Examples of Hedging Live Cattle.[a]

| | Cattle | | Date | |
|---|---|---|---|---|
| **Example 1** | **No Change in the Market** | | | |
| Purchase | 600 pound @ $30/cwt = | $180 | 1-1 | Sell/June Futures Contract $30/cwt = $300 |
| Cost of gain | 400 pound @ $23/cwt = | 92 | | |
| | | $272 | | |
| Sell | 1,000 pound @ $30/cwt = | 300 | 6-1 | Buy/June Futures Contract $30/cwt = $300 |
| | Profit | $ 28 | | Profit = -0- |
| | Net Profit $28-0 = $28/head | | | |
| **Example 2** | **Market Increase $3/cwt** | | | |
| Purchase | 600 pound @ $30/cwt = | $180 | 1-1 | Sell/ June Futures Contract $30/cwt = $300 |
| Cost of gain | 400 pound @ $23/cwt = | 92 | | |
| | | $272 | | |
| Sell | 1,000 pound @ $33/cwt = | 330 | 6-1 | Buy/June Futures Contract $33/cwt = $330 |
| | Profit | $ 58 | | Loss = $30 |
| | Net Profit $58-$30 = $28/head | | | |
| **Example 3** | **Market Decline $3/cwt** | | | |
| Purchase | 600 pound @ $30/cwt = | $180 | 1-1 | Sell/June Futures Contract $30/cwt = $300 |
| Cost of gain | 400 pound @ $23/cwt = | 92 | | |
| | | $272 | | |
| Sell | 1,000 pound @ $27/cwt = | 270 | 6-1 | Buy/June Futures Contract $27/cwt = $270 |
| | Loss | $ 2 | | Profit = $30 |
| | Net Profit $30-$2 = $28/head | | | |

a. All results are on a per head basis (1,000 pounds/head).

Source: Gum, Russell and John R. Wildermuth, "Hedging by Cattle Feeders--Sound Management?", Progressive Agriculture in Arizona, Vol. XXII, No. 6, College of Agriculture, University of Arizona, Tucson, November-December 1970.

The theory of hedging which is most applicable to live cattle futures trading has been developed by Working [13, p. 326]. Working concluded that a hedger does not hedge solely to reduce risk as traditional theory suggests. For example, if the futures price is high relative to the price of feeder cattle and the cost of feed, a feeder may hedge to assure a margin of profit. If the futures price is less favorable he may decide to take his chances on improved cash markets at delivery.

## Operation of the Live Cattle Futures Market

"It has frequently been suggested that for succesful futures trading, the commodity must be storable, be adaptable to standardized grading, have a seasonal pattern of production and storage, and be produced by a large number of producers and used by a large number of users" [11, p. 1485]. Live cattle do not possess the first three of these characteristics since they are not storable and must be marketed within a short period after they reach marketable weights. A grading system exists for live cattle, but there is consider-

able variation within grades; therefore, it is difficult to determine if the futures price applies to the upper or lower end of the choice grade. Furthermore, the emergence of large commercial feedlots feeding cattle on a year-round basis has substantially reduced seasonal patterns of production in slaughter cattle.

The opponents of the live cattle futures market feel that the above factors seriously limit its potential for hedging purposes. Nevertheless, live cattle futures trading has been carried on in significant volume since 1964. The first contract called for a par delivery of 25,000 pounds of 100 percent choice grade steers at Chicago. Omaha was designated as an alternate delivery point at 75¢ per hundred pounds allowance. Weight ranges were 1050-1150 pounds with estimated yield requirements of 61 percent, or 1151-1250 pounds with estimated yield requirements of 62 percent. The Market made six contracts available per year with February, April, June, August, October and December as contract months. Trading for future delivery was to terminate on the 20th day of the contract month with deliveries against open live beef cattle contracts allowable on any business day of the contract month (excluding Fridays and days preceding holidays) after trading in the contract month terminated.

A number of changes have been made in the CME contract since trading was first initiated in November 1964. In July 1968, the delivery clause was amended, deleting Monday as a delivery day and permitting delivery on the remaining days, any time after the *sixth* calendar day of the contract month. The contract size was increased from 25,000 pounds to 40,000 pounds effective with the August 1969 delivery. The number of deliverable good grade steers used as substitutes, at two cents per pound discount, was increased from five head out of the top half of the good grade steers, to eight head per contract. Delivery units containing six but not more than 11 head of good steers, at three cents per pound discount, were changed to include nine but not more than 17 head as substitutes.

Table 2. Total Volume Traded, Midwest Futures Contracts

| Year | February | April | June | August | October | December |
|---|---|---|---|---|---|---|
| 1965 | No contract | 3,498 | 5,894 | 12,377 | 11,428 | 9,674 |
| 1966 | 6,743 | 10,238 | 35,486 | 22,127 | 13,004 | 30,166 |
| 1967 | 27,409 | 49,883 | 49,122 | 42,930 | 43,343 | 65,949 |
| 1968 | 69,284 | 50,931 | 52,952 | 39,063 | 25,239 | 32,972 |
| 1969 | 55,605 | 63,994 | 124,191 | 293,691[a] | 210,657 | 147,393 |
| 1970 | 101,278 | 99,346 | 154,308 | 144,017 | 87,981 | 73,006 |
| 1971 | 84,939 | 152,808 | 143,146 | | | |

[a]Par delivery unit increased from 25,000 pounds to 40,000 pounds effective with August 1969 delivery.

Source: Chicago Mercantile Yearbooks, 1970-1971.

Effective with 1967 contracts, Kansas City, Missouri was added as an acceptable delivery point, with $1.00 per hundredweight allowance. In August 1971, Omaha, Nebraska replaced Chicago as the base delivery market for contracts traded on the Chicago Mercantile Exchange. Guyman, Oklahoma was added as a delivery point with a $1.00 per hundredweight allowance; Peoria and Chicago, Illinois became delivery points with a premium of $0.50 per hundredweight. Kansas City was deleted.

Effective with the August 1969 contract, the limit of the daily price fluctuations was changed from 1½ cents (150 points) to 1 cent (100 points). Mondays were restored as acceptable delivery days and the conversion fee was increased from $25.00 to $36.00.

Upon opening, the market was traded actively. The first contract month, April 1965, had a total volume of 3,498 contracts (Table 2). By the end of 1965, the live cattle market was the third most active market on the exchange. Trading increased fairly steadily to a high of 69,284 open contracts for February of 1968, then declined to 25,239 in October. From October 1968, the volume rose to a new high of 293,691 contracts in August 1969. There has been considerable fluctuation since that date but contract volume has remained relatively high. Additionally, effective August 1969, each contract represented 60 percent more pounds of live animals. (For details on volume of *all* live cattle contracts traded by months, see Appendix, Table 1.)

A Western Live Cattle Futures Market was opened in 1966. It was felt that the price differentials between the Western and Chicago markets increased the risk for Western feeders using the Midwest market for hedging. Furthermore, the size of the Arizona-California feeding industry seemed to be large enough to support a futures market. The structure of the industry, with its

large commercial feedlots, indicated that the Western market might be more actively traded than the Midwest market.

The Western Live Cattle Futures Contract called for a par delivery of 40,000 pounds of 100 percent choice grade steers at Los Angeles. Weight ranges were 900-1100 pounds with a yield requirement of 61 percent. The average weight of cattle actually delivered on contracts was limited to between 950-1050 pounds. Good grade steers were deliverable at a smaller discount to par than for deliveries of the Midwest contract.

The Western market was never actively traded (Table 3). After a year of operation without sufficient volume, it was felt that the contract specification did not fit the needs of the Western feeding industry. In April 1967, a new contract was written, calling for a par delivery unit of only 90 percent choice, with no more than 12 top good grade steers. This was considered to be more representative of the type of cattle being produced in the Western market. The new contract also called for delivery to begin on the 16th calendar day of the contract month instead of the 20th, which is the day the contract closes. This was done in an effort to bring the futures price closer to the cash price at the close of the contract.

Table 3. Total Volume Traded, Western Futures Contracts

| Year | Feb. | April | June | Aug. | Oct. | Dec. |
|---|---|---|---|---|---|---|
| 1966 | | 314 | 695 | 614 | 497 | 462 |
| 1967 | 34 | 118 | 194 | 154 | 302 | 145 |
| 1968 | 35 | 101 | 218 | 12 | 100 | 5 |

Source: Chicago Mercantile Exchange Yearbooks, 1965-1968.

Livestock and livestock products were added to the Commodity Exchange Act in June 1968 in order to bring these commodities under Commodity Exchange Authority regulation. This move required all livestock exchanges to be approved by the Secretary of Agriculture and designated as a contract market under Section 5 of the Commodity Exchange Act. Section 5 required delivery at a point where the cash commodity is sold in sufficient volume and under such conditions as to reflect fairly the general value of a commodity and differences in value between grades. Since the Exchange did not supply the necessary information to show that the designated delivery point at Artesia, California could meet the requirements of Section 5(a), the Western contract was terminated when trading in the existing contracts ceased.

# III. Analysis of Strategies for Feedlot Owner-Feeders

## The Decision Models for Feedlot Owner-Feeders

In order to determine if the live cattle futures market provides hedging opportunity for cattle feeders, and specifically if the Midwest contract provides hedging opportunity for Arizona-California cattle feeders, a statistical decision model was used consisting of simulated representative commercial feedlots for both the Midwest and the Arizona-California areas. Each operation was assumed to be on a program involving buying and selling an equal number of cattle each week, beginning with the week the live cattle futures market opened.

The model assumed that choice grade feeder calves were put on feed at an average weight of 600 pounds. The feeding period used was 22 weeks with the cattle being sold for slaughter at choice grade at an average weight of 1025 pounds. Feeding and yardage costs were not budgeted since these costs would not affect the decision to hedge, except for one strategy.

Average weekly prices for 550-750 pound choice steers were used to determine the cost of the feeder cattle purchased. Fort Worth price quotations were used for the Arizona-California feedlot since an estimated 80-90 percent of the cattle fed in this region originate in Texas and the Southwest [12]. Kansas City price quotations were used for the Midwest feedlot [9].

Total revenue was computed using average weekly prices for 900-1100 pound choice steers. Phoenix price quotations were used for the Arizona-California feedlot [8] while Chicago and/or Omaha price quotations[4] were used for the Midwest feedlot [9]. The futures price quotations used were weekly closing prices of the Chicago Mercantile Exchange Live Cattle Contract [1]. (Feeder cattle prices, slaughter prices, and the relationship between futures prices and Phoenix slaughter cattle prices are presented in the Appendix, Figures 1-3.)

The data were analyzed on the basis of two time periods covering seven years, beginning in 1964. The first period was from December 1964 to August 1968, and the second from August 1968 to November 1971. It was observed that the market was relatively stable with almost no indication of trend during the first period. The second time span, however, involved relatively large fluctuations in prices superimposed on a distinct upward trend. These differences were hypothesized to have significant effects on the possible outcome for different strategies involving hedging. It was, therefore, decided to carry out the analysis for each of the two separate periods.

Four decision strategies were applied to simulated feedlot operations for feedlot owner-feeders, for each of the two time periods. These strategies were: (1) non-hedge strategy, (2) complete hedge strategy, (3) selective hedge strategy using a breakeven price, and (4) selective hedge strategy using a price index for predictive cash cattle prices.

## THE NON-HEDGE

This strategy consisted of placing the same number of cattle on feed each week and selling an equal number of slaughter cattle each week on the cash market. This strategy was used in an attempt to average feeder and slaughter cattle prices over a long period of time. It is commonly used by feeders as a method of minimizing risks and maximizing profits in the long run under conditions of price uncertainty and, therefore, has been used here to establish a basis of comparison with the strategies including hedging. For this strategy, Equation 1 provides the basis for calculation of the average weekly revenue per head, in excess of the cost of the feeders.

$$1. \qquad AR = \frac{\sum_{t=1}^{n} 1025(SP_{t+21}) - 600(FP_t)}{n}$$

AR = Average weekly revenue per head, in dollars, above feeder costs.

SP = Slaughter price in dollars per pound.

FP = Feeder price in dollars per pound.

t = Week cattle are placed on feed.

n = Number of weeks.

## THE COMPLETE HEDGE

This system assumed all cattle were hedged at the time they were purchased. Thus, each week as cattle were placed on feed, a futures contract was sold for an equivalent number of animals. When the cattle were sold for slaughter at the end of the 22-week feeding period, the contracts were bought back. Thus, the feeder has some price insurance throughout the feeding period by having eliminated the risks associated with price variations in the cash market. However, the risks associated with changes in basis differential remain. Average revenue for this strategy was computed by Equation 2.[5]

$$2. \qquad AR = \frac{\sum_{t=1}^{n} 1025[(SP_{t+21}) + (P_{f_t} - P_{f_{t+21}})] - 600\ (FP_t)}{n}$$

AR = Average revenue per head, in dollars above feeder costs.

SP = Slaughter price in dollars per pound.

FP = Feeder price in dollars per pound.

$P_f$ = Futures price in dollars per pound.

t = Week cattle are placed on feed.

n = Number of weeks.

4. COMPARISONS WERE MADE USING BOTH CHICAGO AND OMAHA QUOTATIONS FOR THE FIRST PERIOD. CHICAGO WAS OMITTED FROM THE LATTER PERIOD ANALYSIS SINCE COMPARABLE PRICE DATA WERE NOT AVAILABLE.

5. IN ORDER TO SIMPLIFY CALCULATIONS, REVENUE AS DETERMINED FOR STRATEGIES INVOLVING HEDGING, IN THIS STUDY, DID NOT MAKE ALLOWANCE FOR A TRANSACTIONS COST. THIS CHARGE VARIED OVER THE PERIOD COVERED BUT DID NOT EXCEED $1.20 PER ANIMAL HEDGED.

## SELECTIVE HEDGE USING A BREAKEVEN PRICE

Under this strategy a breakeven price was computed to determine when to hedge. If the futures price corresponding to the time the cattle were to be sold,[6] i.e., t+21, was greater than the breakeven price at time t, when the feeder cattle were purchased, the cattle were hedged. If the futures price was lower than the breakeven price, the cattle were assumed to be placed on feed unhedged.

The breakeven price was computed using an average total cost of gain of $22.05 per hundred pounds (see cost budget, Appendix, Table 2). Although the cost estimates were for Arizona feeders, it was assumed that Midwest feeders were competitive; therefore, the same budget was used for computing the breakeven price for both the Western and Midwestern feedlots. A cost of $0.12 per hundred pounds was added for brokerage fees and interest on margin money. Brokerage fees were $36.00 per contract and interest on margin money was computed at seven percent, on $500.00 per contract. A return to management of $0.50 per hundred pounds was included in the breakeven price. Equation 3 was used to determine the breakeven price.

Using the computed breakeven price to determine when to hedge, total revenue above feeder costs, for each animal placed on feed unhedged was determined by Equation 4, and for each animal placed on feed and hedged, Equation 5.

Average revenue per head per week was then derived by Equation 6.

3. $$BP = \frac{600\ (FP) + 425(CG) + TC}{1025}$$ [7]

BP = Breakeven price in dollars per pound.

FP = Feeder price in dollars per pound.

CG = Cost of gain in dollars per pound.

TC = Transactions cost, including commission charges, interest on margin money and a management fee.

4. $$TR_t = 1025(SP_{t+21}) - 600(FP_t)$$

5. $$TR_t = 1025[(SP_{t+21}) + (P_{f_t} - P_{f_{t+21}})] - 600(FP_t)$$

Average revenue per head per week was then derived by Equation 6.

6. $$AR = \frac{\sum_{t=1}^{n} TR_t}{n}$$

## SELECTIVE HEDGE USING A CASH PRICE PREDICTOR

In this strategy, an estimated slaughter price was used as a basis for the hedging decision. When the futures price was equal to or above the estimated slaughter price, cattle were placed on feed and hedged. If the futures price was below the estimated slaughter price, the cattle were placed on feed unhedged.

The estimated slaughter price was obtained by adjusting the present slaughter price using a five-year moving average of a monthly slaughter cattle price index. The price index indicates in percentage terms, the relationship of the actual price for a given month to the average price for 12 months. When an index is computed for each month, an estimate of month-to-month variation

6. IF THE TIME OF SALE IS NOT A CONTRACT MONTH, THE CONTRACT SOLD IS FOR THE NEAREST ONE FOLLOWING THAT MONTH.

7. TRANSACTIONS CHARGE AND MANAGEMENT FEE WERE INCORPORATED ONLY IN THE COMPUTATION OF THE BREAKEVEN PRICE. THIS CHARGE WAS CONSIDERED NECESSARY TO PROVIDE A MORE ACCURATE DECISION BASIS FOR HEDGING OR NOT HEDGING.

of price is obtained. If the October price index is 98 and the July price index is 101, the July price can be adjusted for monthly variation by multiplying it by the October price index and dividing the product by the July price index. The monthly price index and the five-year moving averages of the Chicago and Omaha slaughter cattle prices are presented in the Appendix, Tables 3 and 4, and the Phoenix slaughter price indexes and moving averages are given in the Appendix, Tables 5 and 6.

In order to determine when to hedge, the cash slaughter price at the time the hedge was being considered was adjusted using Equation 7.

Revenues were computed for this strategy by the same equations as were used in the third strategy. The only difference was in the criteria used to make the decisions as to when to hedge.

A t-test was used to determine if the average net revenues between strategies within a given market, and between markets within a given strategy, were significantly different. An f-test was used to determine if the variances associated with the average net revenues were significantly different.

7. $$ASP = I_{t+5}\,(SP_t)/I_t$$

ASP = Adjusted slaughter price in dollars per pound.

SP = Slaughter price in dollars per pound.

I = Slaughter cattle price index.

t = Time period, months.

Table 4. Results of Decision Strategies, Chicago, Omaha and Phoenix Markets During 192 Weeks, 12/4/64 - 8/3/68.

| | Strategy 1 | Strategy 2 | Strategy 3 | Strategy 4 |
|---|---|---|---|---|
| | ----------Dollars---------- | | | |
| Chicago Market | | | | |
| Revenue per Head per Week | 114.36 | 111.82 | 112.95 | 117.45 |
| Variance | 324.72 | 116.42 | 115.78 | 203.92 |
| Standard Deviation | 18.02 | 10.79 | 10.76 | 14.28 |
| Omaha Market | | | | |
| Revenue per Head per Week | 108.19 | 105.66 | 106.79 | 109.12 |
| Variance | 307.30 | 120.12 | 110.88 | 169.78 |
| Standard Deviation | 17.53 | 10.96 | 10.53 | 13.03 |
| Phoenix Market | | | | |
| Revenue per Head per Week | 113.33 | 110.80 | 111.17 | 114.67 |
| Variance | 352.69 | 211.12 | 199.37 | 199.94 |
| Standard Deviation | 18.78 | 14.53 | 14.12 | 14.14 |

## Results of the Analysis of the Feedlot Owners' Decision Models

The average revenues per head and their variances, generated by the decision model, give some indication of the effectiveness of the live cattle futures market in providing hedging opportunities for cattle feeders both in the Midwest and Western markets for the two different time periods analyzed. A comparison of the results of the first decision strategy, in the Midwest and Western markets, where cattle were assumed to be placed on feed unhedged, with the results of the three decision strategies using hedging, gives some idea of the hedging potential offered by the live cattle futures market.

### TIME PERIOD I

For the period December 4, 1964 through August 3, 1968, the revenue per head above the cost of the feeder, generated by Strategy 1, which did not include hedging, was higher than the revenue per head of the complete hedge strategy, by $2.54 for the Chicago market and $2.53 for the Omaha market (Table 4). It also produced $1.41 and $2.16 more per head, respectively, for the Chicago and Omaha markets, than Strategy 3, using a selective hedge based on a breakeven point. Although these differences existed, only the differences between Strategies 1 and 2 in the Omaha market were statistically significant, according to the t-test and then only at the 90 percent confidence level (Appendix, Table 7).

Strategy 4, incorporating a selective hedge based on an estimated cash price, resulted in the highest weekly revenue per head, of all the strategies, for both Midwestern markets. The revenue per head for this strategy in the Chicago market was statistically greater than Strategy 1, at the 90 percent confidence level, and greater than the second and third strategies at the 99 percent confidence level for both Midwestern markets.

When comparing the variances in revenues generated by each strategy in the Chicago and Omaha markets, the f-tests indicated that the variance for Strategy 1 was significantly greater than the other three decision strategies (Appendix, Table 8). The probability of experiencing a loss on any given pen of cattle was lower for the hedging strategies within reasonable estimates of costs of gain (Table 5). These results suggest that a Midwest feeder could have significantly reduced his probability of a loss on his feeding operation by using a hedging program during this period without reducing the revenue per head significantly. For instance, at a cost of gain of $24.00 per hundredweight, the probability of a loss for a Chicago feeder, not hedging, was approximately 25 percent, for a given pen of cattle, compared to 14 percent for a feeder using a strategy which included selective hedging.

The results for the decision strategies in the Phoenix market were similar to that of the Midwest markets. Revenues per head for the first strategy were greater than for the second and third strategies by $2.53 and $2.16, respectively (Table 4). As in the Chicago market, the t-tests indicated the differences between the per head revenues were not significant. Although the fourth strategy resulted in the highest revenue per head, the t-test showed the difference was significant only in relationship to the second and third strategies. Hence, for the Phoenix market, there was no indication that the use of hedging would have resulted in a significantly different revenue per head than when hedging was not used. As in the Midwest market, the fourth decision strategy had a significantly higher revenue per head than the other two hedging strategies (Appendix, Table 7).

The variance of the weekly revenue per head for the first decision strategy in the Phoenix market was significantly higher than the variance of the strategies involving hedging. Also, as for the Midwest markets, the results suggest Western cattle feeders could have significantly reduced the probability of a loss for any given pen of cattle by one of the strategies which included hedging (Table 5). For example, at a cost of gain of $24.00 per hundredweight, there was a 27 percent chance of a loss when hedging was not included in the strategy, compared to an 18 percent chance when a selective hedge was used, as in Strategy 4.

Table 5. Probability of Loss for Each Strategy for Various Costs of Gain.

| Strategy | Chicago | | | |
|---|---|---|---|---|
| Cost of Gain | 1 | 2 | 3 | 4 |
| $ | Percent | | | |
| 21.00/cwt. | 8.2 | 2.0 | 1.4 | 2.4 |
| 22.00/cwt. | 12.3 | 4.5 | 3.5 | 4.7 |
| 23.00/cwt. | 17.9 | 9.7 | 7.9 | 8.4 |
| 24.00/cwt. | 24.5 | 18.1 | 15.4 | 14.0 |
| 25.00/cwt. | 32.6 | 30.2 | 26.8 | 21.8 |
| 26.00/cwt. | 41.7 | 45.2 | 40.9 | 31.2 |

| Strategy | Omaha | | | |
|---|---|---|---|---|
| Cost of Gain | 1 | 2 | 3 | 4 |
| $ | Percent | | | |
| 21.00/cwt. | 14.0 | 6.7 | 4.7 | 6.4 |
| 22.00/cwt. | 20.0 | 13.3 | 10.4 | 11.5 |
| 23.00/cwt. | 27.4 | 23.6 | 19.5 | 19.2 |
| 24.00/cwt. | 36.3 | 37.1 | 32.6 | 29.1 |
| 25.00/cwt. | 45.6 | 52.0 | 48.0 | 41.3 |
| 26.00/cwt. | 55.2 | 67.0 | 63.7 | 54.4 |

| Strategy | Phoenix | | | |
|---|---|---|---|---|
| Cost of Gain | 1 | 2 | 3 | 4 |
| $ | Percent | | | |
| 21.00/cwt. | 10.0 | 7.9 | 6.1 | 3.4 |
| 22.00/cwt. | 14.5 | 11.7 | 10.6 | 6.7 |
| 23.00/cwt. | 20.3 | 18.4 | 17.1 | 11.5 |
| 24.00/cwt. | 27.4 | 27.1 | 25.8 | 18.4 |
| 25.00/cwt. | 35.2 | 37.8 | 36.3 | 27.4 |
| 26.00/cwt. | 44.0 | 49.2 | 48.0 | 38.2 |

Comparisons were also made with respect to returns per head and the variances of returns between the respective markets. The Chicago market produced statistically greater returns than the Omaha market, at the 99.9 percent confidence level (Appendix, Table 7). Differences in variances for revenues between the two markets were not statistically significant. However, the probability of a loss based on estimated variances was generally higher for Omaha than Chicago, since revenues were significantly lower.

The revenues per head in the Chicago market were higher for each strategy than in the Phoenix market. Although the absolute values were higher for the Chicago market, only Strategy 4 produced revenues significantly greater than the same strategy for the Phoenix market. This indicates that a Chicago feeder would not necessarily have obtained a higher revenue per head than a Phoenix feeder when using the futures market for hedging. Although Strategy 4 resulted in a significantly higher revenue per head for the Chicago market, the result is probably

attributable to the fact that a monthly price index gives a better estimate for the Chicago market than for the Phoenix market. Therefore, another method of estimating the slaughter price might well have given the advantage to the Phoenix market.

When the variances of the revenues for each decision strategy for the Midwest and Western markets were compared, the Chicago feeder appeared to have an advantage over the Western feeder when hedging. The variances for the first strategy, which did not include a hedging practice were not significantly different between the two markets. While loss probabilities were slightly higher in the Phoenix market, the differences were not statistically significant. The variances for Strategies 2 and 3 were both significantly lower for the Chicago market. Similarly, for these two hedging strategies, the probability of a loss was significantly less for the Chicago feeder.

Analysis of the differences between the Omaha and Phoenix markets revealed that the latter produced significantly greater revenues per head over all four strategies. The variances of revenues, however, were found to be significantly lower in the Omaha market for Strategies 2 and 3. They were also lower for the other two strategies but did not test as significant. Despite the lower variance in revenues obtained from the Omaha market, the probability of experiencing a loss on any given lot was generally higher due to the lower levels of the revenues.

The results of the decision model indicate that, for the first time period considered in this study, no significant difference was found in expected revenue between the strategy which did not include hedging and the strategies which included hedging, except in one case. For feeders in the Chicago market using the fourth decision strategy, which was a selective hedge based on a projected slaughter price, the model produced a significantly higher revenue per head than the non-hedge strategy, a result not shared by the Omaha or Phoenix markets. The three strategies which included hedging resulted in significantly lower variances of revenue per head than the non-hedge strategy in all markets.

The probability of a loss for any given pen of cattle was generally found to be less when a hedging practice was included in the feeding program. Although this was the case for both the Midwest and Western markets, the greatest reductions in loss probability were for the Midwest market.

These results indicate that the Midwest live cattle futures market offered hedging potential for both the Midwest and Western cattle feeders although a Chicago feeder had a definite advantage over the Omaha and Phoenix feeders (Table 4). The results suggest that opportunity for successful hedging was available for cattle feeders, but a policy of selective hedging would have been preferable to a policy of hedging all cattle placed on feed. Additionally, the selective hedge used in Strategy 4 was based on an unsophisticated model for predicting future prices. The closer the prediction to reality, the better the results of this strategy would be. Since a very simple predictor gave favorable results, it suggests considerable potential exists for the use of a selective hedge based on more reliable predictions of fat cattle prices.

A study by Dobson obtained similar results [2]. This study showed a slightly greater difference between revenue per head between the hedged cattle and unhedged cattle over the same time period, 1965-68. Dobson did not include any selective hedge strategies and made no estimate of the variance of the revenues. He concluded that a feeder who could afford to take risk could develop a selective hedge strategy to take advantage of hedging on a declining cash market while a smaller feeder might have to hedge more frequently, especially if he could lock in a satisfactory profit. These conclusions are supported by the results produced by the two selective hedge strategies especially for the Midwest market. The Western feeder could not have reduced his risk to the extent of a Midwestern feeder but still could have used a selective hedge strategy to his benefit.

**TIME PERIOD II**

The second time period included 173 weeks from August 10, 1968 through November 27, 1971. The two time periods, combined, covered a total of 365 weeks. Only the Omaha and Phoenix markets were considered in the analysis of the second time period.

For the Omaha market, Strategy 1 showed a higher revenue per head fed than any of the strategies involving hedging. Strategy 1 revenues were $20.19, $17.90 and $6.10 per head higher than Strategies 2, 3, and 4, respectively (Table 6). The statistical t-test showed Strategy 1 to be significantly greater than the second and third strategies at the 99.9 percent confidence level and significantly greater than the fourth strategy at the 95 percent confidence level (Appendix, Table 9). The fourth strategy resulted in $14.09 per head more than Strategy 2 and $11.80 more than Strategy 3 (Table 6). The t-test results showed revenues from Strategy 4 were significantly greater than either of the other hedge strategies at the 99.9 percent confidence level.

There was no significant difference between the revenues produced by the second and third strategies, although the revenue per head was $2.29 higher for Strategy 3 than Strategy 2.

For the Omaha market, the f-test indicated that the variance of the revenues, for the second and third decision strategies, were significantly lower than either the first strategy or the fourth strategy, at the 99 percent confidence level. No significant differences were noted between the variances of revenues for the first and fourth strategies (Appendix, Table 10).

While the variances were less for Strategies 2 and 3, the probability of loss was greater than for the other two strategies throughout the

Table 6. Results of Decision Strategies, Omaha and Phoenix Markets, for 173 Weeks, 8/10/68 - 11/27/71.[a]

| | Strategy 1 | Strategy 2 | Strategy 3 | Strategy 4 |
|---|---|---|---|---|
| | ----------Dollars---------- | | | |
| Omaha Market | | | | |
| Revenue per Head | 120.47 | 100.28 | 102.57 | 114.37 |
| Variance | 751.31 | 247.43 | 303.45 | 704.90 |
| Standard Deviation | 27.41 | 15.73 | 17.42 | 26.55 |
| Phoenix Market | | | | |
| Revenue per Head | 127.64 | 107.45 | 108.05 | 122.08 |
| Variance | 739.30 | 228.01 | 212.28 | 754.60 |
| Standard Deviation | 27.19 | 15.10 | 14.57 | 27.47 |

[a]Chicago, Illinois was deleted as a major market for the 8/10/68 - 11/27/71 time period.

Table 7. Probability of Loss for Each Strategy for Various Costs of Gain

| | Omaha | | | |
|---|---|---|---|---|
| Cost of Gain | Strategy 1 | Strategy 2 | Strategy 3 | Strategy 4 |
| Dollars | Percent | | | |
| 21.00/cwt. | 12.7 | 24.2 | 22.4 | 17.1 |
| 22.00/cwt. | 16.3 | 33.4 | 30.1 | 21.5 |
| 23.00/cwt. | 20.3 | 43.6 | 38.9 | 26.4 |
| 24.00/cwt. | 25.1 | 54.4 | 48.8 | 31.9 |
| 25.00/cwt. | 30.1 | 65.2 | 58.3 | 37.8 |
| 26.00/cwt. | 35.9 | 74.5 | 67.7 | 44.0 |

| | Phoenix | | | |
|---|---|---|---|---|
| Cost of Gain | Strategy 1 | Strategy 2 | Strategy 3 | Strategy 4 |
| Dollars | Percent | | | |
| 21.00/cwt. | 7.9 | 11.3 | 9.9 | 11.5 |
| 22.00/cwt. | 10.4 | 17.9 | 15.9 | 14.8 |
| 23.00/cwt. | 15.9 | 26.1 | 23.9 | 18.7 |
| 24.00/cwt. | 17.4 | 35.9 | 33.7 | 23.3 |
| 25.00/cwt. | 21.5 | 46.8 | 45.2 | 28.1 |
| 26.00/cwt. | 26.4 | 57.9 | 56.8 | 33.7 |

range of costs used. The probability of loss was less for Strategy 4 than for 2 or 3, but greater than for the non-hedge strategy (Table 7). While Strategy 1 had the highest variance of revenues, the higher levels of revenues offset this disadvantage.

The Phoenix and Omaha markets exhibited similar relationships between the decision strategies. The non-hedge strategy for the Phoenix market produced $20.19, $19.59 and $5.56 more revenue per head fed than Strategies 2, 3, and 4, respectively (Table 6). The t-test results (Appendix, Table 9) indicated that a significant difference existed between the revenues produced by the first strategy and the second and third strategies at the 99.9 percent confidence level but not between the revenue produced by Strategies 1 and 4. The revenue per head from Strategy 4 was $14.63 greater than Strategy 2 and $14.03 more than Strategy 3. The t-test indicated Strategy 4 produced significantly higher revenue per head than either Strategy 2 or 3 at the 99.9 percent confidence level. The difference between the revenues per head for Strategies 2 and 3 was only $0.60 and was not statistically significant.

The relationships between the variances of the revenues resulting from using the various strategies in the Phoenix market are very similar to those of the Omaha market (Appendix, Table 10). The variances for revenues of Strategies 1 and 4 were each significantly greater than either total hedge or the selective hedge strategies, but no significant difference was noted between the variance of the first and fourth strategies.

The probabilities of loss, estimated using different costs of gain, generally bear a similar relationship, for the various strategies in the Phoenix market, as did those calculated for the Omaha market (Table 7).

Comparison of the results produced by each market for this time period show significantly higher revenue per head generated by feeders in the Phoenix market for all the strategies considered. The variances of revenues were gener-

ally lower for the Phoenix market with the exception of Strategy 4, which was lower in the Omaha market. However, only Strategy 3 proved to be significantly lower for the Phoenix market. The combination of lower revenues and relatively higher variances made the probability of a loss consistently greater for the Omaha market.

For the second time period, the results of the decision model indicate that the strategy of not hedging produced significantly greater revenues for both markets than did either the total hedge or selective hedge strategies. The variances of revenues for strategies involving hedging were all lower than for the non-hedge method, for both markets, but only those of the second and third strategies tested significantly lower, also in both markets.

The probabilities of loss were found to be less for the non-hedge strategy and for the selective hedge based on a predicted delivery price, than the other strategies involving hedging. Although the variances of revenues tested significantly lower for Strategies 2 and 3, the reduction in revenues more than offset this advantage. As a result, the probability of a loss was greater than for Strategies 1 and 4.

For this time period, the results indicate that a policy of continuous feeding without using the option of hedging under the conditions assumed in this study was the preferred method to use.

## SUMMARY OF RESULTS

Differing conclusions result from the two-period analysis of the four strategies. In the first period, the selective hedge, based on a simple predictive model, gave slightly higher revenues than all the other systems. Statistically, the differences between revenues of the selective hedge and the non-hedge were not significant; however, the variance of revenues for Strategy 4 was considerably less and the probability of a loss was much lower. During this period, a well-designed model to predict cash prices on the date of delivery could have been used effectively to reduce risk of losses on given lots of cattle. Strategies 2 and 3 would also reduce risks, relative to the non-hedge, but it appeared evident some real loss in terms of revenues would result.

The second period had much more decisive differences between the strategies, thus bearing out the hypothesis stated initially that market conditions could be expected to affect the results of the various strategies. In the second time period, Strategy 1 produced significantly higher revenues. Strategies 2 and 3 were again the least desirable. While Strategy 1 generally had a larger variance of revenues, the risk of loss remained lower since revenues were so much larger. In this period, it appeared the best strategy of a feeder would have been to use an averaging procedure with an even number of cattle put on feed each week rather than to employ hedging, at least as used in these models.

The prime reason for the differences, over time, can be explained by the price movements and the relationship between cash and future prices for the two time periods. From December 1964 to August 1968, prices were relatively stable with no trend indicated (Appendix, Figures 1-2). For much of the period, the futures prices available to feeders as a hedge at the time cattle were placed on feed generally exceeded the offsetting contract price available at the time the fat cattle were ready for sale (Appendix, Figure 3). Thus, the hedge provided a means for locking in higher prices than the market provided at the time of delivery. From August 1968 to November 1971, however, market prices fluctuated within a much wider range and an upward trend developed. During this time period, the futures market generally underestimated the prices on dates of delivery, thereby locking in lower prices for a hedged position.

The use of a more accurate predictive model in the second time period would have improved the results of Strategy 4, largely by reducing the number of hedged positions. In a more volatile market, such as in the second period, accuracy in prediction becomes more important and at the same time, more difficult.

Based on the analysis, there does not appear to be any justification for a policy of continuous hedging except under special market conditions. Such a strategy will likely result in lower returns over time without significantly reducing risks relative to an evenflow system without a hedge. Also, there is no evidence to support the hypothesis that Phoenix area feedlot operators were at a disadvantage to Omaha feeders relative to the use of the futures market for hedging cattle. There is, however, an indication that feeders located near the Chicago market may have enjoyed some advantage over the other markets in question. This may have been due to a relatively small basis differential between the cash and futures market experienced in the Chicago market as compared to the Omaha and Phoenix markets [4] (see Appendix, Table 11 for basis differentials for the Omaha and Phoenix markets).

Undoubtedly, a more sophisticated system of predicting movements in cash prices would provide a better basis for making decisions. The closer the predictor to reality, the less possibility of making the wrong decision relative to the use of the futures market. However, losses due to adverse changes in the basis position cannot be eliminated. If these are excessive, feeders remote from delivery points will likely be in a poorer position since delivery costs will be higher.

The relatively unfavorable position of those using the Omaha market is at least partly a function of the system of analysis. If production costs had been included, revenues probably would not be much different between the Omaha and Phoenix market results.

# IV. Analysis of Strategies for Custom Feeders

## The Custom Feeders' Decision Model

Operations were simulated for custom feeders where feedlot ownership was not involved. Since custom feeders do not have fixed plant cost obligations to meet, they have considerably more flexibility in their decisions. It is, therefore, possible that they may use hedging in their feeding operations with somewhat different results than those observed in the analyses to this point.

Two strategies were developed: (1) a selective feeding "no risk" strategy employing a hedge for all cattle fed, (2) selective feeding without hedging.

Estimates of net returns for both strategies were made for seven separate 52-week periods representing the first seven years of existence of the live cattle futures contract. Annual estimates were made since changes in feeding and feeder costs were significant in the decision model. The estimates on a yearly basis were computed only for the Omaha and Phoenix markets. Representative cost estimates based on industry experience were used for the annual analysis (Table 8). Individual operations as well as area differences undoubtedly would be at variance with these estimates. Feeder, slaughter and futures prices were taken from the same sources as those used in the analysis of the owner-feeder model (Chapter III).

Table 8. Estimated Costs of Gain, Custom Feeders, 600-Pound Feeder Calf

| Year | Cost of Gain per Hundredweight[1] | Cost per Animal[2] |
|---|---|---|
| 1964-65 | $23.50 | $ 99.88 |
| 1965-66 | 24.00 | 102.00 |
| 1966-67 | 23.50 | 99.88 |
| 1967-68 | 22.75 | 96.69 |
| 1968-69 | 23.00 | 97.75 |
| 1969-70 | 25.25 | 107.31 |
| 1970-71 | 25.50 | 108.38 |

1) Costs do not include interest on investment in the feeder.
2) Based on 425 pounds of gain.

8. $$GR = 1025\ (P_{f_t})$$

$GR$ = Gross revenue per animal.

$P_f$ = Futures price in dollars per pound for nearest delivery month.

$t$ = Week cattle are placed on feed.

9. $$\text{Total Cost} = 600(FP_t) + 425(CG) + \$10.25$$

$FP_t$ = Feeder price in dollars per pound.

$CG$ = Cost of gain in dollars per pound.

10. $$NR = 1025[(SP_{t+21}) + (P_{f_t} - P_{f_{t+21}})] - [600(FP_t) + 425(CG)]$$

$NR$ = Net revenue per head placed on feed.

$SP$ = Slaughter price in dollars per pound.

$P_f$ = Futures price in dollars per pound.

$FP$ = Feeder price in dollars per pound.

$t$ = Week cattle are placed on feed.

$t+21$ = Week cattle are sold.

$CG$ = Cost of gain in dollars per pound.

## The "No Risk" Strategy

In the analysis of hedging potential for custom feeders, an assumption was made that in addition to making profits, feeders wished to minimize risks. Therefore, no feeding was undertaken without being able to lock in a "net revenue" equal to or greater than zero.

The "no risk" strategy incorporates a decision model somewhat like Strategy 3 of the Feedlot Owner-Feeders Model of Chapter III, except that the investor feeds cattle only when a hedged position is indicated to be profitable. Projected gross returns per animal for this analysis were determined by multiplying the assumed average finished weight of 1025 pounds by the futures price of the contract month nearest the month in which the cattle were to be sold (Equation 8). When these returns exceeded the costs of the feeder and feeding, plus a factor of $10.25 per animal added to eliminate most of the risks of loss from negative basis differentials (see Appendix, Table 11), the cattle were placed on feed and hedged (Equation 9). Thus, cattle would not be fed unless net revenue determined by Equation 10 was equal to or greater than zero. Unlike the strategies in Chapter III, which assumed

continuous feeding of an equal number of animals per week, the numbers fed were considered to be completely flexible. Custom feeders can make such decisions, assuming all costs variable, since they have no fixed investment in plant or other facilities.

## Custom Feeders Strategy Without Hedging

This strategy was used as a check on the income advantages of hedging for the custom feeder. The same decision criteria were used in deciding whether or not to feed, but returns were based solely on cash market prices.

Comparisons were made assuming the custom feeder used Equation 10 above to decide whether or not to feed but did not hedge his operations. Under this option, revenues were estimated by the following equation.

$$11. \qquad NR = 1025(SP_{t+21}) - [600(FP_t) + 425(CG)]$$

Symbols are as in Equation 10.

## Results of the Custom Feeders' Decision Model

The results of the analysis of the custom feeders' strategy suggest that such a system is feasible and profitable for the investor (Tables 9-12). However, the situation has changed considerably during the seven-year period studied. In the first three years, the number of weeks in which the model indicated feeding should be carried on were relatively large. In the last four years, the feeding opportunities were limited, especially in the Omaha market. Weeks in which feeding produced losses due to adverse basis differentials associated with hedging were not large. These could have been reduced by raising the safety factor added to the cost estimates but this would have increased the danger of eliminating feeding in some of the weeks when profits occurred.

When hedging, the average net returns per animal fed exceeded $8.00 in all years for both the Phoenix and Omaha markets (Table 11). The highest return was at Phoenix with a net of $19.49 per head for 1965-66. Assuming returns to be net of all charges other than interest, profits exceeded eight percent on investment for all years using the Phoenix market and in all but one in the Omaha market.

Generally, the results were not as favorable for the Omaha as the Phoenix market. This was at least partly a function of overestimating feeding costs in the Omaha area relative to Phoenix, since the same cost levels were used. Most evidence suggests Midwest feeding costs were probably lower than in the Western region, largely because of feed price differences.

As indicated earlier, the latter part of the period, which produced fewer opportunities to feed, was one with prices rising and fluctuating more than in the first part of the period. While some profit opportunities existed, using the futures market as a hedge for the feeding operations, generally the futures price at the time cattle were being placed on feed underestimated cash prices at time of delivery. Thus, while the risk was increased, feeding without hedging produced higher returns in the latter period. Weeks of profit ranged from three per year to 39 per year for the Omaha market and from 11 to 44 weeks for the Phoenix market. They totaled 125 or 34 per-

Table 9. Phoenix Market Comparisons of Hedge and Non-Hedge Options for Custom Feeders

| Year | Total Weeks Fed | Profit | | | | Loss | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Hedge | | Nonhedge | | Hedge | | Nonhedge | |
| | | Weeks | Percent | Weeks | Percent | Weeks | Percent | Weeks | Percent |
| 1964-65 | 38 | 31 | 81.6 | 32 | 84.2 | 7 | 18.4 | 6 | 15.8 |
| 1965-66 | 44 | 38 | 86.4 | 19 | 43.2 | 6 | 13.6 | 25 | 56.8 |
| 1966-67 | 44 | 44 | 100.0 | 38 | 86.4 | 0 | -- | 6 | 13.6 |
| 1967-68 | 39 | 33 | 84.6 | 39 | 100.0 | 6 | 15.4 | 0 | -- |
| 1968-69 | 33 | 26 | 68.8 | 27 | 81.8 | 7 | 21.2 | 6 | 18.2 |
| 1969-70 | 13 | 13 | 100.0 | 11 | 84.6 | 0 | -- | 2 | 15.4 |
| 1970-71 | 14 | 11 | 78.6 | 14 | 100.0 | 3 | 21.4 | 0 | -- |
| Total | 225 | 196 | 87.1 | 180 | 80.0 | 29 | 12.9 | 45 | 20.0 |

Table 10. Omaha Market Comparisons of Hedge and Non-Hedge Options for Custom Feeders

| Year | Total Weeks Fed | Profit | | | | Loss | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Hedge | | Nonhedge | | Hedge | | Nonhedge | |
| | | Weeks | Percent | Weeks | Percent | Weeks | Percent | Weeks | Percent |
| 1964-65 | 30 | 28 | 93.3 | 30 | 100.0 | 2 | 6.7 | 0 | -- |
| 1965-66 | 32 | 29 | 90.6 | 6 | 18.8 | 3 | 9.4 | 26 | 81.2 |
| 1966-67 | 40 | 39 | 97.5 | 24 | 60.0 | 1 | 2.5 | 16 | 40.0 |
| 1967-68 | 3 | 3 | 100.0 | 3 | 100.0 | 0 | -- | 0 | -- |
| 1968-69 | 19 | 15 | 78.9 | 19 | 100.0 | 4 | 21.1 | 0 | -- |
| 1969-70 | 6 | 6 | 100.0 | 5 | 83.3 | 0 | -- | 1 | 16.7 |
| 1970-71 | 6 | 5 | 83.3 | 6 | 100.0 | 1 | 16.7 | 0 | -- |
| Total | 136 | 125 | 91.9 | 93 | 68.4 | 11 | 8.1 | 43 | 31.6 |

Table 11. Yearly Results of Custom Feeders "Hedge Strategy", 12/4/64-11/27/71, Phoenix and Omaha Markets

| Year | Weeks of Profit | Percent of Total | Weeks of Loss | Percent of Total | Weeks Not Feeding | Percent of Total | Average Return Per Head | Percent Return[a] | Total Profit for Period[b] |
|---|---|---|---|---|---|---|---|---|---|
| | Weeks | % | Weeks | % | Weeks | % | $ | % | $ |
| 1964-65 | | | | | | | | | |
| Phoenix | 31 | 60 | 7 | 13 | 14 | 27 | 8.73 | 8.3 | 331.90 |
| Omaha | 28 | 54 | 2 | 4 | 22 | 42 | 8.11 | 7.7 | 243.16 |
| 1965-66 | | | | | | | | | |
| Phoenix | 38 | 73 | 6 | 12 | 8 | 15 | 19.49 | 18.4 | 857.89 |
| Omaha | 29 | 50 | 3 | 6 | 20 | 38 | 14.92 | 14.6 | 494.30 |
| 1966-67 | | | | | | | | | |
| Phoenix | 44 | 85 | 0 | 0 | 8 | 15 | 17.34 | 16.4 | 762.80 |
| Omaha | 39 | 75 | 1 | 2 | 12 | 23 | 11.89 | 11.2 | 475.44 |
| 1967-68 | | | | | | | | | |
| Phoenix | 33 | 63 | 6 | 12 | 13 | 25 | 9.47 | 9.0 | 369.39 |
| Omaha | 3 | 6 | 0 | 0 | 49 | 94 | 9.31 | 8.8 | 27.94 |
| 1968-69 | | | | | | | | | |
| Phoenix | 26 | 50 | 7 | 13 | 19 | 37 | 15.56 | 14.7 | 513.50 |
| Omaha | 15 | 29 | 4 | 8 | 33 | 63 | 14.97 | 14.1 | 283.54 |
| 1969-70 | | | | | | | | | |
| Phoenix | 13 | 25 | 0 | 0 | 39 | 75 | 14.85 | 14.0 | 193.11 |
| Omaha | 6 | 12 | 0 | 0 | 46 | 88 | 11.49 | 10.9 | 68.92 |
| 1970-71 | | | | | | | | | |
| Phoenix | 11 | 21 | 3 | 6 | 38 | 73 | 15.13 | 14.3 | 211.78 |
| Omaha | 5 | 10 | 1 | 2 | 46 | 88 | 18.08 | 17.1 | 108.49 |
| Totals | | | | | | | | | |
| Phoenix | 196 | 54 | 29 | 11 | 139 | 38 | 14.40 | 13.5 | 3240.27 |
| Omaha | 125 | 34 | 8 | 3 | 228 | 63 | 12.80 | 12.1 | 1701.80 |

[a] Costs based on an average investment of $250 per animal. This is a net return over all costs excluding a market interest charge on investment.

[b] Based on one animal placed on feed in any given week.

cent of the weeks possible in the Omaha market and 196 weeks or 54 percent of the possible feeding weeks in the Phoenix market.

The weeks of loss each year in the Omaha market ranged from zero to four and totaled 11 or three percent of all the weeks in the period of time concerned. In the Phoenix market, losses were experienced for up to seven weeks per year. Feeding was indicated for 225

Table 12. Yearly Results of Custom Feeders "Nonhedge Strategy", 12/4/64-11/27/71, Phoenix and Omaha Markets

| Year | Weeks of Profit | Percent of Total | Weeks of Loss | Percent of Total | Weeks Not Feeding | Percent of Total | Average Return Per Head | Percent Return[a/] | Total Profit for Period[b/] |
|---|---|---|---|---|---|---|---|---|---|
| | Weeks | % | Weeks | % | Weeks | % | $ | % | $ |
| 1964-65 | | | | | | | | | |
| Phoenix | 32 | 61 | 6 | 12 | 14 | 27 | 31.94 | 30.2 | 1213.60 |
| Omaha | 30 | 58 | 0 | 0 | 22 | 42 | 32.94 | 31.1 | 987.62 |
| 1965-66 | | | | | | | | | |
| Phoenix | 19 | 37 | 25 | 48 | 8 | 15 | -2.75 | -2.7 | -120.78 |
| Omaha | 6 | 12 | 26 | 50 | 20 | 38 | -9.14 | -8.6 | -292.38 |
| 1966-67 | | | | | | | | | |
| Phoenix | 38 | 73 | 6 | 12 | 8 | 15 | 10.11 | 9.6 | 444.74 |
| Omaha | 24 | 46 | 16 | 31 | 12 | 23 | 2.94 | 2.7 | 117.41 |
| 1967-68 | | | | | | | | | |
| Phoenix | 39 | 75 | 0 | 0 | 13 | 25 | 33.10 | 31.2 | 1290.86 |
| Omaha | 3 | 6 | 0 | 0 | 49 | 94 | 22.81 | 21.6 | 68.42 |
| 1968-69 | | | | | | | | | |
| Phoenix | 27 | 52 | 6 | 12 | 19 | 36 | 39.23 | 37.0 | 1294.55 |
| Omaha | 19 | 37 | 0 | 0 | 33 | 63 | 33.19 | 31.4 | 630.60 |
| 1969-70 | | | | | | | | | |
| Phoenix | 11 | 21 | 2 | 4 | 39 | 75 | 12.77 | 12.1 | 165.95 |
| Omaha | 5 | 10 | 1 | 2 | 46 | 88 | 12.09 | 11.4 | 72.51 |
| 1970-71 | | | | | | | | | |
| Phoenix | 14 | 27 | 0 | 0 | 38 | 73 | 33.66 | 31.8 | 471.20 |
| Omaha | 6 | 12 | 0 | 0 | 46 | 88 | 23.58 | 22.3 | 141.49 |
| Totals | | | | | | | | | |
| Phoenix | 180 | 49 | 45 | 13 | 139 | 38 | 21.16 | 20.0 | 4760.12 |
| Omaha | 93 | 25 | 43 | 12 | 228 | 63 | 12.69 | 12.1 | 1725.67 |

[a/] Costs based on an average investment of $250 per animal. This is a net return above all costs excluding a market interest charge on investments.

[b/] Based on one animal placed on feed in any given week.

weeks with 29 of these resulting in losses. The weeks not feeding ranged from 12 to 46 and from eight to 39 for the Omaha and Phoenix markets, respectively. For the total period studied, feeding occurred under the model in 37 percent of the weeks for the Omaha market and 62 percent for the Phoenix market.

Feeding without protection of the hedge produced somewhat different results (Table 12). Since the decision to feed or not to feed was made using the same model for both the hedging and non-hedging methods, the resulting number of weeks not feeding are the same for both methods. Only the number of weeks of profit and loss show any difference as far as numbers of cattle are concerned. The net revenues per animal and the rates of return also differ for the two methods.

In the Phoenix market feeding without hedging reduced the number of weeks showing profits by 16 to 180 or 49 percent of the possible feeding weeks. The weeks showing losses, during which cattle were placed on feed, increased by 16 to a total of 45. In the Omaha market the weeks of profit decreased from 125 to 93, and the weeks of losses increased by a like amount to 43.

Net revenues per head ranged from -$2.75 and -$9.14, respectively, for the Phoenix and Omaha markets in 1965-66 to $39.23 and $33.19 in 1968-69. For the whole period, net revenue per head was nearly $7 more with the non-hedge strategy in the Phoenix market but remained exactly the same for the Omaha market at $12.69. The average rate of return for the Phoenix market was 20 percent without hedging versus 13.5 percent using the hedge. Therefore, the custom feeder made no gains in the Omaha market by not hedging, but did increase his income variability and his risk. In the Phoenix market, net returns were significantly higher without hedging. Since there was only one year with an absolute loss, the results would not appear to support hedging as a strategy, even for custom feeders in this area, at least with the decision model employed in this analysis.

The processes described above are subject to error even though the hedge strategy reduced risks substantially and the non-hedge strategy produced some higher net revenues per head. The basis differential may exceed the limits set by the model and result in some loss, though small. Cost estimates may be in error due to the high variability between lots of cattle, even when fed by the same feedlot owner or manager. If costs are overestimated, profits may be foregone since the model may indicate losses are to be expected. If costs are underestimated, feeding may occur when it should not have been undertaken.

The model may be made more restrictive, especially if costs can be fairly accurately predicted. For example, a minimum rate of return on investment could be incorporated. This would reduce the number of cattle placements and the gross income per period but would raise the rate of return on investments made, if that is a critical factor.

# V. Feeder Reaction

**Questionnaire Responses**

Information on the use of the live cattle futures market by Arizona-California cattle feeders was gathered by mailing 300 questionnaires to cattle feeders in both states. There were 30 responses from Arizona feedlot owners, 65 from California, and 10 from feeders who did not own feedlots, for a total of 105 completed questionnaires. Although only 35 percent of the feeders responded, they accounted for 69 percent of the cattle on feed in California and 75 percent of the cattle on feed in Arizona.

About 20 percent of the respondents had a feeding capacity below 4,000 head, 50 percent had between 4,000 and 16,000 head, 20 percent were above 16,000 head, and 10 percent were non-owners. Eleven or approximately 10 percent of the respondents had warm-up operations. The responses indicate custom feeding and forward contracting increases as the size of the feedlot increases.

A total of 59 respondents indicated that they had traded on the live cattle futures market at least once. Live cattle futures was the first futures commodity traded by 33 or approximately 55 percent of these. Thus, a fairly large number of the Arizona-California feeders had little or no previous experience with futures trading.

The larger feedlots indicated more use of the live cattle futures market than the small ones. For feedlots of a capacity of 8,000 head or more, approximately 70 percent of the respondents had traded on the live cattle futures market compared to 40 percent of feeders with capacities below 8,000. Also, a greater number of the feedlots over 8,000 head had previous experience trading on other commodity futures markets.

Only 28 of the feeders who had traded at least once on the live cattle futures market were still using it and only 36 planned to use it in the future. Of the 23 feeders who discontinued using the market, 14 said they had lost money by hedging their cattle.

Only 18 feeders had traded on the Western live cattle futures market when it was in operation, 16 in California and two in Arizona. Forty feeders thought a Western live cattle contract was needed and 46 indicated they would use it, if an active Western contract existed. This suggests that a large percentage of the trading on a Western live cattle contract would have to be speculators since there would be only modest support from cattle feeders for hedging purposes. This is especially true of Arizona feeders as only seven indicated they would use the Western contract if one existed.

When asked to classify themselves as either speculators or hedgers, eight considered themselves speculators, 23 considered themselves hedgers, and 28 indicated that they participated as both. Of the 51 who participated as hedgers, 48 attempted to hedge selectively (i.e., hedge only at certain times when they thought that it would increase their profits).

From a list of 10 reasons for not using the live cattle futures market for hedging, the reason most often given was that the Midwest contract did not provide an effective hedge for Western feeders. The second reason most often given was that it would be too costly to make delivery of cattle when the contract came due. The responses to this question indicated that many Arizona-California feeders admittedly did not understand enough about the live cattle futures market or were just not interested in the market. There were seven feeders who did not know a live cattle futures market existed.

The reason most often given for using the live cattle futures market for hedging was that it reduced price risk in cattle feeding. Only 13 indicated that hedging allowed them to increase their profits, while five indicated that hedging allowed them to obtain needed credit.

## Implications

In answering the question of why the Western Live Cattle Contract was unsuccessful, a theory presented by Working [13] must be examined. This theory is concerned with the question of need for concentration of trading in futures markets. While it would seem hedgers would be served best by having numerous futures exchanges and several different contracts in each, this does not prove true in reality. The reason seems to lie in the cost of hedging.

There are two aspects of the cost of hedging. One is the commission charge that is paid for the futures transaction. The second cost occurs from the fact that a hedger must sell futures at bid prices and buy futures at ask prices. Traders making numerous trades must sell at bid prices and buy at ask prices and are referred to as day traders or scalpers. These traders buy and sell a large volume of futures at a small margin in order to make a profit. This margin becomes the second aspect of the cost of hedging.

On an inactive futures market, a scalper's margin must be high since the volume of business is restricted to a limited number of transactions per day. Additionally, a position must be held in the market for several hours or even days, whereas in an active market, buying and selling can occur in a matter of minutes, thereby reducing the risk involved. The higher scalper's margin required in the relatively inactive market makes hedging more costly. Consequently, if a hedger has two futures markets to choose between, he will choose the most active.

When the Western contract was initiated, the Midwest contract was already actively traded. Therefore, even though the Western contract applied more closely to the quality of the cattle being fed in Arizona-California feedlots and was nearer the location where the cattle were being fed, an Arizonan would most likely choose to hedge on the Midwest contract because it was already an active market. This theory was supported by the responses of the feeders and rationalizes their actions in failing to support the Western contract.

Many feeders argue that they do not need the futures market for risk reduction since they use a system of averaging to reduce the effects of market uncertainty. Under this system, the feeder tries to maintain a fairly constant number of cattle on feed with about the same number being sold each week. If this is actually done, the feeder will receive average returns, with equal weight to market highs and lows. The relative merits of this system are supported also by the analysis of the various strategies as given in this report. Attempts to improve on the "averaging" process through the use of hedging would require a fairly sophisticated model of prediction in order to hedge on a selective basis. A non-selective hedge results in a relatively high cost to the feeder.

It is not apparent, however, that feeders either can or do feed continuously with an even number for sale each week. Availability of feeders, conditions of climate, systems of financing, among other factors, cause variability in the numbers on feed during the year in any given lot. Most large lots operate on a custom feeding basis which means they are vulnerable to availability of outside capital. Therefore, both feedlot owners and custom feeders probably have a relatively high variability in the numbers on feed at any one time. Similarly, small lot owners tend to feed for sale on a two or three times a year basis. Under these conditions, the futures market may provide an important means of reducing risk and of maintaining financial solvency. At least its possibilities should be investigated for each situation at the time the decision is being made to place cattle on feed.

# VI. Summary and Conclusions

Analysis of the results of the decision models revealed that different market conditions existed for the two different time periods under consideration. The first time period exhibited relatively little price fluctuation with the futures price available for hedging at the time cattle were placed on feed generally exceeding the cash price received at the time cattle were ready for sale, thereby assuring the hedger a higher price than the market provided at the time of delivery. The second time period was characterized by more widely fluctuating prices with an upward trend. The futures price usually underestimated the fat cattle price, thereby locking in a lower price for a hedged position. A feeder may reduce the risk of loss but has essentially lost a chance to realize maximum profit and should the cost of production exceed this futures price, a loss is assured.

The analysis via the strategies described earlier supports the above observations. For the first part of the analysis, the variance for revenues was substantially less for all strategies than in the second period. In both market areas and time periods, the complete hedge of Strategy 2 and the selective hedge of Strategy 3 resulted in lower revenues and lower variances than the other two strategies. In period one, Strategy 4, with a hedge based on price indexes as a predictor, resulted in the highest average net revenues. Strategy 4 also provided the lowest probability of sustaining losses in a given week.

Analysis of the first time period suggested that Strategy 4, a selective hedge based on a projected slaughter price, would provide the best results. Since income differences to the non-hedge strategies were not large, the lower risk levels provided an advantage, especially for individuals with limited credit availability to cover periods of losses.

The results, using the same decision strategies, in the second time period, do not support the above conclusion, however. While the variance of revenue in the non-hedge strategy was large, average revenue per head was also significantly larger, in both market areas, than for any other strategy. In addition, the probability of loss occurring was lower for the non-hedge program. The complete hedge and the hedge based on costs produced much lower revenues. The results of the latter strategy improved when costs of feeding used were increased, thereby reducing the number of hedged positions, but it did not change the conclusion as to the best plan for that time period.

The results from using the "no risk" strategy suggest that profits may be made with little risk involved.

However, all losses cannot be eliminated when using a single value as a safety factor. Losses occur when using the "no risk" alternative when the basis between the cash and futures price at the time of delivery exceeds the safety margin of $1.00 per hundredweight or $10.25 per animal. It is also possible that, should the basis be considerably less than the safety margin or if the cash price is greater than the futures price, then often the decision not to feed will be made when, in fact, a decision to feed may have produced a profit. This may explain the limited number of weeks cattle were placed on feed for the last four years in the Omaha market and for the last two years in the Phoenix market. A method involving different error or safety margins for each season or month, based on past experience, should help reduce losses and improve profits.

Several conclusions may be drawn from the analysis. First, except under special market circumstances, there does not appear to be any justification to hedge all feeding and, in fact, such a strategy may result in lowered returns over time, in addition to reducing risks, relative to the non-hedge system. Second, there is no evidence to support the hypothesis that feedlot operators in the West are at a disadvantage to Omaha feeders relative to the use of the futures market for hedging. There is, however, an indication that feeders located near the Chicago market may have enjoyed some advantage over the other markets in question due to a relatively small basis differential. Third, the feeder that feeds and hedges, only if the projected returns exceed the costs of feeding, may expect to make profits for several consecutive weeks at a time, with little risk involved, if he estimates the cost of feeding closely.

The evidence and conclusions also help explain the failure of the Western contract. The survey data gathered in 1968 indicated part of the failure appeared to be lack of understanding by Western feeders of the futures market and the shortage of speculative interest. The analysis suggests, however, that Western feeders could use the Midwest contracts for hedging their operations as well as Midwest feeders can.

The system of market averaging and of financing feeder cattle in the larger Western feedlots provides advantages which eliminated the need for hedging from their point of view. The study supports this position for the second period of the analysis but not for the first. This results from a tendency of the futures price to lag with respect to movements in cash prices. Assuming this situation continues to persist the probability of increasing returns, as well as reducing risk through hedging, will be greatest on declining markets. Losses are more likely to result from hedging on rising markets. In either case hedging, if used, should be used selectively and the more sophisticated the system of future cash price prediction employed to assist in selection of the correct strategy, the better the results will be.

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# Appendix

Table 1. Monthly Volume of Live Cattle Futures Contracts Traded with Annual Totals, All Contract Months.

| Year | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1964 | a | a | a | a | a | a | a | a | a | a | 191 | 1,386 | 1,577 |
| 1965 | 1,081 | 1,943 | 3,012 | 3,760 | 6,059 | 9,144 | 4,964 | 5,185 | 2,866 | 3,786 | 3,126 | 14,397 | 59,291 |
| 1966 | 15,327 | 12,680 | 15,402 | 11,306 | 7,510 | 12,262 | 10,405 | 20,636 | 12,557 | 16,810 | 19,009 | 17,242 | 170,798 |
| 1967 | 32,357 | 27,584 | 22,596 | 20,175 | 27,056 | 25,497 | 21,544 | 21,838 | 31,691 | 27,067 | 20,362 | 21,999 | 299,787 |
| 1968 | 25,961 | 31,906 | 21,080 | 25,507 | 15,812 | 16,920 | 17,586 | 16,575 | 10,838 | 18,861 | 20,004 | 32,058 | 253,108 |
| 1969[b] | 35,316 | 46,633 | 109,670 | 88,523 | 102,305 | 125,692 | 153,733 | 123,654 | 69,984 | 70,452 | 27,784 | 59,925 | 1,013,671 |
| 1970 | 41,878 | 38,574 | 66,030 | 71,341 | 68,865 | 69,003 | 36,902 | 50,736 | 28,602 | 32,910 | 26,978 | 46,995 | 578,817 |
| 1971 | 73,200 | 86,533 | 64,131 | | | | | | | | | | |

[a]No contract for live cattle.

[b]Par delivery unit increased from 25,000 pounds to 40,000 pounds effective with August, 1969 delivery.

Source: Chicago Mercantile Exchange Yearbook, 1970-71.

Table 2. Costs per Pound of Gain--Yearling Steers, Arizona

| Item | Size Category[a] I | II | III |
|---|---|---|---|
| Depreciation | .96 | .45 | .33 |
| Taxes, interest, insurance | .86 | .52 | .34 |
| Total fixed costs | 1.82 | .97 | .67 |
| Salaries and wages | 1.73 | 1.30 | 1.10 |
| Utilities | .22 | .19 | .15 |
| Gas, oil, grease | .19 | .11 | .10 |
| Repairs | .41 | .23 | .27 |
| Vet. fees | .31 | .15 | .24 |
| Nutrition services | .00 | .02 | .06 |
| Legal and accounting | .02 | .06 | .03 |
| Trucking and freight | .06 | .10 | .01 |
| Promotion | .00 | .01 | .01 |
| Other costs | .10 | .11 | .07 |
| Death loss[b] | .49 | .49 | .49 |
| Interest on cattle in lot[c] | 1.45 | 1.42 | 1.41 |
| Feed costs[d] | 17.44 | 17.44 | 17.44 |
| Total variable costs | 22.42 | 21.63 | 21.38 |
| Total cost/lb. of gain | 24.24 | 22.60 | 22.05 |

[a]Size category I is less than 4,000 capacity; size category II is 4,000 to 10,000 capacity, size category III is 10,000 to 26,000 capacity. Custom fed cattle are fed in a 10,000 to 26,000 capacity lot with a charge of $10 per ton of feed fed.

[b]One percent death loss valued at 26 cents per pound for an 800-pound steer.

[c]Interest on feeders valued at 26 cents per pound plus interest on costs of gains. Interest is a seven percent per year rate.

[d]Feed cost calculated assuming an average price of feed at $46.49 a ton and a 1 to 7.5 conversion ratio.

Source: Progressive Agriculture in Arizona, College of Agriculture, University of Arizona, Vol. XX, No. 6, pp. 20-21, November-December 1968.

Table No. 3. Chicago-Omaha Choice 900-1100 Pound Steers - Monthly Slaughter Price Indexes[a/]

| | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1959 | | | | | | | | | | | | 94.40 |
| 1960 | 98.06 | 100.70 | 106.15 | 105.56 | 105.10 | 98.94 | 96.66 | 93.85 | 93.93 | 95.55 | 101.58 | 105.22 |
| 1961 | 109.90 | 105.32 | 102.61 | 100.16 | 94.08 | 91.87 | 92.19 | 97.75 | 97.92 | 97.85 | 100.59 | 102.43 |
| 1962 | 101.77 | 102.77 | 103.37 | 103.10 | 96.17 | 92.23 | 95.14 | 100.69 | 108.16 | 107.51 | 111.18 | 107.84 |
| 1963 | 103.15 | 95.84 | 92.58 | 94.65 | 92.11 | 94.03 | 103.46 | 104.89 | 107.47 | 103.30 | 101.90 | 98.26 |
| 1964 | 100.13 | 97.10 | 97.19 | 94.71 | 90.14 | 93.04 | 99.87 | 106.72 | 108.95 | 103.73 | 101.00 | 96.40 |
| 1965 | 96.38 | 95.41 | 96.62 | 99.72 | 104.44 | 105.27 | 101.01 | 101.95 | 99.77 | 98.10 | 97.00 | 96.75 |
| 1966 | 98.83 | 102.49 | 107.44 | 104.07 | 100.00 | 95.38 | 95.43 | 97.15 | 98.13 | 97.33 | 96.83 | 96.84 |
| 1967 | 100.24 | 98.38 | 96.65 | 95.37 | 97.85 | 99.10 | 100.39 | 101.75 | 101.81 | 100.22 | 97.44 | 95.95 |
| 1968 | 98.61 | 101.31 | 101.85 | 100.58 | 98.52 | 98.42 | 97.91 | 97.99 | 97.86 | 98.08 | 98.61 | 98.10 |
| 1969 | 97.59 | 97.20 | 99.50 | 98.48 | 100.00 | 111.73 | 104.76 | 100.53 | 95.37 | 92.76 | 91.35 | 92.93 |
| 1970 | 95.15 | 99.93 | 105.19 | 103.23 | 99.63 | 103.81 | 104.81 | 100.17 | 97.33 | 93.82 | 89.25 | 88.04 |
| 1971 | 97.61 | 104.28 | 102.70 | 103.69 | 102.98 | 99.41 | 98.60 | 98.95 | 96.53 | 95.31 | 99.30 | |
| 12 year Average | 99.75 | 100.08 | 100.99 | 100.27 | 98.42 | 98.53 | 99.24 | 100.31 | 100.61 | 98.93 | 98.84 | 97.76 |

[a/] Chicago prices employed in calculation of index numbers prior to March 1969; Omaha slaughter prices were used thereafter.

Table 4. 5-Year Moving Average of Monthly Slaughter Cattle Price Indexes, Chicago and Omaha.[a/]

| | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60-64 Average | 102.60 | 100.35 | 100.38 | 99.64 | 95.52 | 94.02 | 97.46 | 100.78 | 103.29 | 101.59 | 103.25 | 101.63 |
| 61-65 Average | 102.27 | 99.29 | 98.47 | 98.47 | 95.39 | 95.29 | 98.33 | 102.40 | 104.45 | 102.10 | 102.33 | 102.03 |
| 62-66 Average | 100.05 | 98.72 | 99.44 | 99.25 | 96.57 | 95.99 | 95.99 | 102.28 | 104.30 | 101.99 | 101.58 | 100.34 |
| 63-67 Average | 99.75 | 97.84 | 98.10 | 97.69 | 96.91 | 97.36 | 100.03 | 102.49 | 103.23 | 100.54 | 98.83 | 99.22 |
| 64-68 Average | 98.84 | 98.98 | 99.95 | 98.98 | 98.19 | 98.24 | 98.92 | 101.11 | 101.30 | 99.49 | 98.18 | 96.84 |
| 65-69 Average | 98.33 | 99.00 | 100.41 | 99.63 | 100.16 | 101.98 | 99.90 | 99.87 | 98.59 | 97.29 | 96.25 | 96.81 |
| 66-70 Average | 98.10 | 99.90 | 102.13 | 100.34 | 99.20 | 101.69 | 100.66 | 99.52 | 98.10 | 96.44 | 94.70 | 96.11 |
| 67-71 Average | 97.86 | 100.26 | 101.18 | 100.26 | 99.80 | 102.49 | 101.29 | 99.88 | 97.78 | 96.04 | 95.19 | |

[a/] Chicago prices employed in calculation of index prior to March 1969; Omaha prices used thereafter.

Table 5. Phoenix Choice 900-1100 Pound Steers - Monthly Price Indexes.

| | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1959 | | | | | | | | | | | | 97.16 |
| 1960 | 99.24 | 99.31 | 101.62 | 104.87 | 106.47 | 103.74 | 101.34 | 98.38 | 96.10 | 92.37 | 93.98 | 102.97 |
| 1961 | 104.04 | 103.35 | 102.01 | 100.00 | 96.16 | 95.16 | 96.50 | 100.17 | 99.30 | 97.22 | 95.21 | 100.44 |
| 1962 | 102.26 | 102.33 | 103.72 | 102.79 | 102.11 | 98.25 | 97.01 | 99.17 | 101.44 | 101.42 | 104.89 | 106.28 |
| 1963 | 106.59 | 102.61 | 94.06 | 94.61 | 90.98 | 95.59 | 107.03 | 105.97 | 104.84 | 100.69 | 95.03 | 93.21 |
| 1964 | 99.25 | 96.37 | 101.51 | 98.62 | 92.08 | 99.56 | 103.57 | 102.94 | 102.85 | 98.52 | 96.69 | 97.63 |
| 1965 | 96.95 | 94.70 | 95.64 | 100.49 | 105.63 | 109.51 | 107.32 | 101.48 | 97.79 | 93.19 | 90.31 | 93.29 |
| 1966 | 98.75 | 105.94 | 111.99 | 105.35 | 101.68 | 100.31 | 97.75 | 97.97 | 98.78 | 94.91 | 94.21 | 100.80 |
| 1967 | 101.03 | 98.38 | 97.88 | 98.75 | 98.13 | 103.29 | 103.60 | 101.89 | 102.80 | 98.13 | 95.49 | 97.78 |
| 1968 | 97.74 | 98.99 | 100.56 | 100.26 | 101.38 | 102.67 | 103.25 | 101.51 | 98.10 | 93.88 | 95.43 | 95.61 |
| 1969 | 94.92 | 95.08 | 100.17 | 103.01 | 111.22 | 115.26 | 109.18 | 99.77 | 94.38 | 89.40 | 90.89 | 97.12 |
| 1970 | 96.94 | 98.65 | 107.06 | 102.68 | 101.24 | 106.63 | 105.76 | 99.79 | 96.17 | 93.55 | 90.58 | 90.68 |
| 1971 | 97.82 | 107.16 | 103.73 | 103.66 | 103.99 | 100.09 | 97.05 | 97.77 | 96.47 | 95.54 | 100.41 | |
| Average | 99.63 | 100.24 | 101.66 | 101.26 | 100.92 | 102.72 | 102.94 | 100.81 | 99.32 | 95.75 | 95.27 | 97.75 |

Table 6. Five-Year Moving Average of Monthly Slaughter Cattle Price Indexes - Phoenix.

| | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60-64 Average | 102.28 | 100.79 | 100.58 | 100.18 | 97.56 | 98.46 | 101.09 | 101.33 | 100.91 | 98.04 | 97.16 | 100.01 |
| 61-65 Average | 101.82 | 99.87 | 99.39 | 99.30 | 97.39 | 99.61 | 102.28 | 101.95 | 101.24 | 98.21 | 96.43 | 100.11 |
| 62-66 Average | 100.89 | 100.39 | 101.38 | 100.37 | 98.50 | 100.64 | 102.54 | 101.51 | 101.14 | 97.75 | 96.23 | 98.17 |
| 63-67 Average | 100.51 | 99.60 | 100.22 | 99.56 | 97.79 | 101.67 | 101.71 | 102.05 | 101.41 | 97.09 | 94.35 | 98.22 |
| 64-68 Average | 98.74 | 98.88 | 101.52 | 100.69 | 99.78 | 103.07 | 103.10 | 101.16 | 100.06 | 95.58 | 94.41 | 96.54 |
| 65-69 Average | 97.88 | 98.62 | 101.26 | 101.57 | 103.61 | 106.21 | 104.22 | 100.52 | 98.37 | 93.76 | 93.27 | 97.62 |
| 66-70 Average | 97.88 | 99.41 | 103.54 | 102.01 | 102.73 | 105.64 | 103.91 | 100.17 | 98.46 | 93.83 | 93.32 | 97.52 |
| 67-71 Average | 97.69 | 99.65 | 101.89 | 101.67 | 103.19 | 105.59 | 103.77 | 100.15 | 97.58 | 94.10 | 94.56 | |

Table 7. Results of t-tests, 12/4/64 - 8/3/68

| Between Strategies | Chicago | Omaha | Phoenix |
|---|---|---|---|
| Strategies 1 & 2 | t = 1.41 | t = 1.70(90%) | t = 1.24 |
| Strategies 1 & 3 | t = 0.93 | t = 0.95 | t = 1.20 |
| Strategies 1 & 4 | t = 1.86(90%) | t = 0.59 | t = 0.79 |
| Strategies 2 & 3 | t = 1.03 | t = 1.03 | t = 0.25 |
| Strategies 2 & 4 | t = 4.36(99.9%) | t = 2.84(99%) | t = 2.33(98%) |
| Strategies 3 & 4 | t = 3.49(99.9%) | t = 1.94(90%) | t = 2.35(98%) |

| Between Markets | Chicago-Omaha | Chicago-Phoenix | Omaha-Phoenix |
|---|---|---|---|
| Strategy 1 | t = 3.41(99.9%) | t = 0.55 | t = 2.78(99%) |
| Strategy 2 | t = 5.55(99.9%) | t = 0.72 | t = 3.92(99.9%) |
| Strategy 3 | t = 5.70(99.9%) | t = 1.30 | t = 3.45(99.9%) |
| Strategy 4 | t = 5.99(99.9%) | t = 1.91(90%) | t = 4.02(99.9%) |

% = Confidence Level

Table 8. Results of F-tests, 12/4/64 - 8/3/68

| Between Strategies | Chicago | Omaha | Phoenix |
|---|---|---|---|
| Strategies 1 & 2 | F = 2.79** | F = 2.56** | F = 1.47** |
| Strategies 1 & 3 | F = 2.80** | F = 2.77** | F = 1.77** |
| Strategies 1 & 4 | F = 1.59** | F = 1.81** | F = 1.76** |
| Strategies 2 & 3 | F = 1.01 | F = 1.08 | F = 1.06 |
| Strategies 2 & 4 | F = 1.75** | F = 1.41** | F = 1.06 |
| Strategies 3 & 4 | F = 1.76** | F = 1.53** | F = 1.01 |

| Between Markets | Chicago-Omaha | Chicago-Phoenix | Omaha-Phoenix |
|---|---|---|---|
| Strategy 1 | F = 1.06 | F = 1.09 | F = 1.15 |
| Strategy 2 | F = 1.03 | F = 1.81** | F = 1.76** |
| Strategy 3 | F = 1.04 | F = 1.73** | F = 1.80** |
| Strategy 4 | F = 1.20 | F = 1.02 | F = 1.18 |

* Significant at 95% Level.

** Significant at 99% Level.

Table 9. Results of T-tests, 8/10/68 - 11/27/71.

| Between Strategies | Omaha | Phoenix |
|---|---|---|
| Strategies 1 & 2 | t = 8.41(99.9%) | t = 8.56(99.9%) |
| Strategies 1 & 3 | t = 7.28(99.9%) | t = 8.37(99.9%) |
| Strategies 1 & 4 | t = 2.10(95%) | t = 1.90 |
| Strategies 2 & 3 | t = 1.29 | t = 0.38 |
| Strategies 2 & 4 | t = 6.02(99.9%) | t = 6.15(99.9%) |
| Strategies 3 & 4 | t = 4.90(99.9%) | t = 5.94(99.9%) |

| Between Markets | Omaha-Phoenix |
|---|---|
| Strategy 1 | t = 2.46(98%) |
| Strategy 2 | t = 4.35(99.9%) |
| Strategy 3 | t = 3.19(99%) |
| Strategy 4 | t = 2.66(99%) |

% = Significance level

Table 10. Results of F-tests, 8/10/68 - 11/27/71

| Between Strategies | Omaha | Phoenix |
|---|---|---|
| Strategies 1 & 2 | F = 3.04** | F = 3.24** |
| Strategies 1 & 3 | F = 2.48** | F = 3.48** |
| Strategies 1 & 4 | F = 1.07 | F = 1.02 |
| Strategies 2 & 3 | F = 1.23 | F = 1.07 |
| Strategies 2 & 4 | F = 2.85** | F = 3.31** |
| Strategies 3 & 4 | F = 2.32** | F = 3.55** |

| Between Markets | Omaha-Phoenix |
|---|---|
| Strategy 1 | F = 1.02 |
| Strategy 2 | F = 1.09 |
| Strategy 3 | F = 1.43** |
| Strategy 4 | F = 1.07 |

* Significant at 95% Level

** Significant at 99% Level

Table 11. Basis Differences Between Phoenix and Omaha Cash Price for Fat Cattle and the Chicago Mercantile Exchange Futures Price, at Date of Delivery.

| Month Sold | 1965 | | 1966 | | 1967 | | 1968 | | 1969 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Phoenix | Omaha | Phoenix | Omaha | Phoenix | Omaha | Phoenix | Omaha | Phoenix | Omaha |
| Jan. | | | -1.70 | -1.10 | -0.32 | -0.80 | +0.29 | -0.17 | -0.52 | -0.09 |
| Feb. | | | -0.88 | -0.84 | -0.22 | -0.65 | -0.47 | -0.72 | -1.13 | -0.94 |
| March | | | +0.17 | -0.08 | -0.60 | -1.46 | -0.16 | -0.49 | -1.26 | -1.98 |
| April | | | -0.18 | -0.45 | -0.03 | -1.39 | -0.58 | -0.78 | -0.22 | -0.76 |
| May | -1.07 | -1.01 | +0.21 | -0.10 | -1.08 | -1.72 | +0.24 | -0.43 | +0.46 | -0.26 |
| June | -0.59 | -0.84 | +0.23 | -0.43 | +0.31 | -0.92 | +0.73 | -0.49 | +0.50 | -0.09 |
| July | -0.06 | -0.49 | -0.57 | -0.47 | -0.47 | -1.19 | +0.65 | -0.15 | +2.40 | +1.44 |
| Aug. | -1.37 | -0.43 | -1.08 | -0.49 | -0.96 | -0.91 | +0.19 | -0.06 | +0.19 | +0.48 |
| Sept. | -1.12 | +0.22 | -1.54 | -0.97 | -0.69 | -0.81 | +0.19 | +0.53 | -0.07 | +0.20 |
| Oct. | -2.31 | -0.91 | -1.66 | -0.95 | -0.87 | -0.87 | -1.31 | -0.33 | -1.65 | -0.69 |
| Nov. | -2.52 | -0.90 | -1.85 | -1.06 | -0.48 | -0.23 | -0.86 | -0.04 | -1.52 | -1.42 |
| Dec. | -2.70 | -1.32 | +0.23 | -1.04 | -0.34 | -0.63 | -1.59 | -1.19 | -0.37 | -1.67 |
| $\bar{X}$ | -1.47* | -0.71* | -0.72 | -0.67 | -0.48 | -0.97 | -0.22 | -0.36 | -0.27 | -0.48 |

| Month Sold | 1970 | | 1971 | | 1972 | | $\bar{X}$ | |
|---|---|---|---|---|---|---|---|---|
| | Phoenix | Omaha | Phoenix | Omaha | Phoenix | Omaha | Phoenix | Omaha |
| Jan. | -0.51 | -1.28 | -0.79 | -1.34 | -0.84 | -0.73 | -0.63 | -0.79 |
| Feb. | -1.81 | -1.19 | -0.37 | -1.06 | +0.04 | +0.57 | -0.69 | -0.69 |
| March | -1.51 | -1.72 | +0.26 | -0.23 | +0.81 | +0.53 | -0.33 | -0.78 |
| April | -0.24 | -0.65 | -0.86 | -0.85 | -0.65 | -0.58 | -0.39 | -0.78 |
| May | -0.52 | -0.76 | +0.05 | -0.20 | | | -0.24 | -0.64 |
| June | +0.44 | -0.82 | +0.62 | +0.30 | | | +0.32 | -0.56 |
| July | +0.28 | -0.35 | -0.25 | +0.33 | | | +0.28 | -0.13 |
| Aug. | -0.05 | -0.19 | -1.24 | -0.62 | | | -0.62 | -0.32 |
| Sept. | -0.03 | +0.11 | -0.36 | +0.18 | | | -0.52 | -0.08 |
| Oct. | -0.75 | -0.85 | -0.86 | -0.64 | | | -1.34 | -0.75 |
| Nov. | -0.22 | -0.78 | -1.43 | -1.59 | | | -1.27 | -0.86 |
| Dec. | +0.06 | -0.99 | +0.13 | -0.46 | | | -0.65 | -1.04 |
| $\bar{X}$ | -0.41 | -0.79 | -0.43 | -0.52 | | | -0.53 | -0.62 |

*Eight month average.

Sources: Chicago Mercantile Exchange Yearbook, 1964-1971.
Chicago Mercantile Exchange Daily Information Bulletin, Jan-Apr, 1972.
Livestock, Meat, Wool Market News, 1964-1972.
Livestock Detailed Quotations (weekly), Phoenix, Arizona, 1964.

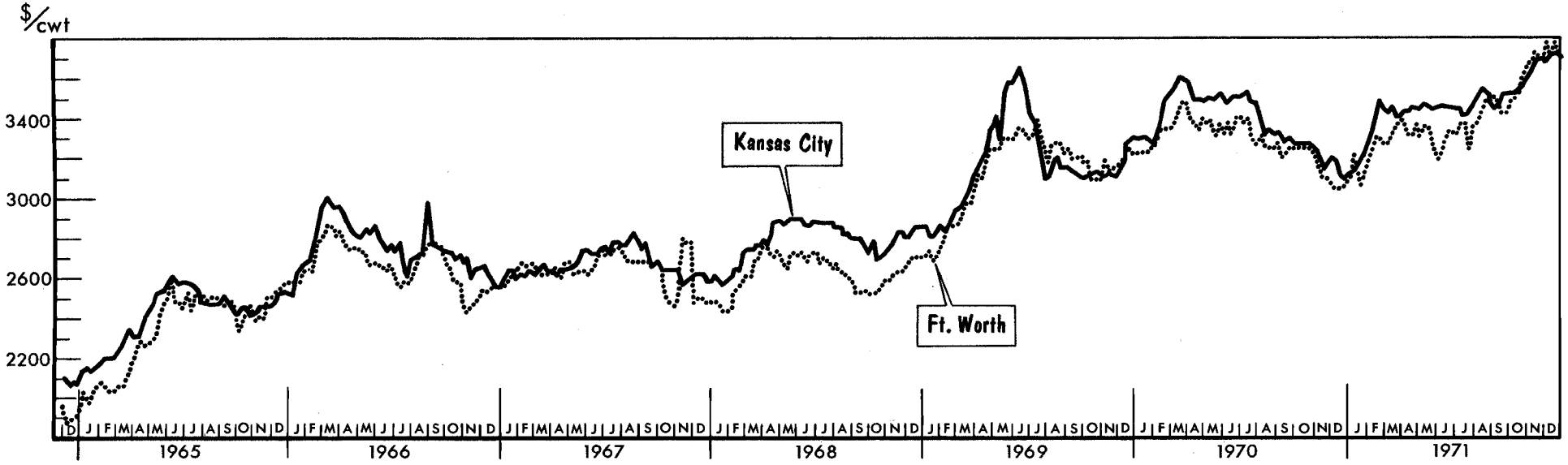


**Figure 1. Weekly Feeder Prices, Kansas City and Fort Worth, 550-750 Pound Choice Steers, 12/4/64—11/27/71**



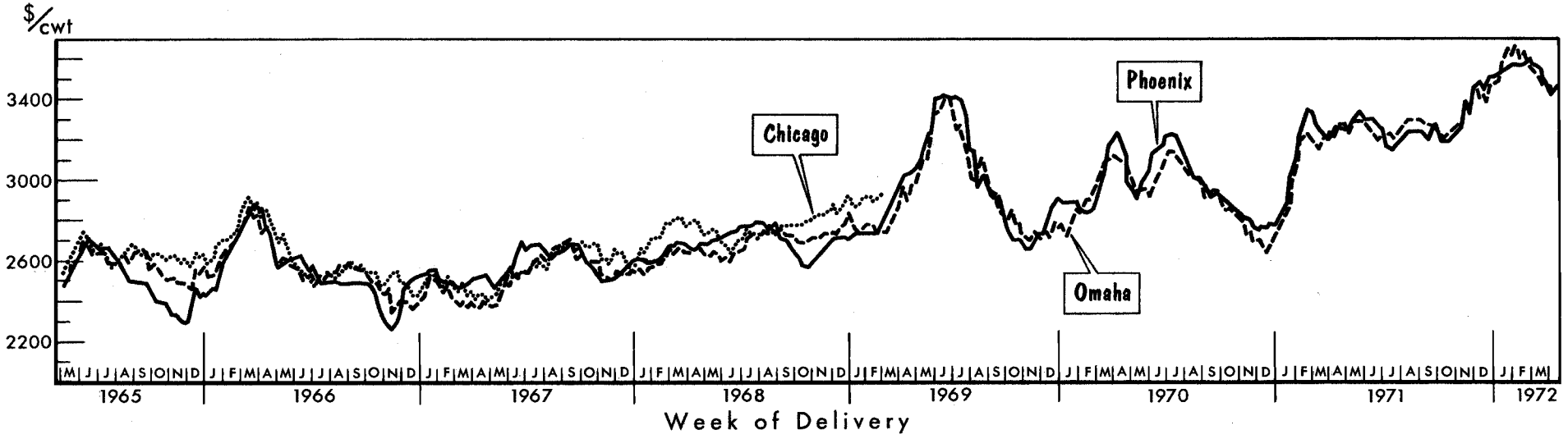


**Figure 2. Average Weekly Slaughter Price, Week of Delivery, 900-1100 Pound Choice Steers, Chicago, Omaha and Phoenix Markets.**

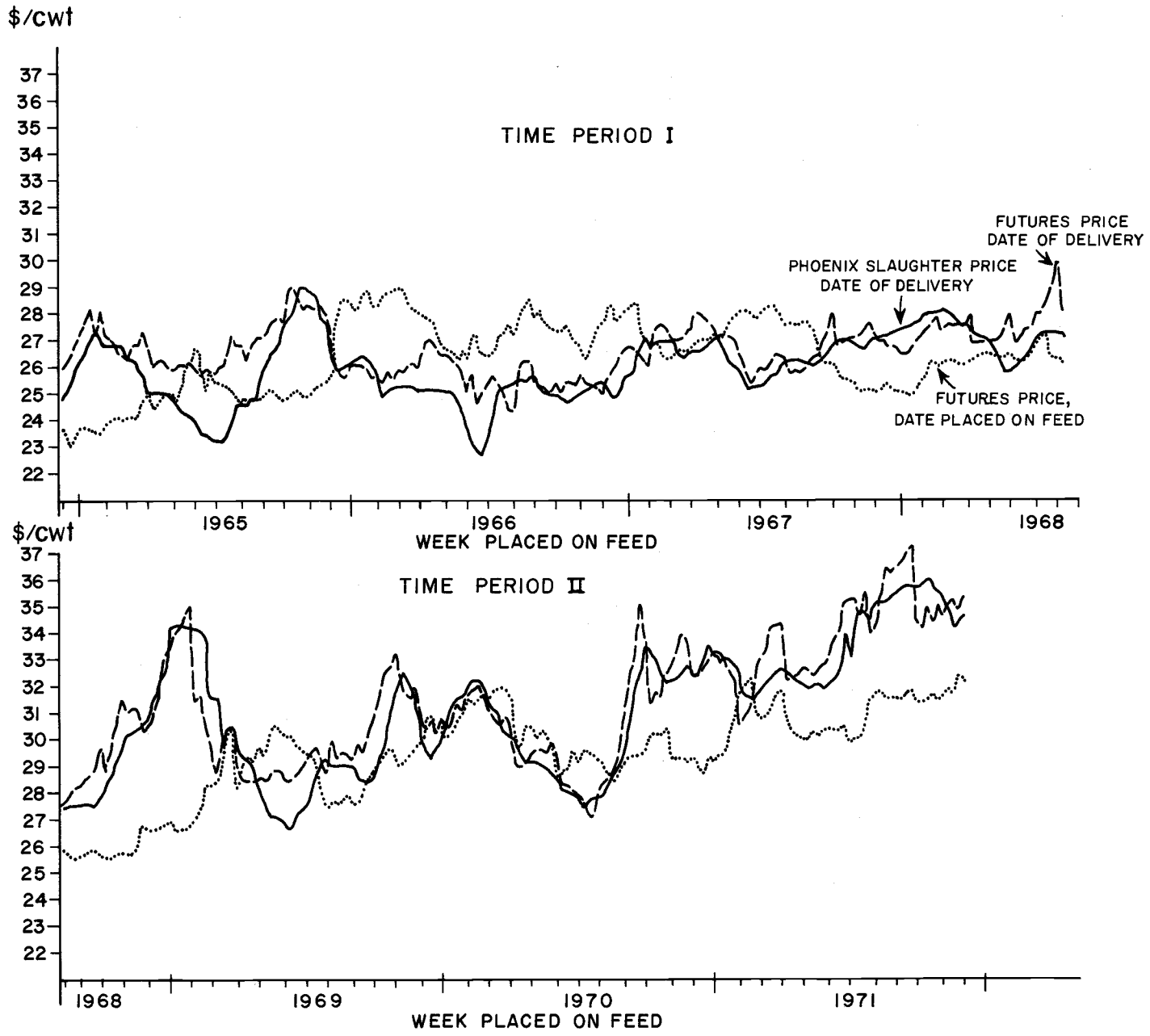


**Figure 3. Futures Prices, Week Placed on Feed and Week of Delivery, Phoenix Cash Price, Week of Delivery**