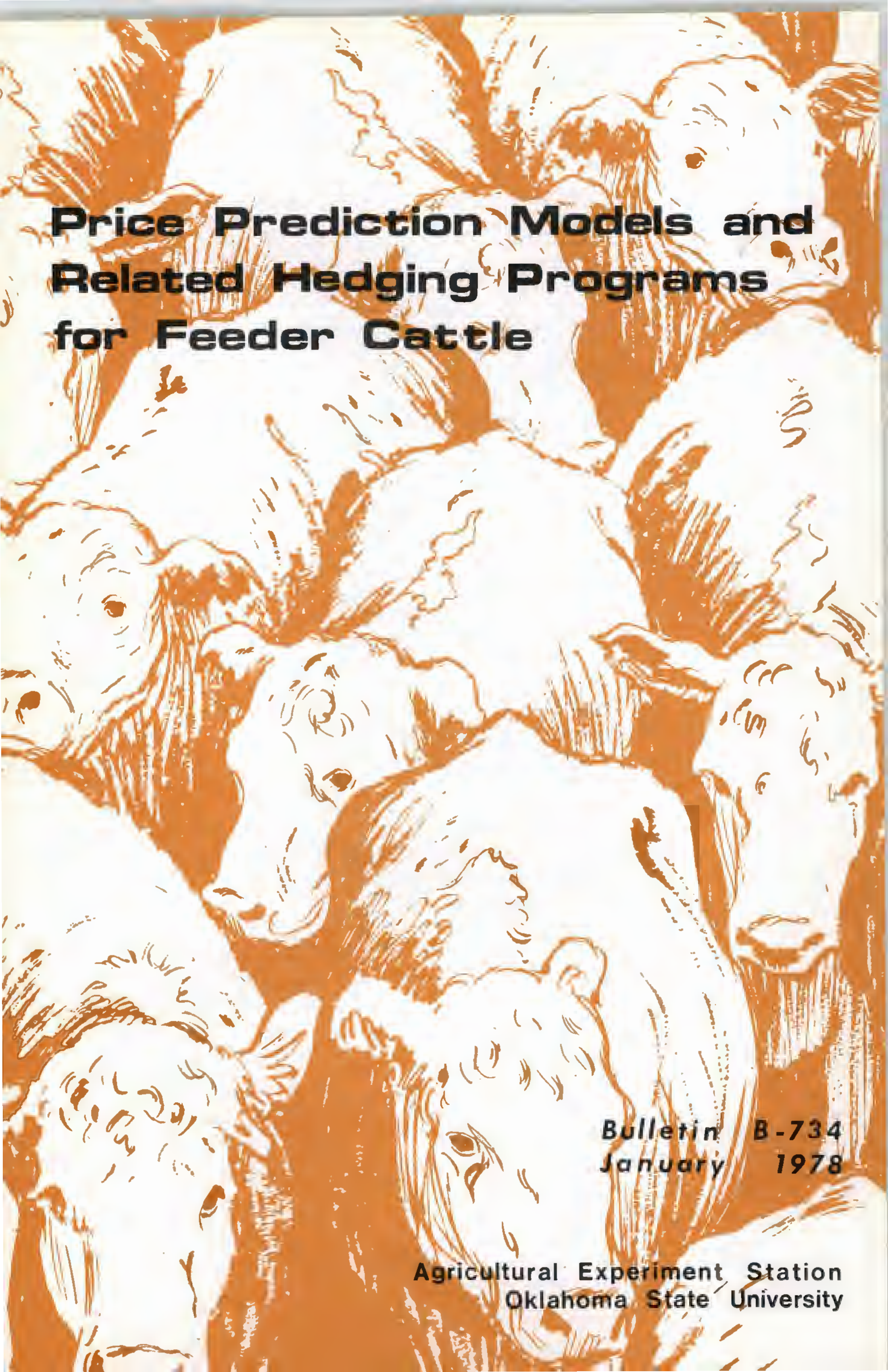

# Price Prediction Models and Related Hedging Programs for Feeder Cattle


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# Price Prediction Models and Related Hedging Programs for Feeder Cattle

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## INTRODUCTION

### Current Situation

The importance of Oklahoma as a cattle producing state has been borne out in the past few years by its consistent national ranking in the top six cattle producing states.[1] Within Oklahoma, the importance of cattle production has long been recognized as a mainstay in both the agriculture economy and also in the entire state economy. In 1975, Oklahoma agricultural production was valued at 1.734 billion dollars of which 621.3 million dollars, or 35.8 percent, was attributable to cattle production[2]. This makes production agriculture in general and cattle production in particular rank consistently in the five largest industries in Oklahoma in value of production.[3]

Each year from 1967 to 1975 cattle numbers increased in the United States and in Oklahoma. The largest increases came from 1972 through 1974. Favorable economic conditions supported these increasing cattle numbers until the last two years. Rising per capita incomes and relatively stable beef prices during the 1960s and early 1970s resulted in an increase in per capita consumption of beef from 99.3 pounds in 1965 to 116.1 pounds in 1972.[4] This apparent increase in demand, combined with an annual growth rate in the total cow herd of less than 2.5 percent and low, stable feed grain prices kept the production of beef cattle at profitable levels. However, these conditions that were favorable to the beef industry started to change in late 1972.

Annual growth rates in the cow herd in excess of three percent during the early 1970s, violatile and high feed grain prices, a recession with

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the resulting decreases in real per capita income[5] and increases in domestic per capita production of beef (up to 119.3 pounds in 1976)[6] have put beef cattle prices in a downward trend since mid-1973. As a direct result of these negative factors the liquidation phase of the cattle cycle began in late 1974. This phase, characterized by high levels of cow and nonfed slaughter, led to record commercial beef production during 1975 and 1976 which accented the downward pressure on beef prices.

## Problem Statement

The cattle industry, since the United States entered the world grain market, has been characterized by highly variable prices. Every sector of the cattle industry from the cow-calf sector to the feeder-packer sector has encountered this variability.

During the past three years the most dramatic swing in the price of feeder cattle on record was observed. Within this period, the average monthly price of 600-700 pound Choice feeder steers at Oklahoma City ranged from an all time high of $62.82 per hundredweight in August of 1973 to a low of $25.32 per hundredweight in February of 1975. Figure 1 shows feeder steer prices from July 1965 to June of 1976. This drop of $37.50 per hundredweight spanned only 18 months and in those few months the producers of not only feeder animals but all beef cattle in-

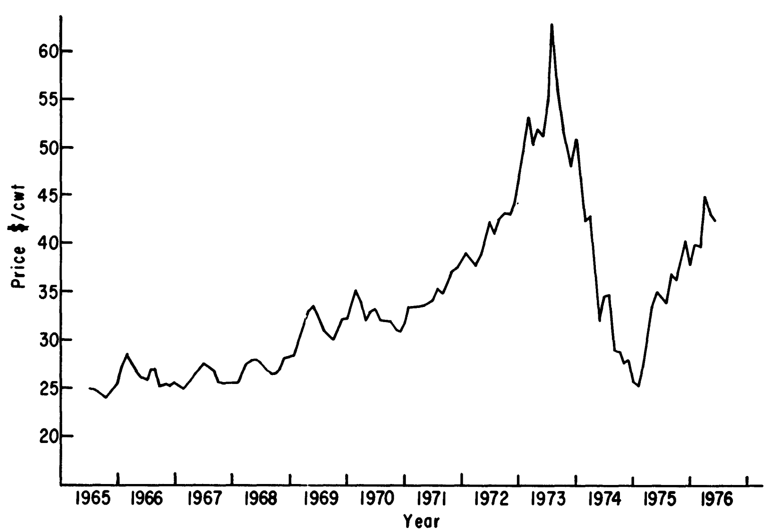


Figure 1. Choice 600-700 Pound Feeder Steer Price, Oklahoma City, 1965-1976.

curred losses unparalleled in the history of the beef industry. Profits were cut severely, but the biggest loss occurred in the reduction of inventory value. From January 1, 1974 to January 1, 1975 the farm value of the cattle inventory in Oklahoma dropped by almost a billion dollars (51.5 percent) even though there was an increase (7.9 percent) in cattle numbers[7].

This variability vividly illustrates the need cattlemen have for risk avoidance tools such as forward contracting and hedging. But decisions relating to both forward contracting and hedging, if they are to be effective, require a capacity to formulate realistic prices expectations for feeder cattle. If consistently accurate forecasts of cash feeder steer prices were readily available to the producer, each risk avoidance tool could be used to its full potential and fluctuations in income of cattle producers could be significantly decreased.

## Objectives

The general objective of this study is to formulate management tools to help in the producer's decision process. This main objective, however, consists of several steps or subobjectives. First, economic variables of significant impact on feeder cattle prices will be isolated and assembled into a conceptual framework for analysis. Next, econometric models that will quantify the impact each variable has on the price of feeder cattle will be formulated and verified and provide an analytical base for price predictions. Predictions of feeder price for a number of planning horizons, one to six months in the future, will then be calculated. Finally, these predictions along with other technical indicators will be used as criteria for implementing and testing alternative hedging strategies.

## Literature Review

Several different models and techniques for forecasting feeder steer price have appeared in the economic literature in recent years. Franzmann and Walker[8] estimated a sine-cosine function using monthly weighted average price of feeder steers at Kansas City over the period January, 1925 through December, 1969. The price series was deflated using the Index of Prices Received by Farmers for All Farm Products, 1910-14=100, to adjust for changes in relative prices among agriculture production alternatives. Useful and relatively accurate direction and changes in direction of the trend in feeder cattle price can be forecasted with the model.

Ferris[9] built an economic model to explain the average price of Good-Choice feeder steers at Kansas City in August through December of the years 1950-1972. The price of feeder cattle in year T was expressed as a function of (1) the annual average price of Choice slaughter steers at Omaha in year T, (2) the price of No. 3 Yellow Corn at Chicago in August through December of year T, and (3) the gross return from a Choice slaughter steer sold in August through December of year T less total cost of feeder steers and feed in the season beginning in August of year T-1. The model is not geared for short-run decision making, but does point out some relevant determinants of feeder cattle prices.

Davis[10], in an effort to develop a forecasting model as a decision aid for producers, formulated an equation to predict monthly prices of feeder cattle using a single logarithmic transformation. The model, using lagged independent series, expressed the logarithm of the average monthly price of Choice 600-700 pound feeder steers at Oklahoma City in month T+9 as a function of the average monthly wholesale price of Choice 600-700 pound beef carcasses at Chicago in month T, the number of thousand-head units of commercial cattle slaughtered in 48 states in month T, and the monthly commercial hog slaughter of 48 states in millions of pounds in month T.

Deviating somewhat from an econometric modeling approach, Keith[11] uses an accounting approach to predict feeder cattle price. He assumes that the demand for feeder cattle is derived from the consumer demand for beef at the retail level. With this assumption he proceeds to project average quarterly feeder steer prices for 1975-1976 from predicted slaughter steer prices.

A multitude of literature concerning the hedging and marketing of slaughter cattle is available but very little can be found on the topic of hedging and marketing of feeder cattle. Davis[12] outlines a set of decision criteria for a given set of feeder steer marketing strategies.

In an effort to evaluate alternative hedging strategies for slaughter cattle Purcell, Hague, and Holland[13] simulated the results of a cattle feeding operation over 295 feeding periods. Actual cash data were used to estimate the costs and revenues of the feeding activity. Using the unhedged operation as a base, several hedging strategies were implemented for each feeding period. Mean net returns and variances of returns for each strategy were then compared to the unhedged operation to judge the effectiveness of the strategies in reducing risk and/or increasing returns.

## Procedure

A predictive equation for feeder steer prices was estimated for each of six planning horizons, one through six months into the future. A large pool of variables related to feeder steer price was drawn from in building the price models. Final selection of the variables was based upon the economic relationships expected on theoretical grounds and the statistical properties each variable exhibited within the equations.

Verifying the predictive power of each equation was accomplished in two ways. First, the statistics of fit were subjected to scrutiny at predetermined levels of significance. Second, backcasts, which represented the predicted prices from each equation, were made over the estimation period and were plotted against actual price to illustrate the effectiveness of the models in determining not only absolute levels of price but also turning points in price movement.

Alternative hedging strategies using feeder cattle futures contracts were tested over part of the inference period of the price equations. Given a set of production situations and the planning horizons associated with each, simulated results of the performance of alternative hedging strategies are presented. Comparisons are made against an unhedged strategy to illustrate the effectiveness of the hedging strategies. The criteria used to compare the strategies are the magnitudes of risk reduction, measured by the standard deviation of returns, and magnitudes of increased returns compared to the unhedged situation. The final decision concerning which strategy the producer uses must come from the producer according to his risk-return preference and his financial position which determines his ability to carry risk.

# FORMULATION AND RESULTS OF THE FEEDER STEER PRICE MODELS

As stated in the problem statement consistently accurate predictions of feeder steer price can enhance the effectiveness of hedging decisions made by feeder steer producers. Because the ultimate objective of this study is to test alternative hedging strategies using the feeder cattle futures contract, some of which are based on price predictions, the formulation and verification of the price prediction models is a major step in the analysis.[14]

All the price prediction models are of the single equation variety and were estimated using the ordinary least squares procedure. Single equation models were chosen over a simultaneous system of equations because the main purpose of the models is to predict price and not to identify detailed supply-demand relationships or estimate structural parameters. The single equation approach offers not only ease of estimation but also ease of understanding and interpretation.

Models were built to predict price from one to six months into the future. For example, feeder steer price in month T+6 is expressed as a function of several explanatory variables in month T for the six-month model. Each of the six price models was formulated in this manner using only lagged versions of the explanatory variables; therefore, none of the explanatory variables had to be predicted.

An assumption that is implicit in using only lagged versions of the explanatory variables is that the explanatory power of that variable is not completely spent in the time period in which it was observed. Some of its impact on price, theoretically a measurable portion, is carried over into future time periods. This assumption is not a gross departure from reality since very few economic variables deposit their full impact within the time period they develop or evolve.

Another assumption which helps to simplify the estimation of the price equations is that the supply schedule observed during any one discrete time interval, a month in this instance, will be totally inelastic (Figure 2). A predetermined number of 600-700 pound Choice feeder steers go to market each month; i.e., the marketing decisions of the producer for that month will be unaltered by any price developments during the month. Any quantitative response to price changes within a

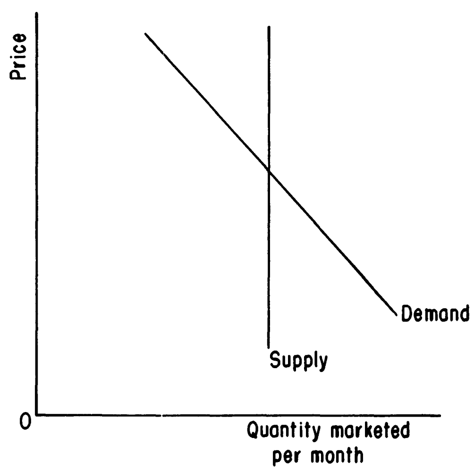


Figure 2. Illustration of Totally Inelastic Supply During a Month.

month is limited by the biological nature of production. The quantity of 600-700 pound feeder steers is essentially fixed and can be varied only by feeding rates and sell-hold decisions which change the distribution of weights within the 600-700 pound range. Since the quantity of feeder steers supplied is assumed to be predetermined during any one month, attention will be focused on the shifters of demand for feeder steers as explanatory variables in the price prediction models.

The period over which the equations were estimated covered roughly one full cattle cycle. This is desirable because each piece or phase of the cycle appears only once in the data and therefore will receive equal weight in the estimation of the price equations. The length of the most recent cycles has been from ten to twelve years. The estimation period used in this study covered eleven years, July of 1965 to June of 1976.

## The Dependent Series

A representative series of feeder steer prices was selected to serve as the dependent variable in the price equations. The Choice 600-700 pound feeder steer price series from Oklahoma City represents prices from a narrowly defined marketing category which was desired. The Oklahoma City market is one of the nation's largest feeder cattle markets and was chosen because it is an important pricing base for the entire Southwest region.

Attention will now be turned to selecting variables to explain the variation in the dependent series. It should be kept in mind as the discussion of the explanatory variables progresses that the series are lagged from one to six months to facilitate the estimation of the six price equations.

## Variables Measuring Quantity of Feeder Steers Supplied

Even though the simplifying assumption of totally inelastic supply during any one month was made, the treatment of supply was not ignored in the formulation of the price models. The major source of supply information was found in the January 1 U.S.D.A. cattle inventory reports. Inventories of several classes of cattle are reported but the two classes of interest for this study are calves—steers, heifers, and bulls—that weigh less than 500 pounds and steers that weigh more than 500 pounds.

The two series were tried separately with the same group of explanatory variables in each of the six price models. Both series improved the models explanatory power substantially but the calves series consistently outperformed the steers series. Even as the inventory of calves series was lagged from one to six months a surprisingly stable coefficient resulted within each of the models in which it was used. Since a high degree of correlation exists between these two series of data, r = .84, the steers over 500 pounds category was eliminated to avoid multicollinearity problems.

The inventory of calves can be seen as helping to set the general price level for the year. Changes in demand then cause price to deviate from the general level established by the intraction of general demand and the inventory level as an indicator of overall supply. As inventory numbers increase, theoretical expectations suggest price would yield to the pressure of increased supplies in the form of inventory. However, the theoretical expectations were not met in this particular situation.

During the course of the buildup phase of the cattle cycle increases in the cow herd get progressively larger. With the increases in cow herd size come increases in calf crop size. Cattle prices trend upward during this phase reflecting the holding of cows and heifers to build the herd and this results in positive correlation in cattle inventory numbers and cattle prices. Likewise, as liquidation of inventories occurs, prices are depressed reinforcing the positive correlation between inventory numbers and prices.

## Variables Affecting Feeder Steer Demand

Demand for feeder steers originates in two sectors, the feeding sector and the packing sector. The feeding sector, however, is by far the largest demander of feeder steers. Packer demand for slaughter purposes emerges when the price of 600-700 lb. cattle fall enough to offset the decrease in quality, dressing percentage, etc. compared to fed cattle.

### Feeding Sector Demand

In the last two quarters of 1975 when record numbers of nonfed beef were slaughtered in 48 states, the number of cattle placed on feed in the 23 major cattle feeding states was still far in excess of the nonfed slaughter. Thus, the largest component of demand for feeder steers comes from the feeding sector. But this is also the most difficult variable to explain. Placements of cattle on feed are variable and highly seasonal with the heaviest placements coming in the last quarter of the calendar year. This seasonality comes from the behavior of the corn belt cattle feeder.

A substantial portion of the cattle feeding in the U. S. still takes place in the corn belt states in farm feedlots of less than 5,000 head capacity. The only factor that seems to affect the placement decisions of this group of cattle feeders is the price of corn, their major cash grain crop. When corn price is relatively high, placements are relatively low and vice-versa. Illustrating, the smallest fourth quarter placements since 1971 occurred in 1974 when corn prices was at historical highs. The relatively low, stable corn prices in recent years have resulted in a largely fixed number of cattle placed on feed regardless of other conditions that exist in the livestock sector. This behavior of the placements variable serves to make it relatively useless in explaining variation in feeder steer price. Other variables had to be found.

Based on preliminary analysis, it was discovered that current corn price and current observations on slaughter steer price, both cash and futures, explain most of the variation in current feeder steer price. When corn price and cash slaughter steer price were lagged from one to six months the explanatory power of each waned. However, when these two variables were combined in the form of the steer-corn ratio they added significantly to the explanatory power of each model. This ratio shows the number of bushels of corn equivalent in value to one cwt. of Choice slaughter steer. The steer-corn ratio has long been used by cattle feeders as an indicator of feeding margins that might exist during the feeding period and is therefore used as a decision criterion for placement of cattle on feed. The use of a ratio of two data series instead of the series themselves helps to alleviate the multicollinearity that might exist between the data.

Again drawing on the results of preliminary analyses quotes from a relevant live cattle futures contract would be a likely candidate as an explanatory variable in the price models. This proved to be the case, but with some limitations.

The explanatory power of the futures variables was potent but could be used only in a limited number of models. The limitation arose from the fact that cattle feeders react to changes in futures prices almost immediately. For example, if the quote of a futures contract that would be used to hedge cattle that were placed on feed immediately made a move to where the feeder could lock in a profit on his cattle, he might react that very day by buying feeder cattle and placing the hedge.

Therefore, the full impact of the futures price change would be felt in the month in which the price change occurred. This makes the futures variable useful only to the nearest term model, T + 1. The futures price held a very strong positive correlation with feeder steer price because of its use as a hedging feasibility and outlook indicator for fed cattle.

A variable that was derived from the futures series was used in two of the models. This variable, which measures changes in the level of futures prices, was the ratio of the two most recent futures observations. A ratio greater than 1.0 (futures price in T greater than futures price in T-1) signifies upward trending futures prices. Feeder steer prices would be expected to move higher in response to the rising futures prices. A ratio less than 1.0 represents downward trending futures and a weakening effect on feeder steer price. In the equations estimated for extended predictions, T + 4 through T + 6, neither the futures series nor the futures ratio series added significantly to the explanatory ability of the models.

Earlier it was suggested that packer demand for feeder cattle will be a function of the price difference between slaughter steers and feeder steers. This variable cannot be classified as representing exclusively packer demand or feeding demand but can be used to help explain behavior in both sectors. For ease of coefficient interpretation a ratio of slaughter steer price to feeder steer price was used in the models. An increasing ratio suggests lower priced feeder steers relative to slaughter steers and an underlying poor outlook for slaughter steers (or rising grain prices). This poor outlook serves to curtail placements and stimulate the packer's demand for feeder steers. Since feeder demand is dominant, a negative effect on price is likely to occur. The effects of a decreasing slaughter-feeder ratio will be the opposite, a positive price effect. This inverse relationship between the ratio and price should produce a negative sign on the estimated coefficient for the ratio.

A ratio of monthly federally inspected cow slaughter to January 1 inventory of cows was used as an indicator of the level of nonfed beef slaughter. In this instance the ratio was chosen over the raw data because it was felt that cow slaughter as a fraction of cow inventory would better explain the relative magnitude and changes in magnitude of nonfed slaughter than would the absolute cow slaughter numbers. Simple correlations between price and the slaughter ratio yielded no coefficients that were significantly different from zero at the 0.05 significance level and only one that was different from zero at the 0.10 level. Therefore, the simple correlation coefficients offered no clues, *a priori,* of what signs could be expected on the regression coefficients.

High levels of nonfed slaughter could signal the liquidation phase of the cattle cycle and the subsequent downward trending prices giving a negative sign to the cow slaughter coefficients. On the other hand, those same high levels of nonfed slaughter may serve to set a floor under or actually support feeder steer prices resulting in a positive sign on the coefficient.

## Treatment of Seasonal, Cyclical, and Shock Variation

### Seasonal

Almost without exception agricultural commodities exhibit a seasonal price pattern. Dummy variables are often used in econometric analysis to account for the seasonal variation in price. However, when a seasonal dummy variable set was added to previously estimated feeder steer price equations, very little additional variation was explained. The regression coefficients were not significantly different from zero. It was first thought that the seasonal pattern in feeder steer price was being "picked up" by one or more of the explanatory variables, all of which have their own seasonal pattern. This was not necessarily the case and after scrutinizing the price series the reason for the ineffectiveness of the seasonal dummy variables became apparent.

From 1964 through 1976 the seasonal high of feeder steer price (a season being a calendar year) occurred in eight different months. June and December had the highest frequencies with highs occurring in each of these months three times. Similarly, the seasonal low of feeder steer price came in eight different months over that same thirteen year period. Again, two months, January and February, had the highest frequencies with three each. A seasonal pattern tends to be somewhat unstable when any of eight months could have the season's high or low price. It can be concluded that in this particular price series any seasonal pattern in prices is not highly stable and is therefore difficult to isolate. This would account for the inability of seasonal dummy variables to explain variation in the price series.

### Cyclical

Cyclical variation in the feeder steer price series is quite apparent. The use of dummy variables was considered to help explain this variation but it was felt that if variables already in the models could explain the pronounced cyclical variation the models would be more desirable without dummy variables.

Two variables in particular, the slaughter steer-feeder steer price ratio and the cow slaughter variable, have patterns which help to explain the cyclical variation. In the upward or building phase of the cycle prices trend upward. Feeder steer price tends to rise faster than slaughter steer price and results in relatively small slaughter-feeder price ratios. Also, in this phase a very small percentage of the cow herd is sent to slaughter as the cow herds are in a growth phase. Eventually, the growth reaches a saturation point at which available demand will no longer take the increasing production at stable or higher prices. Prices begin to fall and larger and larger percentages of the cow herd are slaughtered. The downward or liquidation phase of the cycle is signaled. Prices trend downward with feeder steer price falling more rapidly resulting in relatively larger slaughter-feeder price ratios.

### Shock

In March of 1973 the U.S. government announced the first peacetime retail price controls on red meats. The price controls lasted only about seven months, into September of 1973, but the effects of the controls resounded through the livestock industry for almost two years. Record prices for all classes of livestock were witnessed in the summer of 1973. These extremely high and volatile prices were fueled by speculation as to when the price controls would be lifted. This speculation led to massive holding action by cattle producers. The holding action invalidated the assumption that price movements during the month do not affect marketing decisions for that month. Therefore, an intercept shift dummy was introduced into the price models to explain the abnormal marketing behavior displayed by producers during and after the price freeze.

The variable has the value 1 from March of 1973 to February of 1974, otherwise its value is 0. The price controls were lifted in September of 1973 but the value 1 of the dummy variables was extended to February of 1974 to account for carryover effects of the price freeze.

## Feeder Steer Price Models

The price equations were estimated over a period of 132 monthly observations, July of 1965 through June of 1976. Each of the equations was specified and selected on theoretical criteria and on the statistical criteria of R squares and t test statistics of the estimated regression coefficients.

As a group the equations were quite significant explaining from 96.5 percent of the variation in feeder steer price in the T+1 model to 90.5 percent in the T+6 model. The equation standard deviations ranged from $1.56 per cwt. in the T+1 model to $2.60 per cwt. in the T+6 model compared with a mean price for all equations of $33.84 per cwt.

Table 1 presents the pseudonyms and definitions of the variables

**Table 1.—Description of Variables Used in Price Equations**

| | |
|---|---|
| PRICE | Monthly average price of Choice 600-700 pound feeder steers at Oklahoma City. Dollars per cwt. |
| DFREEZE | Intercept shift dummy variable for retail price freeze on red meats. Has the value of 1 from March of 1973 through February of 1974. Its value is 0 otherwise. |
| CALVES | January 1 inventory of steers, heifers, and bulls that weigh less than 500 pounds. Thousand head. |
| STR-CRN | Steer-corn ratio. Ratio of monthly average prices of Choice 900-1100 pound slaughter steers at Omaha and No. 2 Yellow Corn at Chicago. Bushels per cwt. |
| SLT-FDR | Slaughter-feeder ratio. Ratio of monthly average prices of Choice 900-1100 pound slaughter steers at Omaha and Choice 600-700 pound feeder steers at Oklahoma City. |
| FUT | Average of first five futures closes in month T + 1 of the contract that would be used to hedge 650 pound steers placed on feed in month T. Dollars per cwt. |
| FUT-RAT | Ratio of the two most recent FUT observations. $FUT_t/FUT_{t-1}$. |
| COW-SLT | Ratio of monthly Federally Inspected cow slaughter and January 1 inventory of cows and heifers that have calved. |

used in the price models. Table 2 shows the estimated equations and some statistics relevant to each.

## One Month Prediction Equation

The variables chosen for the one month model were DFREEZE CALVES, STR-CRN, SLT-FDR, and FUT. These explanatory variables explained 96.5 percent of the variation in feeder steer price, the largest of any of the models. The equation standard deviation was $1.56 per cwt. and all the estimated coefficients were significant at observed significance levels of less than 0.001 making the entire model quite acceptable using statistical criteria. Multicollinearity in the data was quite evident, however, based on examination of the simple correlation coefficients. The CALVES variable seemed to be the problem variable with significant correlations with FUT ($r=.82$), STR-CRN ($r= -.43$), and SLT-FDR ($r = .53$). The signs of the coefficients did not seem to be affected by the multicollinearity as each conformed to what was expected on theoretical grounds.

The largest residual found in the set calculated for the estimation period, —$5.67 per cwt., came in February of 1974 five months after the end of the retail price freeze. At that time the data used to calculate the

**Table 2.—Estimated Regression Equations for the One Through Six Month Feeder Steer Price Models**

| Model | Intercept | DFREEZE | CALVES | STR-CRN | SLT-FDR | COW-CLT | FUT | FUT-RAT | $R^2$ | Std.** Dev. | Durbin |
|---|---|---|---|---|---|---|---|---|---|---|---|
| T + 1 PRICE | — 5.523 | 4.198 | 0.0007087 | 0.5339 | —18.44 | | 0.7295 | | .965 | 1.56 | .923 |
| | (— 2.23)* | ( 5.45) | ( 4.92) | (14.22) | (—12.66) | | (13.52) | | | | |
| T + 2 PRICE | — 35.67 | 11.16 | 0.002448 | 0.3928 | —26.27 | | | 11.69 | .921 | 2.35 | 1.236 |
| | (— 7.13) | (13.39) | (24.90) | ( 7.42) | (—13.52) | | | (3.10) | | | |
| T + 3 PRICE | — 40.41 | 11.22 | 0.002436 | 0.4775 | —23.88 | | | 12.77 | .926 | 2.29 | 1.056 |
| | (— 8.34) | (13.95) | (25.37) | ( 9.28) | (—12.71) | | | (3.50) | | | |
| T + 4 PRICE | — 31.16 | 11.54 | 0.002361 | 0.5679 | —23.82 | 391.8 | | | .922 | 2.34 | .939 |
| | (— 9.68) | (13.86) | (23.57) | (10.65) | (—11.26) | (3.70) | | | | | |
| T + 5 PRICE | — 34.05 | 11.72 | 0.002264 | 0.6417 | —20.36 | 478.7 | | | .913 | 2.48 | .960 |
| | (— 9.48) | (13.24) | (21.25) | (11.22) | (— 8.99) | (4.25) | | | | | |
| T + 6 PRICE | — 36.67 | 12.03 | 0.002159 | 0.7289 | —15.62 | 513.3 | | | .905 | 2.60 | .780 |
| | (—10.54) | (13.01) | (19.51) | (12.10) | (— 6.54) | (4.13) | | | | | |

*Numbers in parentheses are calculated t-values of estimated coefficients.
**Compared to a mean price of $33.84 per cwt.

predicted value for February of 1974 showed a simultaneous increase in price of corn of 22 cents per bu. and slaughter steers of $9.00 per cwt. The value of STR-CRN and SLT-FDR showed sharp changes accordingly and combined to push the predicted value away from actual price. The overall predictive power of the model was impressive as can be seen from the plot of actual and predicted values from the T + 1 model in Figure 3. Price levels and changes in price were predicted most adequately. However, the price freeze period did create prediction problems even with the influence of the dummy variable present.

## Two Month Prediction Equation

Th variables contained in the two month model were DFREEZE, SLT-FDR, CALVES, STR-CRN, and FUT-RAT. Ninety-two percent of the variation in the PRICE series was explained by these variables. A significance level of 0.01 or less was observed for each estimated coefficient. These statistical properties combined with the high $R^2$ and an equation standard deviation of $2.35 per cwt. made the model a very effective price predictor. The multicollinearity problem lessened somewhat in this equation but was still prevalent. Again, CALVES was correlated significantly with STR-CRN (r= —.41) and with SLT-FDR (r = .53). The variables SLT-FDR and STR-CRN were also highly cor-

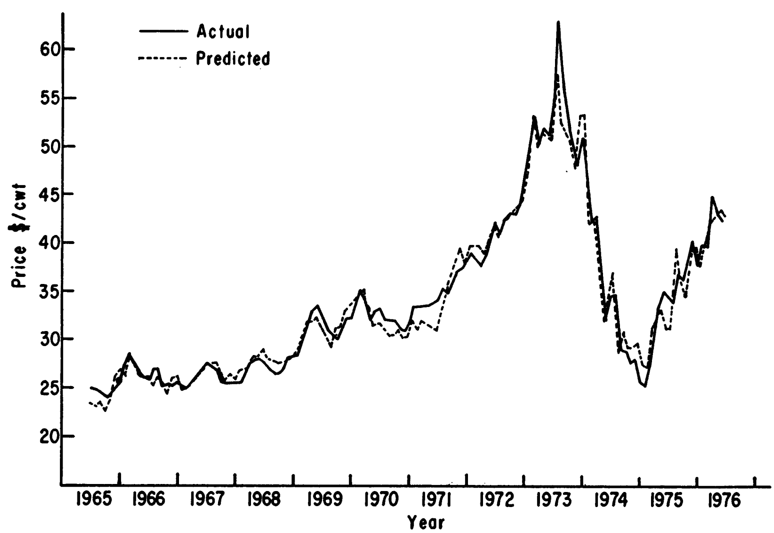


Figure 3. Choice 600-700 Pound Feeder Steer Price, Oklahoma City, 1965-1976, Actual vs. One Month Predictions.

related (r= —.55). The coefficient signs did not appear to be disturbed by the multicollinearity as all were consistent with *a priori* analysis.

A $12.55 per cwt. discrepancy, largest for this model, between the actual and predicted prices occurred during the month feeder steer price reached an all time high, August of 1973. This was also in the month before the price controls were lifted. A 40 cent per bu. price rise in corn compounded the problem presented by the price freeze and resulted in the large residual. Otherwise, the model did very well in tracking with actual prices. When a change in price directions was missed the model reacted very quickly to correct the miss as can be seen in Figure 4.

## Three Month Prediction Equation

The three month model incorporates the variables DFREEZE, CALVES, STR-CRN, SLT-FDR, and FUT-RAT. With an equation standard deviation of $2.29 per cwt., the variables explained 92.6 percent of the variation in feeder steer prices. The same multicollinearity problem found in the first two models plagued this model as well. Significant correlation coefficients existed between CALVES and STR-CRN (r=—.39), CALVES and SLT-FDR (r = .53), and STR-CRN and SLT-FDR (r=—.56). The estimated coefficient signs, however, conformed to ex-

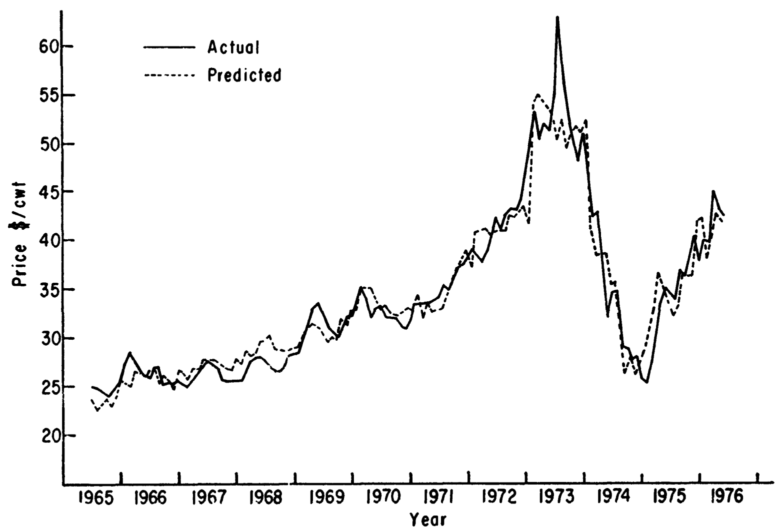


Figure 4. Choice 600-700 Pound Feeder Steer Price, Oklahoma City, 1965-1976, Actual vs. Two Month Predictions.

pectations and all had observed significance levels of less than 0.001. The freeze period produced the largest residual for the three month model. The presentation of actual and predicted prices in Figure 5 shows the model's general predictive ability over the estimation period.

## Four Month Prediction Equation

A new variable, COW-SLT, was introduced in the four month model. Along with COW-SLT, the variables DFREEZE, CALVES, STR-CRN, and SLT-FDR explained 92.2 percent of the variation in the PRICE series. The standard deviation of the equation was $2.34 per cwt. Each of the estimated coefficients had observed significance levels of less than 0.001 making the equation statistically acceptable.

The same data correlation situation existed in this equation as in the previous ones. The new variable, COW-SLT, was a problem variable correlated with CALVES ($r = .38$). Among other variables correlated with CALVES were STR-CRN ($r = -.34$), and SLT-FDR ($r = .59$). It was interesting that the correlation coefficient between PRICE and COW-SLT was not significantly different from zero ($r = .05$), but the COW-SLT regression coefficient was highly significant. This suggests multicollinearity is having an effect on the coefficients. Besides the sign on the

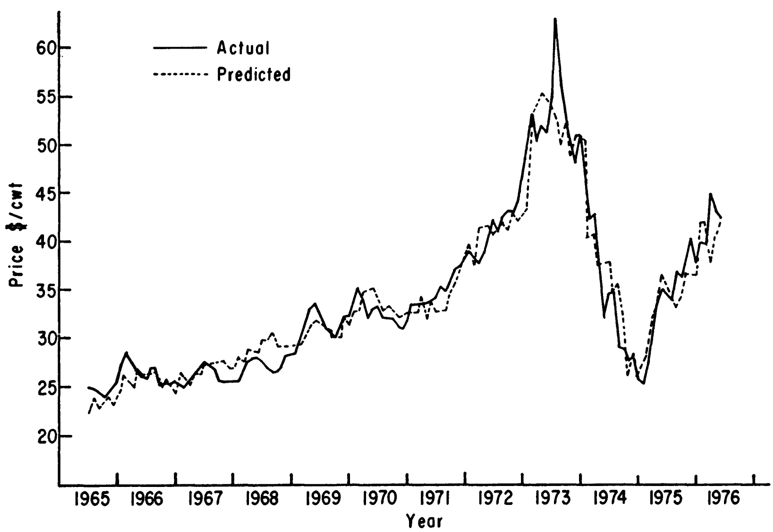


Figure 5. Choice 600-700 Pound Feeder Steer Price, Oklahoma City, 1965-1976, Actual vs. Three Month Predictions.

COW-SLT coefficient, all the signs were consistent with expectations. For COW-SLT, however, there was doubt in prior analysis as to what the sign should be. The sign in this equation was positive suggesting that large numbers of COW-SLT representing larger nonfed slaughter could have helped support feeder steer price.

The DFREEZE variable was always significant but could not always capture the entire effect of the price controls. The largest difference between actual and predicted prices again comes in the price freeze period. Except for that period, the model did an adequate job of tracking actual price as can be seen in Figure 6.

### Five Month Prediction Equation

The same variables appeared in the five month model as in the four month model, DFREEZE, CALVES, STR-CRN, SLT-FDR, and COW-SLT. The equation was statistically acceptable with an $R^2$ of .913 and a standard deviation of $2.48 per cwt. The estimated coefficients all had observed significance levels of less than 0.0001.

The same variables as in previous models exhibited multicollinearity but again the coefficients signs and magnitudes were as expected. Figure 7 presents the actual and predicted prices over the estimation period for the five month equation.

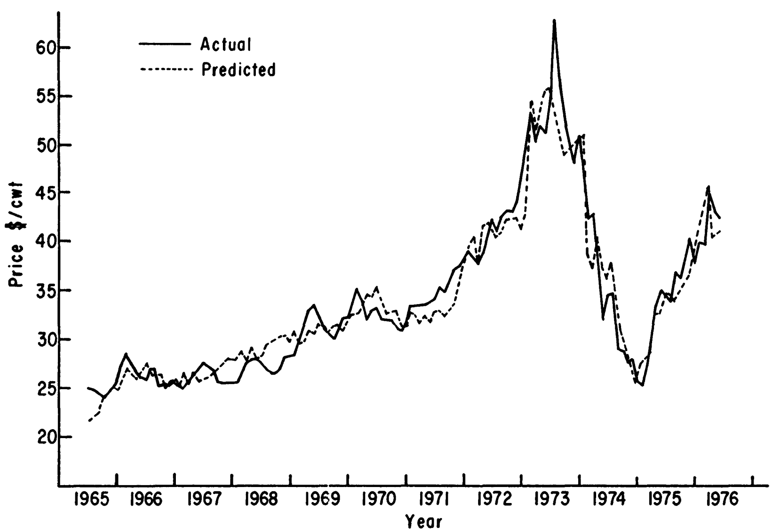


Figure 6. Choice 600-700 Pound Feeder Steer Price, Oklahoma City, 1965-1976, Actual vs. Four Month Predictions.

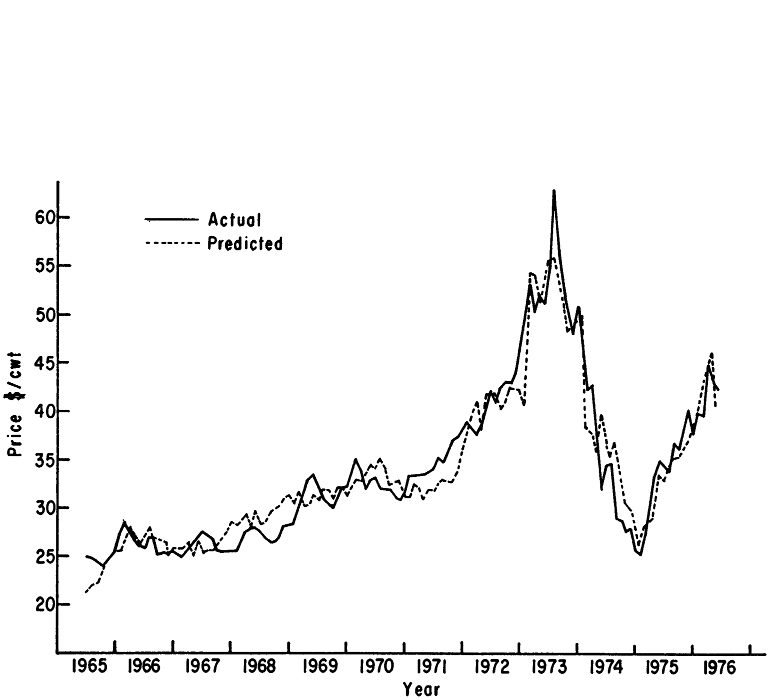


Figure 7. Choice 600-700 Pound Feeder Steer Price, Oklahoma City, 1965-1976, Actual vs. Five Month Predictions.

## Six Month Prediction Equation

As in the two previous models, DFREEZE, CALVES, STR-CRN, SLT-FDR, and COW-SLT constituted this model. The variables explained 90.5 percent of the variation in price and produced an equation standard deviation of $2.60 per cwt. A problem series of residuals occurred from March of 1974 to June of 1975. These sixteen observations had an average residual size of $3.84 per cwt. However, during this period some radical changes were taking place in the data. This was the beginning of the liquidation phase of the cattle cycle and a drought in the corn belt states severely damaged the corn crop.

The data used to calculate the predicted values from March of 1974 to June of 1975 occurred from September of 1973 to December of 1974. During this latter time period COW-SLT increased 62 percent, STR-CRN increased 44 percent and SLT-FDR fell 65 percent. These combined changes accounted for increased residual size for the 16-month period starting in March of 1974. Figure 8 shows the actual and predicted prices for the entire estimation period.

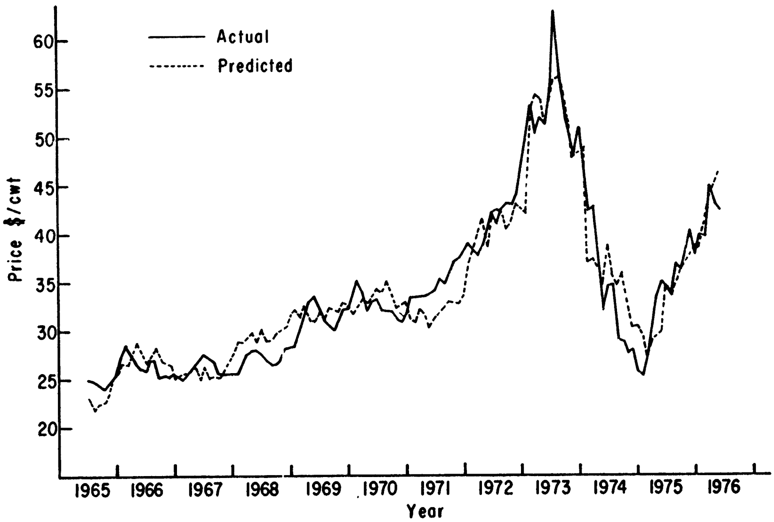


Figure 8. Choice 600-700 Pound Feeder Steer Price, Oklahoma City, 1965-1976, Actual vs. Six Month Predictions.

## Evaluation of the Prediction Equations

The six equations as a group performed well in their purpose of price prediction considering both major phases of the cattle cycle were represented in the estimation period. The equations consistently explained more than 90 percent of the variation in the PRICE series and exhibited an ability to correct themselves quickly in the case of a missed direction or level of price. This is essential if the models are to be used as a base for hedging decisions.

An analysis of the residuals showed no seasonal or cyclical pattern but a consistent pattern of autocorrelation was found to exist considering the Durbin-Watson statistic. This was not entirely unexpected and is often prevalent in econometric analysis of time series. The assumption was made that the same pattern of autocorrelation will exist in the future as existed over the estimation period and the autocorrelation of residuals presented no problems in the analysis. Table 3 presents a current record of the performance of the price models. At this point, a note about the availability of data is needed. The data observations for month T are usually not available until about the third week in month T + 1. For example, the T + 1 price prediction cannot be made until towards the end of the T + 1 month. This limits the usefulness of the T + 1 model

Table 3.—Actual and Predicted Feeder Steer Prices Outside the Estimation Period

| Date | Actual Price | Predicted Prices | | | | | |
|---|---|---|---|---|---|---|---|
| | | T+1 | T+2 | T+3 | T+4 | T+5 | T+6 |
| July 1976 | 39.08 | 41.26 | 41.57 | 41.43 | 41.57 | 40.28 | 40.75 |
| Aug. 1976 | 38.99 | 39.25 | 40.53 | 40.99 | 41.66 | 40.70 | 39.35 |
| Sep. 1976 | 36.16 | 39.37 | 39.76 | 39.86 | 40.87 | 41.09 | 39.38 |
| Oct. 1976 | 35.53 | 35.94 | 40.69 | 39.06 | 40.89 | 40.09 | 40.21 |
| Nov. 1976 | 34.95 | 37.41 | 38.19 | 39.97 | 39.95 | 40.22 | 38.98 |
| Dec. 1976 | 36.06 | 36.64 | 39.17 | 37.61 | 40.80 | 39.25 | 39.15 |

but not that of the others since hedging decisions usually take place more than one month from the end of the production period.

## TESTING ALTERNATIVE HEDGING STRATEGIES FOR FEEDER STEERS

The greatest problem plaguing farmers is not low prices but volatile prices. When stable prices exist the farmer can, through a systematic adjustment process, seek the most profitable set of production alternatives that are available to him. Volatile prices, whether high or low, make effective production and marketing decisions very difficult.

Hedging is one approach that can be used to alleviate the risk associated with fluctuating prices of both inputs and outputs therefore facilitating more effective production and marketing decisions. The major objective of hedging is to reduce the risk inherent in the price patterns of most farm commodities. Increasing net returns is not a primary objective of hedging but if hedging activity can increase returns in addition to reducing risk it is even more desirable.

Hedging with futures contracts shifts the risk of adverse price fluctuating from the producer to the speculator. The speculator is willing to assume the risk because of profit potential from changes in price levels of the futures contract. The presence of speculative interest in a futures market is essential to the success and effectiveness of the futures contract as a hedging tool. The speculator also provides volume and, therefore, liquidity in the futures market. The higher the volume the more accessible the market and the better the actual futures trading mechanism works.

In 1971 a feeder cattle futures contract was established on the Chicago Mercantile Exchange. This afforded the feeder steer producer the opportunity to hedge his cattle.

One problem exists when using the feeder cattle futures contract. The feeder cattle contract, since its beginning, has never attracted a large speculative interest. Because of this the volume is low at times and accessibility to the market becomes limited. The volume increased during 1976 and the liquidity of the contract is improving.

For the purposes of this analysis it will be assumed that the feeder cattle contract has perfect accessibility, i.e. a feeder cattle futures contract can be bought or sold on any day after that day's closing price. This simplification facilitates analysis but does not destroy the applicability of the results.

## Method of Analysis

The testing of the alternative hedging strategies was accomplished by simulating production and hedging situations. Four production alternatives were chosen to represent the most common practices followed by a Northwestern Oklahoma feeder steer producer. The costs and revenues of each alternative were simulated over a four-year period beginning in November of 1972 using actual cash prices. Results of eight alternative hedging strategies that were applied to each of the production alternatives were also simulated using actual futures prices for the feeder cattle contract. The net returns of the combined production and hedging activities were then summarized with means and standard deviations of each hedging strategy and presented for comparison.

The costs that are charged during the production period are for the following:

1) The 400-500 pound Choice stocker at the weekly average price of those steers at Oklahoma City;
2) Any protein supplement that might be used during the production period at the bulk rate for soybean meal at Decatur, Illinois, in dollars per ton plus $4.00 per ton for handling and delivery;
3) Miscellaneous costs of production. A total of $15.00 per head other costs for hay, salt and mineral, sales commission, trucking, vet and medicine, and machinery and equipment maintenance and repair;
4) Interest on the operating costs. A ten percent annual interest rate is charged on 1), 2), and 3) over the production period; and
5) Commission fee and interest on margin requirements. The margin requirement for trading a feeder cattle contract is $800. A ten percent annual rate of interest is charged for this money over the production period. The commission for trading a feeder cattle contract is $50 and is subtracted from returns on the hedg-

ing activity. Each contract hedges 65 head of 650 pound feeder steers and these costs are reduced to per head costs.

No charge is assessed for the use of the pasture on which the steers are raised.

The production revenues come from the sale of the 650 pound steer at the end of the production period. This is calculated using the average price for Choice 600-700 pound feeder steers at Oklahoma City during the week the steer goes to market. A two percent death loss is accounted for in figuring the revenue.

## Production Alternatives

The first production alternative involves the use of small grain grazing. A set of stocker steers are bought in each of the first three weeks in November at an average weight of 500 pounds and are placed on wheat pasture. The steers gain an estimated 1.3 pounds per day. Protein supplement and hay are supplied in bad weather. A set of steers is sold weighing 650 pounds in each of the first three weeks in March.

The next alternative corresponds to the wheat farmer who does not plan to harvest his wheat. The stocker steers are purchased and placed on wheat pasture in each of the first three weeks of November weighing an average of 400 pounds. The steers gain 1.3 pounds per day until March. From March until May the steers gain 1.6 pounds per day until they are taken off the grazed out wheat and marketed during the first three weeks in May. When the feeder steers are sold they weigh 650 pounds.

In the third strategy stocker steers are purchased during the first three weeks in March when they come off wheat pasture and are placed on native grass pasture. The steers, weighing an average of 450 pounds in March, are supplemented with protein and hay until the grass can support them towards the middle of April and gain 1.3 pounds per day. The market weight of the steers coming off native pasture during the first three weeks in August is 650 pounds.

The final production alternative considered also utilized native pasture. Stocker steers are bought during the first three weeks in May weighing an average of 450 pounds, after the grass is well into the growing season. The steers are not supplemented in this case and gain 1.3 pounds per day. The 650 pound feeder steers are sold during the first three weeks in October.

### Measurements Used in Comparing Hedging Strategies

The mean and standard deviation of net returns in dollars per head is calculated for each of the 48 observations of the production alternatives and for the seven strategies tested for each production alternative. The mean net returns are used to compare profitability. The standard deviation is used as a measure of risk. The coefficient of variation, the standard deviation expressed as a percentage of the mean, is also used.

### Use of Moving Averages in Futures Trading

One of the many technical tools used in futures trading is moving averages. Moving averages are used to identify price trends and changes in price trends.

In this analysis two moving averages are used, a ten-day and a five-day. Each day's observation of the ten-day moving average is calculated by averaging the ten most recent closing prices of the futures contract in question. The five-day moving average is calculated in a similar manner using the five most recent closes. The longer of the two averages, the ten-day, is more stable. Therefore, the five-day average will lead the ten-day average when the price trend changes directions.

On any particular day when the five-day moving averages lies below the ten-day moving average, the price is said to be downward trending. A change in trend is signaled when the two averages cross. When the five-day average crosses the ten-day average from below the beginning of an upward trend is signaled. If the five-day cuts the ten-day from above a new downtrend is indicated. Figure 9 illustrates the movement and crossing action of the two moving averages.

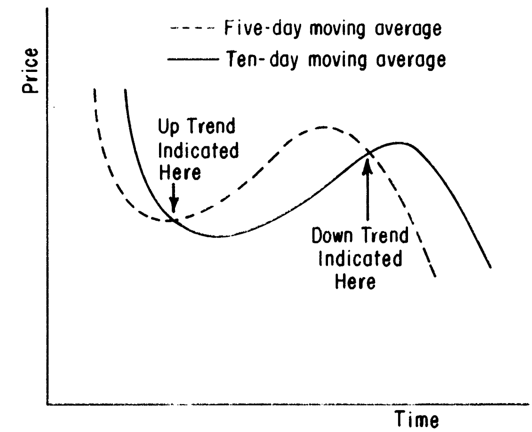


Figure 9. Illustration of Crossing Action of Moving Averages.

When trading futures contracts with moving averages for speculative purposes a contract is sold when the average signal a downtrend. When an upturn is indicated the futures contract sold previously is liquidated by buying it back and another one is purchased to take advantage of the upward moving price.

Hedging with futures contracts under the moving average criteria uses the "crossing" action but has several variations some of which will be explained in more edtail in the following sections. Among other places a more detailed discussion of the use of moving averages in futures trading can be found in Tewles, Harlow, and Stone.[15]

## Hedging Strategies

The mechanics of hedging with futures contracts has been discussed at some length by various researchers and, therefore, will not be elaborated on here. Hague[16] did an excellent job of outlining the necessary characteristics of cash-futures price relationships that make the hedge work.

### Strategy I

This is the no hedge strategy and corresponds to the production activity. It is used to measure the effect the other hedging strategies have on the mean net returns and standard deviation of returns. The results of this strategy were a mean return of $31.65 per head and a standard deviation of $53.21.

All of the other strategies that were used contain this strategy as a base. The net returns for the other alternatives are obtained by adding the net return from Strategy I to the returns from the hedging activity of that particular alternative.

### Strategy II

Strategy II is a rather naive hedging plan. When the cattle are purchased a hedge is placed by selling a futures contract, also called a short hedge. At the end of the production period when the cattle are marketed the hedge is lifted by purchasing a futures contract, liquidating the hedge. The hedging activity of this alternative is most profitable in a downward trending market. The returns lost in the falling cash market are made up in the futures market. Similarly, in an upward trending market, money is lost on the hedge but a greater return from the cash operation is made with the upward trending market. This tends to smooth the flow of net returns resulting in a relatively small standard deviation of returns. However, over time, the returns to the hedging activity should average about zero leaving the average returns from this strategy about equal to those from Strategy I. These expectations are borne out by the statistics for this strategy, a mean return of $30.57 per head with a standard deviation of $20.66.

### Strategy III

This srategy is a variation of Strategy II. The hedge is placed the first time the moving averages signal a down market. The hedge is then held for the entire production period and lifted when the cattle are marketed. This strategy will keep the cattle unhedged if, at the first of the production period, prices are trending upward and will place the hedge at the first change in this trend. However, if prices are going down when the cattle are purchased the strategy corresponds to Strategy I. The mean and standard deviation of returns should be a little higher than the pervious strategy. The simulated average return for this strategy was $31.82 per head with a standard deviation of $22.73.

### Strategy IV

Strategy IV offers the most potential for increasing net returns of any of the strategies. With this strategy a hedge is placed when the moving averages indicate a down turn in prices. The hedge is retained as long as the five-day average lies below the ten-day average. The hedge is lifted when the moving averages cross signaling an upturn in prices. As long as the five-day lies above the ten-day the cattle remain unhedged. If the five-day average crosses the ten-day average from above pointing to a downward change in price the hedge is again placed. The hedge is then held until an upward trend is designated by the averages.

This scheme lets the producer get the benefits of the upward trending cash prices which he does not receive when a hedge is held regardless of price movements. In addition, the protection against adverse price movements is present when a down trend in price is present. The simulated results for this strategy show a mean return of $60.83 per head and a standard deviation of $35.17.

## Strategy V

A "yes-no" hedging decision based on a price forecast combined with Strategy II constitutes Strategy V. The decision concerning whether or not to hedge is made at the beginning of the production period. If the futures price at the beginning of the production period is greater than the cash price forecast adjusted with a confidence value[17] for the end of the production period, the cattle are hedged with Strategy II. In Strategy II the cattle are hedged when purchased and the hedge is held until the cattle are marketed. If the futures price is less than the adjusted cash price forecast the cattle remain unhedged throughout the production period. The simulation yielded a mean return and standard deviation for this strategy of $48.16 and $38.32 per head, respectively.

## Strategy VI

As with Strategy V, this strategy employs the cash price forecasts. When the adjusted price that is forecast for the end of the production period lies below the futures price at the beginning of the production period, hedging is undertaken using Strategy III. With Strategy III the hedge is placed when the moving averages indicate the first downtrend in prices for that production period and is held until the cattle are marketed. Again, when the futures price is less than the adjusted price forecasts there is no hedging during the production period. The simulated results for this alternative on a per head basis were a mean return of $47.42 and a standard deviation of $38.56.

## Strategy VII

Strategy VII uses the price forecasts in conjunction with Strategy IV. When the adjusted price forecast lies above the initial futures price of the production period no hedging is done. Otherwise, hedging is engaged using Strategy IV. The hedges of Strategy IV are placed and lifted using the five and ten-day moving averages. The average return in the simulation of this strategy was $49.78 per head with a standard deviation of $39.97.

### Strategy VIII

Price forecasts are the exclusive criteria in this hedging strategy. When the initial price forecast is made for the month in which the cattle will be marketed the adjusted forecast is compared to the futures price at the beginning of the production period. If the futures price lies above the forecast a hedge is placed and held until the next price forecast is made for the end of the production period. If the futures price is less than the forecast no hedge is considered until the next forecast becomes available. The time between forecasts is about one month.

When the new forecast is made it is compared to the most recent futures price and the decision is again made as to whether the hedge should be lifted or maintained if it was placed initially or, if there was no hedge, whether or not one should be placed. This process is repeated every time a new forecast price becomes available until the end of the production period. Compensation was made in the simulation program for the restrictions on the availability of forecasts mentioned earlier. The simulated results of this strategy show a mean return of $48.46 per head and a standard deviation of $49.95.

## Comparison of the Alternative Hedging Strategies

Table 4 presents the summary statistics of the eight alternative strategies considered in this analysis. Changes from the control strategy, Strategy I, are also shown in the table.

The prime objective of hedging, reducing risk, here measured with the standard deviations of returns, is met in every case with a decrease in the standard deviation compared to the "no hedge" strategy. The secondary objective of hedging, increasing returns, is met in all instances but one, Strategy II.

Judging from the means and standard deviations, any of the hedging strategies would be an improvement from the unhedged strategy. Deciding which strategy should be used is not as obvious as deciding whether or not to hedge. The strategy to be used is up to the producer and will depend upon his preferences.

The main requisite for using any of the strategies is a thorough

## Table 4.—Results of Simulated Hedging Strategies in Dollars Per Head

| Strategy | Mean Returns | Change in Returns Strategy I | Standard Deviation of Returns | Change in Std. Dev. from Strategy I | Coefficient of Variation | Low Return | High Return |
|---|---|---|---|---|---|---|---|
| I | 31.65 | ———— | 53.21 | ———— | 168.1 | —58.09 | 121.20 |
| II | 30.57 | — 1.08 | 20.66 | —32.55 | 67.6 | —24.70 | 64.63 |
| III | 31.82 | + 0.17 | 22.73 | —30.48 | 71.4 | —24.70 | 76.20 |
| IV | 60.83 | +29.18 | 35.17 | —18.04 | 57.8 | 0.40 | 117.11 |
| V | 48.16 | +16.51 | 38.32 | —14.89 | 79.5 | —56.37 | 121.20 |
| VI | 47.42 | +15.77 | 38.56 | —14.65 | 81.3 | —56.37 | 121.20 |
| VII | 49.77 | +18.12 | 39.97 | —13.24 | 80.3 | —56.37 | 121.20 |
| VIII | 48.46 | +16.81 | 49.95 | — 3.26 | 103.08 | —56.37 | 121.20 |

understanding of the use of futures markets. The success of the strategy chosen is also dependent upon the producer's willingness to stay with the choice he makes. After these essentials are met the final choice will depend on the producer's preferences concerning risks and returns and his financial ability to carry risk.

The producer who wishes to cut risks to a minimum would possibly opt for the strategy offering the smallest standard deviation of returns, Strategy II. This strategy cuts the standard deviation from the control strategy more than 50 percent while reducing returns only $1.00 per head. On the other hand, if the producer's only goal is profit maximization, he might select Strategy V. When this strategy is implemented returns are increased almost 100 percent and the standard deviation of returns is decreased $18.00 or 34 percent from a base of $53.21. The coefficient of variation, mean as a percentage of the standard deviation, for Strategy IV is also the lowest of any of the alternatives making it a most desirable option.

The strategies that utilized the price forecasts as criteria for hedging also performed satisfactorily. Returns were increased about $17.00 with the standard deviation reduced significantly. The returns were not as high as the strict moving average alternative of Strategy IV but this was expected. The price projections offered trend projections from one to six months into the future while the moving averages identified day to day changes in trends. The price forecast models were successful in identifying long-run trends in price as can be seen from the increased returns of the strategies in which they were used.

The results of the simulation show conclusively that hedging is an effective management tool in reducing the risks a feeder steer producer encounters. Returns are not always increased with hedging but the more sophisticated approaches to hedging have the potential of increasing returns as well as reducing risk.

## SUMMARY AND CONCLUSIONS

Feeder steer producers have been subjected to highly volatile prices in the past four years. Since the beginning of 1973 changes in average feeder steer prices between two consecutive months have been greater than $5.00 pr cwt. on seven occasions. In this environment of fluctuating prices it is difficult for the producer to make effective production and marketing decisions. Management tools that can remove some of the uncertainty caused by volatile prices should prove valuable to the producer as a decision aid. The development of such management tools was the major objective of this undertaking.

Single equation models to predict price of Choice 600-700 pound feeder steers at Oklahoma City from one to six months in the future were estimated over the time period July 1965 to June 1976. This time period covers essentially one full cattle cycle. The assumption that the supply of feeder steers marketed during any one month was fixed (a totally inelastic supply curve during the month) was made to simplify the estimation of the supply component of the price prediction equations. The January 1 inventory of bulls, steers and heifers under 500 lbs. was used to set the supply available for the entire year. With this level established, the monthly supply of steers in the 600-700 lb. range was considered to be fixed insofar as response to price changes within the month is concerned.

Since the supply curve was assumed totally inelastic during the month, demand shifters were sought to determine the price.

A live cattle futures price, representing price expectations for slaughter steers, was used in one model as an index of feeding demand for feeder steers. A ratio of the futures observations was also used in two other equations to identify any trend that might exist in futures prices. A steer-corn ratio, representing feeding margins, and the slaughter steer-feeder steer price ratio, which indicates relative values between slaughter and feeder steers, were also used to depict feeding demand for feeder steers. In addition to representing feeder demand the slaughter-feeder price ratio helped to identify packer demand for feeder steers. A cow slaughter variable was also used to potray packer demand.

Seasonal and cyclical variation in price were not treated explicitly in the price models. No consistent seasonal pattern was displayed by feeder steer price so no action was taken to explain seasonal variation. The cow slaughter variable and the slaughter-feeder steer price ratio helped to explain the cyclical variation in feeder steer prices. A 0-1 dummy variable was used to account for the abnormal marketing behavior of feeder steer producers that occurred during and immediately following the government-imposed retail meat price freeze in 1973.

The price prediction equations contained only lagged versions of the explanatory variables. This technique eliminated the necessity of building prediction models for one or more of the explanatory variables and greatly simplified the use and application of the price prediction models.

Each of the six price equations fitted exhibited impressive statistics. The explanatory variables in the models consistently explained more than 90 percent of the variation in the feeder steer price series. Observed significance levels on the explanatory variables in each model were 0.01 or less. Standard deviations of the equations ranged from $1.56 per cwt. to $2.60 per cwt. The mean of the dependent feeder steer price series was $33.84 per cwt.

Considering that both major phases of the cattle cycle were included in the estimation of the price equations the plots of actual and predicted prices showed the models to be consistently good predictors of cash feeder steer price.

The ultimate goal of this study was to develop tools to reduce the risk confronted by the feeder steer producer due to fluctuating prices. These tools were embodied in the alternative hedging strategies that were formulated and tested.

The results of four production alternatives a feeder steer producer might use were simulated using actual cash prices for inputs and outputs over a four-year period beginning in November of 1972. The four alternatives were:

1) Steers weighing 500 lbs. are placed on wheat pasture in November and sold off wheat pasture in March weighing 650 pounds;
2) Steers weighing 400 lbs. are placed on wheat pasture in November. Steers graze out wheat and are sold in May weighing 650 pounds;
3) Steers weighing 450 lbs. are grazed on native pasture from March until August and sold in August weighing 650 pounds; and
4) Steers weighing 450 lbs. are grazed on native pasture from May until October and are sold in October weighing 650 pounds.

Eight simulated hedging strategies using feeder cattle future contracts were applied to each of the production alternatives. In general, the hedging strategies used a moving average system of futures prices, the price predictions or some combination of the two. The strategies were as follows:

I) No hedging. This strategy corresponds to the production activity and is used as a control for comparison;
II) The hedge is placed at the beginning of the production period and held throughout;
III) The hedge is placed the first time the moving averages signal a downturn in futures prices in the production period and held throughout the period;
IV) Hedges are placed when moving averages indicate a downturn in futures prices and are lifted when an upturn is signalled;
V) The hedge is placed as in Strategy II if the first futures price of the production period is greater than the adjusted price forecast for the end of the period;
VI) The hedge is placed as in Strategy III if the first futures price is greater than the adjusted price forecast;
VII) Hedges are placed and lifted with Strategy IV if the initial futures is greater than the adjusted price forecast; and

VIII) The hedge is placed and lifted with adjusted price forecasts only. When the price forecast is available for the end of the production period, a hedge-no hedge decision is made. The criterion is to hedge if the forecast is less than futures prices. Otherwise, no hedge is employed. Each time a new forecast is available the hedge-no hedge decision is reviewed. The new forecasts come at one-month intervals.

The primary objective of any hedging strategy is to reduce risk. Each of the strategies tested did reduce risk compared to the control as measured by the standard deviation of returns. The standard deviations of returns per head ranged from $20.66 to $49.95 compared to $53.21 for the control. The secondary possible motive for hedging, increasing returns, was achieved by every strategy except Strategy II which showed a $1.08 per head decrease in net returns. Mean returns per head ranged from $30.57 to $60.83 compared to $31.65 for the control. The coefficients of variation were all much smaller than the control showing the effectiveness of the Strategies II through VIII in reducing risk and/or increasing returns.

The simulated results of the hedging strategies strongly suggested that any of the hedging programs presented is better than not hedging at all. However, the decision as to which hedging strategy to use must be made by the individual producer according to his preferences concerning risk and returns and his financial ability to carry risk.

## FOOTNOTES

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[15]Teweles, Richard J., Charles V. Harlow, Herbert L. Stone, *The Commodity Futures Game, Who Wins?, Who Loses?, Why?* McGraw-Hill Book Co., New York, New York, 1974, pp. 176-178.

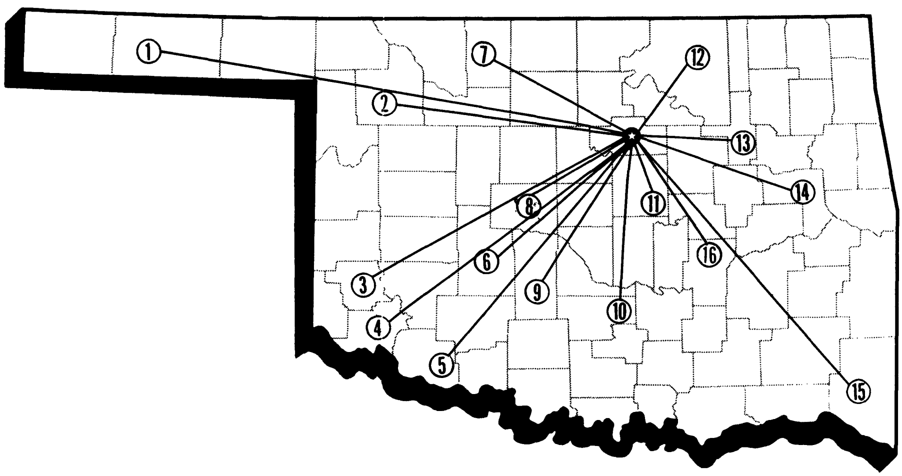
[16]Hague, T. M., "Economic Evaluation of Alternative Hedging Strategies for the Cattle Feeder". (Unpublished M.S. Thesis, Oklahoma State University, 1972).

[17]The confidence value used is the standard deviation of the appropriate prediction equation.

OKLAHOMA

# Agricultural Experiment Station

## System Covers the State




**Main Station — *Stillwater, Perkins and Lake Carl Blackwell***

1. **Panhandle Research Station — *Goodwell***
2. **Southern Great Plains Field Station — *Woodward***
3. **Sandyland Research Station — *Mangum***
4. **Irrigation Research Station — *Altus***
5. **Southwest Agronomy Research Station — *Tipton***
6. **Caddo Research Station — *Ft. Cobb***
7. **North Central Research Station — *Lahoma***
8. **Southwestern Livestock and Forage Research Station — *El Reno***
9. **South Central Research Station — *Chickasha***
10. **Agronomy Research Station — *Stratford***
11. **Pecan Research Station — *Sparks***
12. **Veterinary Research Station — *Pawhuska***
13. **Vegetable Research Station — *Bixby***
14. **Eastern Research Station — *Haskell***
15. **Kiamichi Field Station — *Idabel***
16. **Sarkeys Research and Demonstration Project — *Lamar***

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