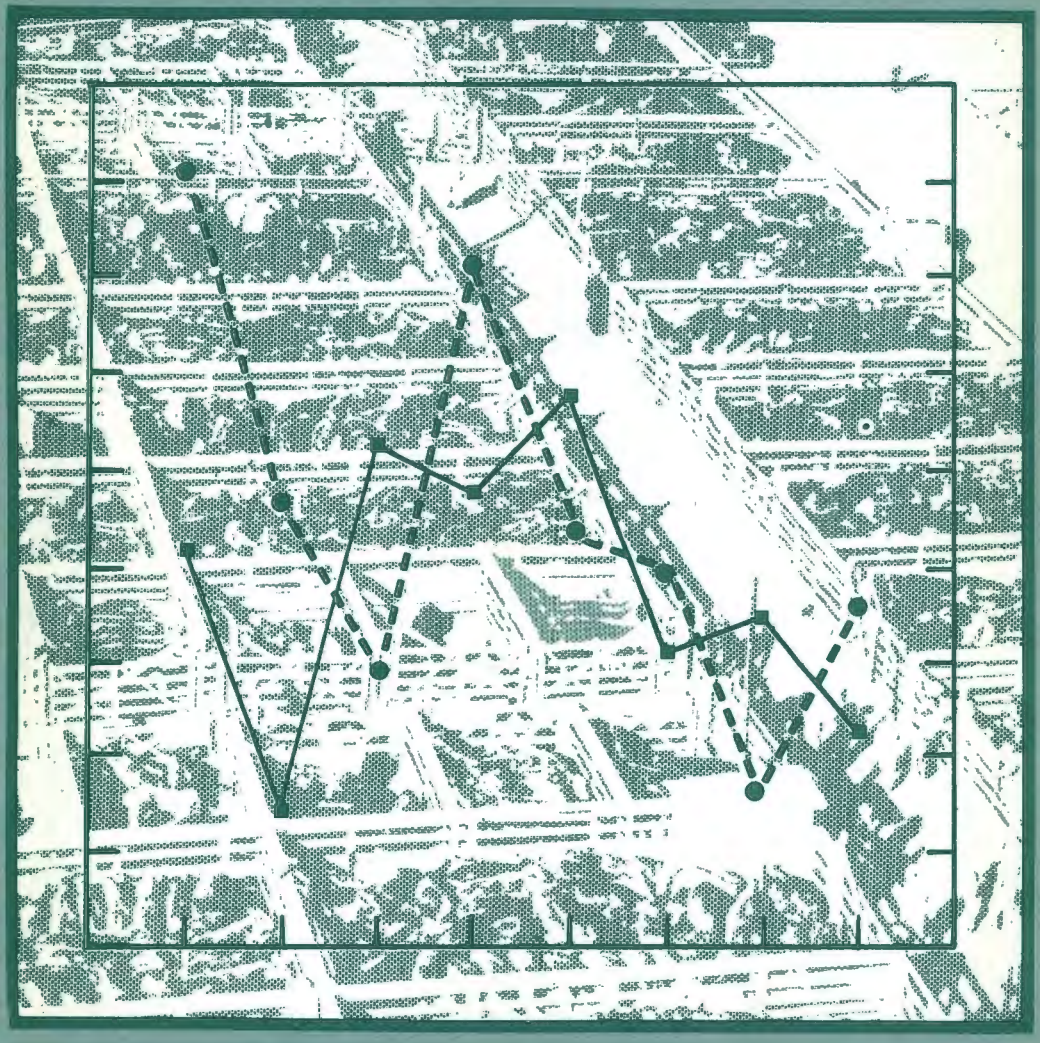
Hedging Strategies to Protect the Financial Position of Cattle Feeders and Lenders



AGRICULTURAL EXPERIMENT STATION BULLETIN B-743
OKLAHOMA STATE UNIVERSITY June 1979

TABLE OF CONTENTS

Introduction 1
The Problem 2
Objectives 2
A Conceptual Framework For Price Risk Management 3
Financial Position and Risk 3
The Importance of Time 3
Selective Hedging to Reduce Price Risk 4
Fundamental Analysis 5
Technical Analysis 5
Implications for the Study 8
The Model and Procedure 8
Calculation of Unhedged Cash Flows 8
Calculation of Cash Flows From Futures Transactions 9
Selection of Fundamental and Technical Indicators 10
Projection of Choice Steer Price 11
Theoretical Considerations for the Behavioral Equation 11
Variables Indicating the Supply of Choice Beef 12
Variables Indicating the Demand for Choice Beef 13
Other Variables 14
Fed Cattle Marketings Projection Model and Results 14
Results of the Fed Marketing Regression 16
Pork Production Model and Results 18
Results of the Pork Production Regression 19
U.S. Per Capita Real Disposable Personal Income Projection Models and Results 20
United States Per Capita Disposable Personal Income Model 21
Consumer Price Index Model 21
U.S. Per Capita Real Disposable Personal Income Projection 22
Results of the Price Regression Equation 22
Alternative Hedging Strategies 26
The Hedging Strategies 26
Summary and Conclusions 36
Selected References 39

Reports of Oklahoma Agricultural Experiment Station serve people of all ages, socio-economic levels, race, color, sex, religion and national origin. This publication is printed and issued by Oklahoma State University as authorized by the Dean of the Division of Agriculture and has been prepared and distributed at a cost of $1,282.59 for 1,100 copies.

Hedging Strategies To Protect The Financial Position of Cattle Feeders And Lenders

Don A. Riffe and Wayne D. Purcell*

Introduction

The concept of price risk is familiar to participants in the cattle feeding industry. Many experienced cattle feeders were subjected to tremendous market-related losses during the period 1973-1977. Lenders have been indirectly affected by the same price risk that affects the cattle feeder.

Although some cattle feeders realize the risk-reducing potential of hedging, many lack the necessary skill to make futures transactions work for them. Lenders can no longer evaluate the managerial abilities of their customers based on production skills alone but must also consider each customer's ability to manage price risk. The widespread lack of skill in dealing with adverse price movements is an important casual factor in the risk to which the agricultural lender is exposed.

Also of major concern are successive periods of technical insolvency.[1] During these periods, many cattle feeders must borrow to pay their currently maturing obligations. There is a tendency for these debts to grow toward the upper limit of the customer's borrowing capacity when price relationships remain unfavorable for extended periods of time. One possible reason is that the situation is regarded as temporary and, with no other remedies available, further credit may be viewed as the easiest way to override the problem. However, the cattle feeder who has nearly exhausted his borrowing capacity may be unable to financially survive until more favorable prices arrive. Since much of the lender's risk evolves from the same factors which determine the cattle feeder's risk, it seems reasonable to assume that any action which improves the financial position of the cattle feeder will be beneficial to both parties.

The prevailing philosophy of agricultural lenders is to refinance intermediate or long-term debt whenever possible for cattle feeding customers with cash flow problems (Federal Reserve Bank of Dallas, 1977).

*Former Research Assistant and Professor respectively in the Department of Agricultural Economics.

Research reported herein was conducted under Oklahoma Agricultural Experiment Station Project No. 1635.

[1] Technical insolvency refers to the inability of a firm to meet its currently maturing obligations.

The repayment ability of borrowers is closely scrutinized and a customer may be referred to a government lending agency if he does not continue to satisfactorily meet the commercial lender's requirements. As more producers have repayment difficulties for extended periods of time, the probability that some of them will be forced out of business increases.

The Problem

Severe losses have been incurred by cattle feeders including experienced long-time customers of particular lenders. These losses are of concern for two major reasons: (1) as cattle feeders increase their debt load, lenders have an increasing stake in the future of these cattle feeders and are increasingly vulnerable to price risk, and (2) the financial position of many cattle feeders has deteriorated to the point that they can no longer survive periods of technical insolvency by borrowing against long-term assets to meet their current needs. Refinancing old debt, mortgaging assets unrelated to cattle feeding, and referral to government agencies are responses to the symptoms of unfavorable market conditions but these responses do not deal directly with the source of the problem.

Obtaining enough operating capital to meet expenses in one period does nothing to reduce the probability of severe cash flow problems in subsequent periods. If cattle feeders have untapped sources of capital from other enterprises, they may decide to use these resources to carry the cattle feeding operation through periods of technical insolvency. But most cattle feeders would prefer the cattle feeding operation to stand on its own.To accomplish this, cattle feeders must develop marketing strategies to deal more effectively with price risk. When cattle feeders are in danger of becoming insolvent, the problem of price risk management also becomes the lender's problem.

Objectives

The overall objective is to develop and evaluate the financial effects of hedging strategies designed to reduce the severity of cash deficits and to minimize periods of technical insolvency in cattle feeding operations. To accomplish the overall objective, more specific subobjectives are as follows:

1. To develop a procedure for evaluation of the selective hedging strategies;
2. To construct a price forecasting model that yields projections suitable for use in making hedging decisions; and
3. To design, test and illustrate hedging strategies based on fundamental and technical analysis of market information.

A Conceptual Framework For Price Risk Management

Financial Position and Risk

It has been shown that a producer may choose a trade-off between risk and expected return which allows the attainment of the highest level of utility (satisfaction) among possible cash/futures positions (Ward and Fletcher, 1971). A number of obstacles may limit the alternatives available to the decision maker. These include legal restrictions, futures contract specifications, and production capabilities. The behavior of a producer may change as the obstacles in his operating environment alter the level of perceived risk. A change in behavior may also evolve because of a change in relative financial position over time. For this study, it is assumed that risk plays a role of increasing importance as financial position weakens and that risk becomes less important as financial position grows stronger.

The Importance of Time

Figure 1 shows the average monthly value of a 1,056 pound Choice steer (Omaha market) plotted against the average monthly value of a 675 pound Choice feeder steer (Oklahoma City market) plus the average monthly value of 3,500 pounds of corn (Number 2 Yellow, Omaha market) for the period 1972-1974. The average annual values for the same

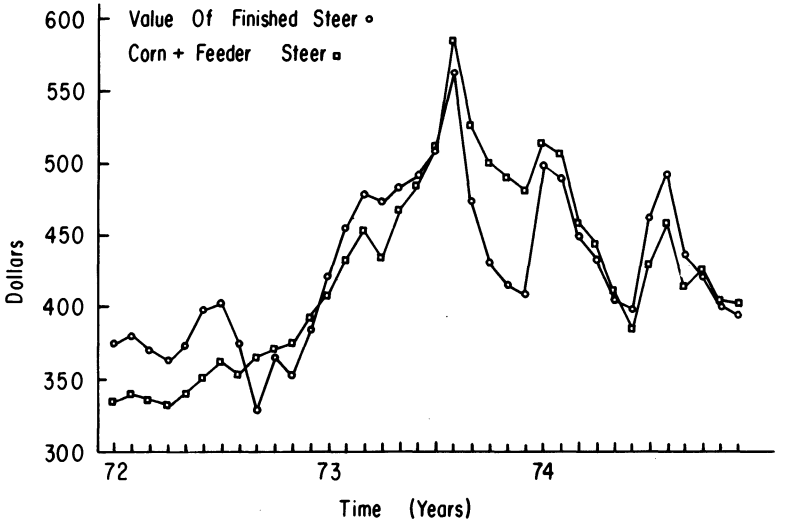


Figure 1. Average Monthly Values of Major Cattle Feeding Inputs and Outputs, 1972-1974.

Table 1. Average Annual Values for Major Cattle Feeding Inputs and Outputs, 1972-1974*

	1972	1973	1974
		(Dollars)	
Value of finished steer	372.08	466.23	438.43
Value of corn & feeder steer	354.48	480.51	435.95
Average annual margin	17.60	—14.28	2.48

*Output value is based on a 1,056 pound steer at average annual prices of 900-1,100 pound Choice steers, Omaha. Major input values are computed by adding the average annual value of 3,500 pounds of No. 2 yellow corn at Omaha to the average annual value of a 675 pound feeder steer based on Oklahoma City prices for 600-700 pound Choice feeder steers.

inputs and outputs are shown in Table 1. The average annual margins (Table 1) give no indication of the distribution of cash flows during the year. For the producer who is nearing his maximum debt capacity, the timing of cash flows becomes important. The weaker the financial position, the greater the probability that a given short-run negative cash flow will result in business failure.

Risk management strategies to improve financial position should be evaluated by their contribution to net cash flows in those short-run periods when cash is needed. Also of importance is the effect of such strategies on cash inflows in periods when the cash flow position is favorable. Ideally, a risk management hedging strategy would offset cash flow deficiencies without reducing cash flow surpluses over time. Thus, in evaluating the contribution of profits from alternative hedging strategies, the distribution of profits over time is just as important, or more important, than the long-run level of total profits.

Selective Hedging to Reduce Price Risk

The term "hedging" does not imply a unique type of behavior to all commodity market participants. Perhaps the best way to define hedging in the present context is to first consider what it is not. Working offered the following many years ago:

> the general concept of hedging as taking offsetting risks wholly, or even primarily, for the sake of reducing net risks, serves so badly as applied to most hedging on futures markets that we need another concept for the most common sort of hedging (Working, p. 324).

The type of hedging referred to as "most common" is a form of operational hedging done primarily by large millers and processors to provide a temporary pricing mechanism. This is not the concept of hedging to be used in this study.

Selective hedging is defined to be the practice of hedging or not hedging according to price expectations based on fundamental analysis or some technical indicator. The purpose of selective hedging is to reduce

or avoid losses through selective exposure to price risk. Commodity stocks may be completely hedged, partially hedged, or wholly exposed to price risk based on the price expectations of the decision maker. Although the reasons for implementing a strategy of selective hedging may be based on risk preference rather than expectations, it is obvious that expectations play a key role in price risk management. One objective of this study is to evaluate the effectiveness of various forms of fundamental and technical analysis as selective hedging guides.

Fundamental Analysis

The fundamental approach to price analysis involves the isolation, quantitative measurement, and evaluation of supply and demand factors. In general, economists tend to favor this approach because of its strong theoretical appeal. Exact price forecasting is not a necessary goal for the fundamentalist. His goal is to forecast the general direction of major price movements for some future time period in relation to current price level.

Fundamental analysis requires a knowledge of the entire production-marketing system and of the relative importance of influential variables. Once the analyst has developed sufficient insight into the supply-demand factors of a given commodity to identify the dominant influences, these most important relationships may be used to form a model of price behavior.

Technical Analysis

Technical analysis does not directly consider the factors which tend to change the equilibrium price level but assumes that past price behavior may be used to indicate future price behavior. The technician believes that certain price patterns precede major changes in price level. Many such patterns have been identified over the years (Teweles, Harlow, and Stone, 1974) but few are so consistent that they may be objectively recognized for testing purposes. Two common exceptions are moving average signals and simple double top and double bottom point and figure chart formations.

A moving average of futures prices is a progressive average. Each day a new closing or settlement price is added to the end of the series. An old closing price is dropped from the beginning of the series. Buy and sell signals are generated by the crossing action of different averages. The length of time (denominator) used in computing a moving average affects its sensitivity to a change in price trend. A system of weighting the individual prices and corresponding time periods may also influence the sensitivity of a moving average. The greater the sensitivity, the greater

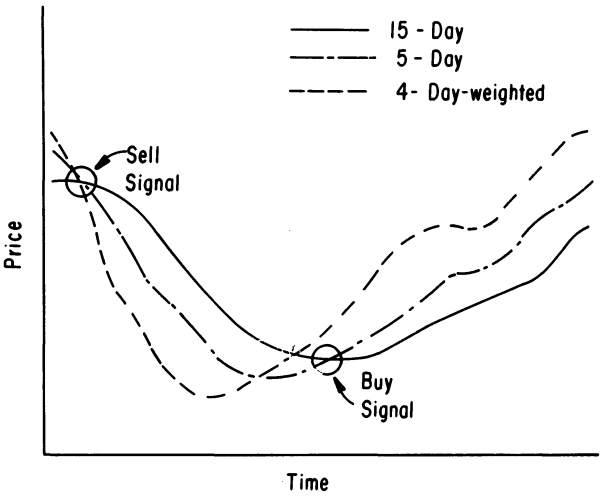


Figure 2. Illustration of Buy and Sell Signals Generated by Crossing Action of Moving Averages.

the number of signals. Some signals may be "false" reactions to temporary price fluctuations. Less sensitive moving averages will reduce the number of false signals, but may signal new trends too late to be of significant value. By combining moving averages with varying degrees of sensitivity to generate buy and sell signals, it is possible to reduce the number of false signals while retaining early detection of changes in price direction.

Figure 2 illustrates the signaling action of 5-day, 15-day, and 4-day-weighted moving averages. When the 4-day-weighted average crosses the 15-day average from above, a change in price trend may be forthcoming. However, the sell signal is not generated until the 5-day average is below the 15-day **and** the 4-day-weighted average is below the 5-day average. The process works in reverse for a buy signal.

Point and figure charts disregard the amount of time elapsed between price movements. They are constructed only to show the direction of price change. Any price fluctuations greater than some specified minimum box size are shown by adding as many "boxes" or "cells" as can be filled by a given fluctuation. By convention, the upward fluctuations in price are represented by X's and the downward fluctuations are represented by O's. Reversals in price trend are signaled by price changes greater than or equal to some specified number of "boxes". Whenever a reversal occurs the next group of X's or O's is plotted one column to the right.

Figure 3 illustrates a point and figure chart with a $.20 box or cell size and a 3-box reversal requirement. When trade is begun in a particular contract, the direction in which plotting is started depends upon the

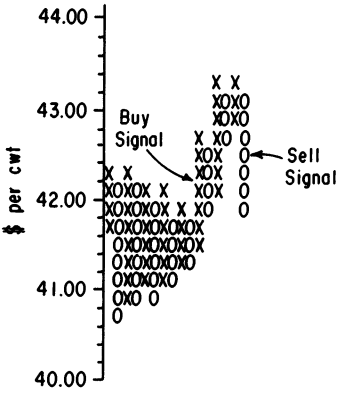


Figure 3. Illustration of Buy and Sell Signals Generated by Double Top and Double Bottom Point and Figure Chart Formations.

closing or settlement price for the first day. If the settlement price is above the mid-point of the trading range, the chartist expects to plot upward moving prices (denoted by X's). If the close is below the midpoint, lower prices are plotted (denoted by O's).

If the close is above the midpoint on the first trading day, an upward moving plot is started. Once an upward plot is begun, the chartist looks each day at the high of the trading range. If the high fills one or more higher boxes each day, the plot is continued to higher prices and the chartist looks only at the highs.

The first day the price moves fail to fill a new higher box, the chartist looks to the low to see if a reversal can be plotted. If one cell can be dropped and at least three cells plotted down, meaning at least three cells are filled after dropping one cell, a reversal has occurred. The downward plotting continues until a day in which the low does not fill at least one new lower cell. The high is then checked for a reversal and the process continues. On some days nothing is plotted. The chartist simply waits until the following day to see if he can continue his trend or plot a reversal. The larger the box size and reversal requirements, the less sensitive the chart will be to minor price movements.

When a string of X's rises to fill the box even with the highest filled box of the immediately preceding string of X's, a "double top" is formed. A buy signal is given if the next higher box is filled (Figure 3). Likewise, a sell signal is generated by a downward "breakout" from a double bottom formation (Figure 3).

Technical tools offer an objective indication of market behavior free from the emotion and bias of the analyst. They also offer a more exact method for the timing of futures transactions than can be obtained from a behavioral model.

Implications for the Study

Assuming that cattle feeders prefer less to more risk, financial position may influence the type of risk management strategy to be followed. Strategies should be evaluated according to the distribution of their net contributions to unhedged cash flows over time. Selective hedging according to simple fundamental and technical indicators provides a method for obtaining strategies with differing profit distributions over time. These alternatives allow the individual decision maker to choose a combination of risk and potential returns.

The Model and Procedure

A computerized cash flow simulation of a cattle feeding operation is used to evaluate the performance of specified hedging strategies for the period 1965-1977. Cash flows are simulated at thirty day intervals for the unhedged operation and for the same operation under each of the hedging strategies. As a matter of convenience, it is assumed that the cattle feeder owns no fixed feeding facilities and hires the services of a custom feedlot. The simulation is not intended to represent the activities of any particular feeding operation, but attempts to combine reasonable estimates of costs and receipts from cash and futures transactions in the appropriate time periods for the purposes of evaluation and illustration.

Calculation of Unhedged Cash Flows

In order to monitor the ability of the cattle feeding operation to stand on its own, it is assumed that 100 percent of the required initial capital can be borrowed and that any additional capital required to maintain the operation may be borrowed at the prevailing rate of interest. The inputs per head and price series used in calculating costs are shown in Table 2. The cattle feeder is assumed to purchase the first set of 116 feeder steers on January 1, 1965 and an additional set of 116 head every thirty days through November, 1977. All other inputs are prepaid and purchased on the same day the feeder cattle are purchased. During a 150-day feeding period, the steers are assumed to gain at the rate of 2.83 pounds per day. This represents a conversion ratio of 1.0 pound of gain for every 8.4 pounds of feed. On the last day of the feeding period, the 1,056 pound steers (after four percent shrink allowance) are sold for that day's average cash price of 900-1,100 pound Choice steers at Omaha. Only 114 head are sold because it is assumed that two steers will die in the feedlot.

Table 2. Per Head Input Costs for the Custom Cattle Feeding Simulation, 1965-1977

Input	Price Series	Type of Price Used
Feeder Steer @ 675 lbs	Oklahoma City, Choice 600-700 lb. Feeders	Weekly Average
Corn @ 2,550 lbs	Omaha, No. 2 Yellow	Weekly Average
Cottonseed Meal @ 340 lbs	Kansas City, 41% Solvent (Wholesale)	Weekly Average
Alfalfa Hay @ 680 lbs	U.S., Price Paid by Farmers	Monthly Average
Nonfeed Expenses*	NONE	Annual Estimate

*Nonfeed Expenses for 1977 were estimated from data obtained in selected issues of the *Livestock and Meat Situation*. Nonfeed expenses are deflated annually from 1977 to 1965 on the basis of the annual changes in the Index of Prices Paid by Farmers. Interest charges and death loss expenses are excluded.

The feeding operation generates no income until the first pen of cattle is sold on May 30, 1965. From that point in time, a pen of cattle (114 head) is sold every thirty days. For the cash flow computations, the first 30-day interval reported is the period from May 1, 1965 through May 30, 1965. During this period and each succeeding 30-day interval, one set of inputs is purchased (cash outflow) and one set of finished steers is sold (cash inflow).

Interest on borrowed capital is charged at annual rates computed by adding two percent to the annual average prime rate charged by banks (U.S. Dept. of Commerce, 1977). An interest payment on total accumulated debt is included as a part of each 30-day cash outflow. All cash outflows increase debt (or decrease cash surplus if it is available) and all cash inflows are used to decrease debt with no provision to withdraw cash for producer living expense or other investments. If a cash surplus exists, interest on this surplus is earned at a rate that is four percent less than the prevailing rate paid on borrowed capital.

Calculation of Cash Flows From Futures Transactions

The finished steers are assumed to meet Chicago Mercantile Exchange futures contract specifications for par market delivery of live cattle. A pen of cattle is hedged (or left unhedged) according to signals specified under the various hedging strategies. Futures contract orders for strategies using point and figure chart formations are filled at the "breakout" price[2] as long as it is within the daily trading range and no limit moves or gaps occur. This is based on the assumption that stop orders may be placed at the calculated breakout price level as a double top or double bottom is observed to be forming. If price gaps and jumps

[2] The breakout price for a sell signal, for example, is the price required to fill the cell which brings a penetration of the double bottom and generates the point and figure sell signal.

the breakout price on any particular day, the order is filled at the settlement price for that day. The settlement price for the next trading day is used when a limit move occurs. All other strategies use the daily settlement price to fill orders for market entry and exit. This approach is based on the assumption that an order can generally be filled within the closing range for any given day.

Cattle which will be ready for sale in non-delivery months or after the 20th day of a delivery month are hedged in the next closest contract month. The contract delivery months used in this simulation are February, April, June, August, October and December. Beginning with the August, 1969 contract, an adjustment is made for the change in trading units from 25,000 pounds to 40,000 pounds. An adjustment is also made for the change in daily limit price fluctuations from $1.00 per cwt. to $1.50 per cwt. in November, 1974. Any futures position in a contract expiring before August, 1969 requires five contracts per pen (114 head), while contracts beginning with August 1969 require three contracts per pen (114 head).

For all strategies, a $1,200.00 initial margin deposit is required per futures contract over the entire feeding period whether the cattle are actually hedged at all times or not. Commissions are charged at $50.00 per "round turn" for the 40,000 pound contracts and adjusted proportionately to $31.25 for the 25,000 pound contracts. Interest on margin money, including required margin calls, is charged at average annual rates.

The last day of a feeding period or the first trading day thereafter signals the offsetting of open futures contracts for that particular pen of cattle under all hedging strategies. It is assumed that no deliveries will be made in fulfillment of futures contracts. The net cash flow from futures transactions, including commissions and interest charges, is calculated at the end of the feeding period and typically coincides with the exact day the cattle are actually sold. Exceptions occur when the last day of the feeding period falls on a weekend or holiday. However, to simplify the analysis the futures flow of cash for all feeding periods will be treated as if it were always received on exactly the same day as the cash market sales receipts.

Selection of Fundamental and Technical Indicators

In formulating the hedging strategies, an attempt is made to keep the futures market entry and exit decision rules as objective and simple as possible. The hedging strategies tested include an unhedged operation and one in which all cattle are routinely hedged for the entire feeding period. Other strategies rely on fundamental and technical indicators to signal the buying and selling of futures contracts.

A single-equation linear regression model is employed to obtain forecast values representative of price expectations. The model is designed to forecast the average quarterly price of 900-1,100 pound Choice steers at Omaha two quarters into the future. Predictions from this model are used in some of the strategies to determine those time periods when pens of cattle should not be hedged.

The moving average signals are generated by the crossing action of 5-day, 15-day and 4-day-weighted moving averages. The point and figure charts are constructed with a 20-cent box size and three box reversal requirement. These technical parameters were chosen from a test of selected parameters commonly used for analyzing futures price movements in live cattle.[3] In the strategies utilizing technical indicators, hedges are placed and lifted according to the appropriate signals.

Projection of Choice Steer Price

Fundamental analysis of market conditions is essential to the process by which price expectations are formed. The need to simplify this process for testing purposes suggests the need for a model of price behavior. Due to the importance attached to the role of price expectations in selective hedging, this section is devoted to the construction of a behavioral model to forecast Choice steer price.

The objective of the price model is to predict the average quarterly price of Choice steers two quarters into the future. To accomplish this, least squares linear regression was employed. The variables included in the single equation model were selected on the basis of economic reasoning, statistical significance, and contribution to explanatory power. Much of the framework for this model was drawn from an earlier work by Moore (1975). This section discusses (1) theoretical considerations for the behavioral equation, (2) projection models for three independent variables, and (3) the results of the price regression equation.

Theoretical Considerations for the Behavioral Equation

In the complex reality of market price determination, it cannot be correctly assumed that any practical model will yield exact predictions. A practical model yielding inexact (but valuable) predictions necessarily contains some error in its behavioral equation(s). This error arises due to imperfect knowledge or because practical considerations make it necessary to limit attention to a relatively small number of the most important variables. Error of this type is accepted because it cannot be avoided. Of

[3] The tests employed involved comparisons in terms of net contribution to the cash flow, the capacity of each strategy to "block" the sustained periods of negative cash flow, etc. For more details, refer to the appendix in the M.S. thesis by Riffe (see references).

more direct concern are two additional types of error, specification error and measurement error. Specification error occurs when at least one important variable is omitted from the behavioral equation, or when one or more variables are incorrectly included in the behavioral equation. Measurement error occurs whenever one or more variables cannot be measured accurately. Careful selection of supply and demand variables should minimize these two types of error.

Explanatory variables (or their proxies) were chosen and tested in the model on the basis of a priori economic reasoning. After evaluating several variables for statistical significance and contribution to explanatory power, the variables which were relatively weak in terms of statistical measures were re-examined for their contribution to total explanatory power. Some of the variables were rejected from the model. The variables retained in the behavioral equation include: Choice steer price (dependent), wholesale beef price, fed marketings of cattle, U.S. per capita real disposable personal income, pork production, non-fed beef production, cold storage holding of beef, retail pork price, seasonal dummy variables, and a dummy variable to account for variation caused by the price controls of 1973.

The data series for the dependent variable was obtained from daily price quotes for 900-1100 pound Choice steers at the Omaha market as reported by *The Wall Street Journal* (1965-1977). The actual observations are simple quarterly averages of the daily price quotes. The Omaha market was used as a data source because of its importance and the widespread availability of its daily market information.

The independent variables in the price model include those to which price displays a lagged response and those to which price responds in the current time period. It is assumed that the impact of the lagged explanatory variables on price is not completely spent in one time period, and further, that a significant portion of the impact is carried at least two quarters into the future. The objective of predicting price two quarters into the future requires prediction of those variables to which price responds in the same or current quarter. The variables considered to be of sufficient importance to merit construction of separate two-quarter projection models were fed marketings of cattle, pork production, and per capita real disposable personal income.

Variables Indicating the Supply of Choice Beef

Choice steers are a major subset of the total number of fed cattle. Fed cattle marketings are reported by the USDA each quarter for the twenty-three major cattle feeding states. This variable is considered to be the primary supply variable for Choice slaughter steers and is projected by a model described later in this section.

Another variable which influences the supply of Choice beef in a particular quarter is the amount of Choice beef in storage. Data on the storage holdings of Choice beef are not available, but a data series is available for the end-of-quarter cold storage holdings of all frozen and cured beef. This variable is not expected to be extremely powerful because cold storage holdings do not usually represent a large proportion of the total beef supply. However, examination of the data indicates that there should be a fairly strong seasonal component with cold storage holdings being seasonally low in the third quarter and seasonally high in the fourth quarter. It is also possible that as meat processors perceive that prices are rising they begin to slaughter more cattle per day thus putting some of the "excess" in short-term storage.

Variables Indicating the Demand for Choice Beef

The demand for Choice steers is derived from the consumer's willingness and ability to pay. Thus, it would be helpful to choose an explanatory variable which monitors any changes in the "average" consumer's willingness and ability to pay for Choice beef. The variable selected is U.S. quarterly per capita real disposable income. This variable is computed from the results of two projections: (1) U.S. quarterly per capita disposable income, and (2) the Consumer Price Index, 1967=100. The income projection is deflated by the Consumer Price Index projection to put the variable in real terms.

The demand for Choice beef is also affected by the price and availability of substitutes. Quarterly commercial pork production is projected separately because it represents the supply of the primary substitute for Choice beef. It is expected that as pork production rises (falls), Choice steer price will fall (rise) in the same quarter, other things equal.

Retail pork price is also included as an explanatory variable. Simple correlation analysis between lagged retail pork price and Choice steer price reveals a correlation coefficient of $r = .70$. The length of the response time lag probably varies over time, but retail pork is expected to add to the explanatory power of the model.

Another substitute for Choice beef is beef of lower grades. A suitable data series measuring the number of non-fed cattle marketed is not available. As a proxy for this variable, quarterly differences between 100 percent and fed marketings as a percent of total commercial cattle slaughter were calculated. The result is a series of percentages consisting of cow slaughter and all other non-fed beef. The non-fed beef other-than-cows component is hypothesized to contain a cyclical influence not present in any other variable in the model. During the liquidation phase of the cattle cycle, the percentage of total commercial cattle slaughter represented by non-fed beef tends to increase dramatically, reach a peak, and

taper off as a new phase of the cycle begins. Thus, the variable has a strong negative correlation to Choice steer price. Although price might not be expected to display a lagged response to the percentage of non-fed beef supplied, testing revealed that the strongest contribution to explanatory power occurred with a one-quarter lag. This is not ideal for a two quarter model, but it was also observed that the influence of the variable is not spent entirely in one quarter. For this reason it was deemed unnecessary to project total commercial cattle slaughter to obtain a value for the non-fed variable one or two quarters into the future.

Wholesale beef price was included as a lagged variable to help set the general price level for the forecasts. Since the demand for Choice steers is derived from the demand for the finished product, it might seem more logical that retail prices be used. However, retail beef prices did not predict as well as wholesale prices, perhaps because retail prices are less flexible in the short run.

Other Variables

Quarterly dummy variables were included in the model to help account for seasonal influences not explained by other independent variables. These seasonal influences might be due to such factors as weather or consumer buying patterns. The dummy variable representing the first quarter was omitted to avoid the statistical problem of singularity. Its effect is measured by the intercept term. In addition, a dummy variable was included in an effort to account for variation caused by price controls in 1973.[4] Each dummy variable has the value zero in all quarters except its designated quarter(s) where it has the value one.

These binary variables are placed in the model on theoretical grounds. Therefore, they are retained in the model without regard to statistical significance or contribution to explanatory power.

Fed Cattle Marketings Projection Model and Results

To obtain a value two quarters into the future for fed cattle marketings, a separate projection model was constructed. As in the price model, the variables were chosen on the basis of economic relevance, statistical significance, and explanatory power. The independent variables are discussed below. The dependent variable is the same fed cattle marketings previously described as an independent variable in the price model.

[4] The dummy variable was assigned the value 1 for the 4 quarters of 1973 and the first 2 quarters of 1974 to pick up the impact of the price ceiling during the period it was in effect and the lagged effect through the first 2 quarters of 1974.

Variables Affecting the Supply of Fed Cattle

In any given year, the supply of feeder cattle is relatively fixed. The pool of cattle from which all Choice beef is eventually drawn is estimated by the USDA each year as of January 1 (U.S. Dept. of Agriculture, 1965-1977b). The inventory variable used in this model consists of all heifers, steers, and bulls under 500 pounds plus steers over 500 pounds.

An estimate of the number of cattle on feed as of the first day in each calendar quarter is also reported by the USDA. The 23-state estimate is broken down by sex and weight. Two explanatory variables were constructed from this information. The number of steers on feed in the 700-899 pound weight category contains an estimate of the number of steers which would ordinarily come out of the feedlot in four to six months at weights of 900-1,100 pounds. The second variable is the sum of the heifers on feed in the less than 500 pound and 500-699 pound weight categories. This variable contains the number of heifers which would ordinarily come out of the feedlot in four to six months at weights of 800 900 pounds.

Variables Indicating the Profitability of Feeding Cattle

The ratio of the quarterly average price of Choice steers to the quarterly average price of cash corn at Omaha is included to serve as an indicator of the relative profitability of feeding cattle. It is expected that as the beef-corn ratio gets larger, more cattle will be placed on feed and be ready for market approximately five months later.

A data series expected to indicate the trend in prices for Choice steers was computed by subtracting the annual average price of the previous year from the current quarterly average price. An increase in the value of the trend variable is hypothesized to have a negative impact on fed marketings because cattle feeders tend to hold cattle and feed them to heavier weights during periods of rising prices. This delays placement of lightweight cattle on feed so that fewer fed cattle will be ready for market in four to six months.

Other Variables That Influence Fed Marketings

As in the price model, quarterly dummy variables were included to help account for seasonal variation not explained by other independent variables. A dummy variable was also included to account for variation caused by the liquidation phase of the cattle cycle as gauged by the percent of non-fed slaughter observed over time.[5]

[5] The liquidation phase of the cycle is judged to be over when non-fed slaughter runs no more than 40% for 3 consecutive quarters.

Table 3. Description Of Variables Used In Fed Marketing Equation

D2, D3, D4	Dummy variables for seasonal variation. Each is numbered according to the calendar quarter of the year that it represents and has the value of 1 in that quarter. Each dummy variable has a value of O otherwise.
DCYCLE	Dummy variable for cyclical variation. The variable has the value 1 during the liquidation phase of the cattle cycle and O otherwise.
INV1	January 1 inventory of heifers, steers, and bulls less than 500 lbs plus steers 500 lbs and over. (1,000 head).
TREND	The current quarterly average price of Choice steers at Omaha minus last year's annual average price. ($ per cwt.).
BFCORN	The ratio of the quarterly average price of Choice steers at Omaha to the quarterly average price of No. 2 Yellow Corn at Omaha. (bu. per cwt.).
STR7-9	Steers on feed in the 700-899 lb. weight category in the twenty-three major cattle feeding states. (1,000 head).
HFRO-7	Heifers on feed in the 0-499 lb. and 500-699 lb. weight categories in the 23 major cattle feeding states. (1,000 head).

Table 4. Estimated Two Quarter Regression Equation for Fed Cattle Marketings

	Coefficient	t**	Probability***
Intercept	—4402.101	(—3.09)	0.0037
D2	—1471.614	(—7.45)	0.0001
D3	—1434.885	(—7.52)	0.0001
D4	— 648.472	(—5.39)	0.0001
Dcycle	— 646.219	(—2.48)	0.0174
Inv1	0.17594	(4.91)	0.0001
Trend	—62.531	(—6.10)	0.0001
BFCorn	—26.427	(—1.43)	0.1597
Str7-9	0.64252	(3.19)	0.0028
Hfro-7	1.56725	(5.90)	0.0001
R^2	.899		
Std. Dev.*	227.12		
Durbin	1.617		

*Compared to a mean of 5,827.22 thousand head.
**Numbers in parenthesis are calculated t-values of estimated coefficients.
***Numbers represent the probability of obtaining an equal or greater absolute value of t if B=O.

Results of the Fed Marketing Regression

The pseudonyms and descriptions of the variables used in the fed marketing regression are presented in Table 3. Table 4 shows the estimated equation and some of the relevant statistics. The explanatory variables accounted for 89.9 percent of the variation in fed cattle marketings.

The estimated equation had a standard deviation of 227.12 thousand head, compared to a mean of 5,827.22 thousand head. The largest residual, —547.28 thousand head, occurred in the second quarter of 1973. All but two of the estimated coefficients were significant at observed significance levels of less than 0.01. By examining the simple correlation coefficients, it was quite evident that multicollinearity existed in the data set.

The BFCORN coefficient had a different sign than was expected on theoretical grounds, but was correlated with INV1 ($r = -.59$), TREND ($r = -.36$), DCYCLE ($r = -.80$), STR7-9 ($r = .42$), and HFRO-7 ($r = .40$). The calculated t-value for BFCORN (—1.43) was also lower than expected. Since these effects appeared to be caused by multicollinearity, BFCORN was kept in the model due to its conceptual economic significance. The overall predictive power of the model may be observed from the plot of actual and predicted values in Figure 4.

The predicted values for the third and fourth quarters of 1977 are forecast values outside the base period of the model (Figure 4). The large forecast error observed for these two values is believed to be accentuated by the fact that the observed data values for BFCORN and TREND were the only variables not indicating a relative decrease in fed marketings for the third quarter. Also, a decrease in fed marketings was indicated by all of the observed data values for the fourth quarter forecast, which has been a rare occurance in the base period. Although actual fed marketings did decline in both quarters, the model overstated this decline.

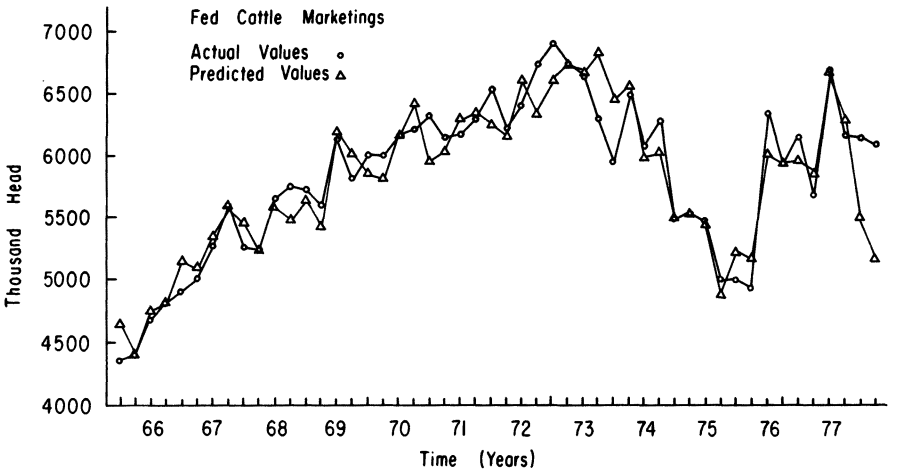


Figure 4. Actual and Predicted Quarterly Fed Cattle Marketings, 1965-1977.

Pork Production Model and Results

This model was constructed to project a value for pork production two quarters into the future. The dependent variable is the same quarterly commercial pork production described as an explanatory variable in the price model.

Variables Indicating Slaughter Hog Numbers

The number of sows farrowing at any point in time has a direct effect on the number of hogs slaughtered six to eight months later. Therefore, the number of sows being slaughtered in a particular quarter may influence the amount of pork produced two quarters later. To measure the relative number of sows going to slaughter each quarter, a variable was constructed consisting of sow slaughter under federal inspection as a percent of total hog slaughter. It is expected that sows will be slaughtered more heavily when producers expect lower prices in the future. The relative level of this variable is expected to account for some cyclical variation in the amount of pork produced.

Another important factor in determining slaughter hog numbers two quarters into the future is the number of hogs in the United States weighing less than 60 pounds in the current quarter. This is the group which will be ready for market in the projection quarter. The USDA reports this figure quarterly in its **Hogs and Pigs Inventory.** (U.S. Dept. of Agriculture, 1965-1977.)

Variables Indicating the Probability of Producing Hogs

The ratio of U.S. No. 1-2 200-220 hogs at Omaha in dollars per cwt. to the price of No. 2 Yellow Corn at Omaha in dollars per bushel is included as an indicator of the profitability of feeding hogs. The hog-corn ratio is lagged four quarters from the dependent variable because it is expected that a change in the profitability of feeding hogs will not affect pork production for about a year. This allows time for producers to react, a month from weaning to rebreeding for the sow, a 3.75 months gestation period, and a five to six month feeding period.

It is hypothesized that those producers who produce both pork and beef will shift emphasis of resources from one to the other as the gap between the hog-corn ration and the beef-corn ration widens or narrows. These fluctuations are not expected to affect pork production for about one year. The beef-corn ratio is included as described previously in the fed marketings model, except that it is lagged four quarters from the dependent variable.

To help explain the behavior of the pork producer who must purchase all of his feed input (as opposed to producing it), a variable combining the costs of the major feed inputs is included. The feed variable is measured in dollars per cwt. and is calculated by adding 12 percent of the quarterly average price of soybean meal to 88 percent of the quarterly average price of corn.

Other Variables That Influence Pork Production

A two-quarter lag of the dependent variable was included to improve the accuracy of the forecasts by setting the general level of production and the position within the hog cycle. Dummy variables were included to account for seasonal variation not explained by other variables in the model. The dummy variables were constructed in a fashion similar to those in the price model.

Results of the Pork Production Regression

Table 5 contains a list of the variable pseudonyms and descriptions. The estimated coefficients and other statistics from the pork production regression are shown in Table 6. The explanatory variables accounted for 80.1 percent of the variation in pork production. The standard deviation was 167.72 million pounds (mean = 3,162.02) with the largest residual, —432.43 million pounds, occuring in the third quarter of 1973.

Table 5. Description Of Variables Used In Pork Production Equation

D2, D3, D4	Dummy variables for seasonal variation. Each is numbered according to the calendar quarter of the year that it represents and has the value of 1 in that quarter. Each dummy variable has a value of 0 otherwise.
SOWPCNT	Sow slaughter under federal inspection as a percent of total hog slaughter.
WT1	The number of hogs in the U.S. weighing less than 60 lbs. (1,000 head).
HCR4	The ratio of U.S. #1-2 200-220 lb. hogs at Omaha in dollars per cwt. to the price of No. 2 Yellow Corn at Omaha in dollars per bushel.
BFCORN4	The ratio of choice 900-1100 lb. steers at Omaha in dollars per cwt. to the price of No. 2 Yellow Corn at Omaha in dollars per bushel.
FEED	12% of soybean meal price plus 88% of corn price. All prices are measured in dollars per cwt.
PORKLAG	Two quarter lag of the dependent variable, pork production. (1,000 head).

Table 6. Estimated Two Quarters Regression Equation for Pork Production

	Coefficient	t**	Probability***
INTERCEPT	698.072	(1.76)	0.0849
D2	—305.044	(—3.35)	0.0018
D3	—347.478	(—3.01)	0.0045
D4	—207.702	(1.46)	0.1502
SOWPCNT	—19.987	(—0.87)	0.3885
WT1	0.06139	(2.38)	0.224
HCR4	34.442	(3.12)	0.0034
BFCORN4	—11.370	(—1.13)	0.2622
FEED	—70.206	(—2.18)	0.0349
PORKLAG	0.55181	(5.15)	0.0001
R^2	.801		
STD. DEV.*	167.72		
DURBIN	1.288		

*Compared to a mean of 3,162.02 million pounds.
**Numbers in parenthesis are calculated t-values of estimated coefficients.
***Numbers represent the probability of obtaining an equal or greater absolute value of t if B=O.

The t-values of the variables, most noticeably SOWPCNT (t = —.87), appear to be rather low. Although some multicollinearity exists in the data, it alone is probably not sufficient to cause severe problems. A more likely explanation is the possibility of first order autocorrelation in the disturbance terms. At the 5 percent significance level, the Durbin-Watson statistic of 1.288 is very near the boundary between positive autocorrelation and the inconclusive range but the test is not reliable because of the lagged dependent variable being used as an explanatory variable. Much of the autocorrelation which appears to exist is probably due to a partial dependence between the lagged dependent variable and the disturbances. Removing the lagged dependent variable from the model would lessen the probability of obtaining biased coefficients, but this greatly reduces the explanatory power of the model. In this model and subsequent models using lagged dependent variables, it is assumed that the same pattern of autocorrelation will exist in the future as existed over the estimation period, 1965-1977. Figure 5 illustrates the predictive power of the model with a plot of actual and predicted values. The predicted values for the third and fourth quarters of 1977 are forecast values outside the base period of the model.

U.S. Per Capita Real Disposable Personal Income Projection Models and Results

Two projection models were formulated to construct U.S. per capita real disposable personal income: (1) a model to project U.S. per capita disposable personal income, and (2) a model to project the Consumer

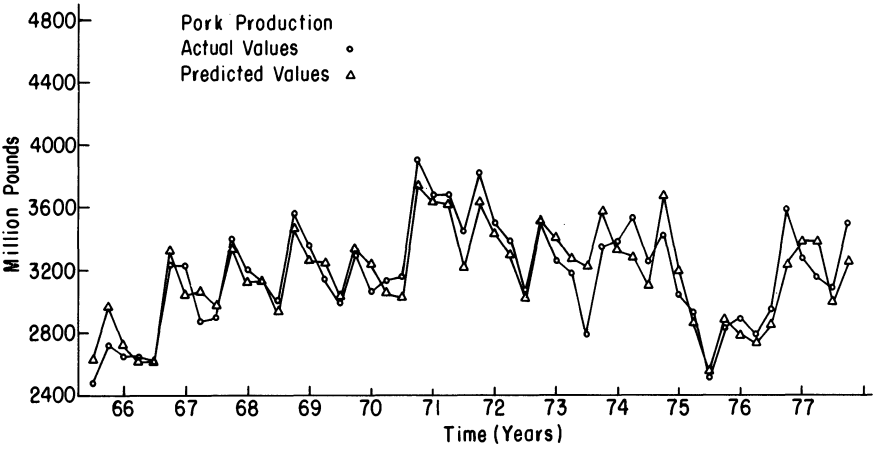


Figure 5. Actual and Predicted Quarterly Pork Production, 1965-1977.

Price Index. The projection from model (1) is deflated by the projection obtained from model (2) to form the explanatory variable used in the price model.

United States Per Capita Disposable Personal Income Model

The dependent income variable is reported in Survey of Current Business (U.S. Dept. of Commerce, 1965-1977). By examining the quarterly data, it is apparent that per capita disposable personal income has been increasing over time. It was hypothesized that a regression with time as the only explanatory variable might yield satisfactory results. A model with time and the lagged dependent variable was selected, however, because the lagged dependent significantly improved the explanatory power of the model.

Table 7 contains the results of the regression equation. The results indicate that the model explained 99.8 percent of the variation in U.S. per capita disposable personal income with a standard deviation of $50.78 (mean = $3,075.57).

Consumer Price Index Model

The dependent variable is the quarterly Consumer Price Index, 1967 = 100. The index is found in **Survey of Current Business,** (U.S. Dept. of Commerce, 1965-1977) as well as many other publications. It was

Table 7. Estimated Two Quarter Regression Equation For U. S. Per Capita Disposable Personal Income

INTERCEPT	TIME	LAGGED DEPENDENT	R^2	STD. DEV.*	DURBIN
—72.827	1.867	1.050	.998	50.78	.841
—(3.01)**	(2.18)	(57.60)			
[0.0035]***	[0.0320]	[0.0001]			

*Compared to a MEAN of $3,075.57.

**Numbers in parenthesis are calculated t-values of estimated coefficients.

***Numbers in brackets represent the probability of obtaining an equal or greater absolute value of t if B=O.

hypothesized that variation in the Consumer Price Index could be explained by a regression with time and the lagged dependent as the only explanatory variables. Table 8 contains the results of the regression equation. The regression statistics indicate that the model explained 99.4 percent of the variation in the Consumer Price Index.

U.S. Per Capita Real Disposable Personal Income Projection

The predicted values from the income projection model were deflated by the appropriate predicted values from the Consumer Price Index model to form the explanatory data series for the price regression

Table 8. Estimated Two Quarter Regression Equation For The Consumer Price Index, 1967=100

INTERCEPT	TIME	LAGGED DEPENDENT	R^2	STD. DEV.*	DURBIN
3.667	0.23175	0.96228	.994	1.91	.147
(1.05)**	(3.29)	(22.49)			
[0.29641]***	[0.0019]	[0.0001]			

*Compared to a mean of 125.59.

**Numbers in parenthesis are calculated t-values of estimated coefficients.

***Numbers in brackets represent the probability of obtaining an equal or greater absolute value of t if B=O.

equation. The predictive accuracy of this forecasting procedure is shown in Figure 6, where actual values are plotted against predicted values for U.S. per capita real disposable personal income. The largest residual, —$172.00 occurred in the first quarter of 1973.

Results of the Price Regression Equation

Three groups of variables comprise the two-quarter forecast model: (1) a set of quarterly dummy variables, (2) the projected explanatory variables fed marketings, pork production, and per capita real disposable personal income, and (3) the lagged explanatory variables wholesale beef price, non-fed beef, cold storage holdings of beef, and retail pork price. The variable pseudonyms and descriptions are given in Table 9.

The estimated regression equation is shown in Table 10. The explanatory variables accounted for 94.7 percent of the variation in Choice steer price. The standard deviation was $1.78 compared to a mean of $34.54. The non-binary variables PORKPROD, NONFED, and BEEFSTOR were not significant at the 0.10 level. In the case of PORKPROD, there is a 33 percent probability that the coefficient is not significantly different from zero. However, each of the variables was found to be highly correlated with one or more of the other explanatory variables. For example, PORKPROD is correlated with NONFED ($r = -.58$), D3 ($r = -.40$), D4 ($r = .38$), and FEDMAR ($r = .58$). The true influence

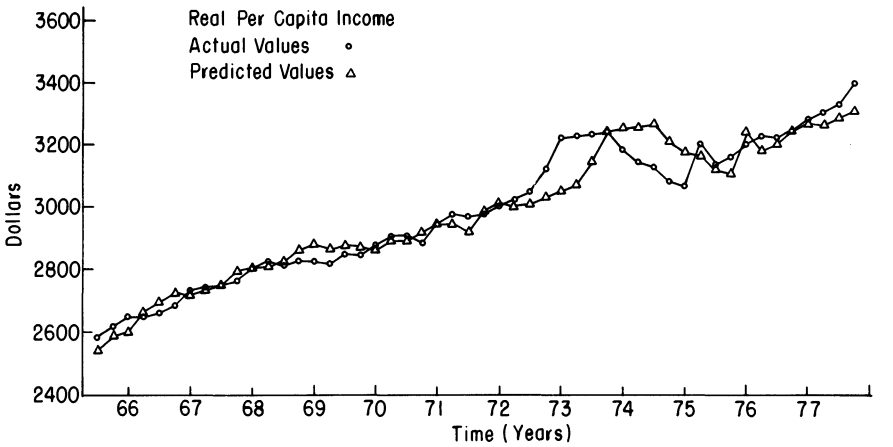


Figure 6. Actual and Predicted Quarterly U.S. Per Capita Real Disposable Personal Income, 1965-1977.

of these variables is believed to be hidden by the effects of multicollinearity since the explanatory power of the model was increased by their presence.

The price forecasts based on actual data are plotted against actual prices in Figure 7. However, the predictive accuracy of the model is

Table 9. Description Of Variables Used In Price Equation

D2, D3, D4	Quarterly dummy variables for seasonal variation.
DFREEZE	Dummy variable to account for variation due to the price controls of 1973.
FEDMAR	Projected fed cattle marketings. (1,000 head).
PORKPROD	Projected pork production. (million lbs.).
INCOME	Projected U.S. per capita real disposable personal income. ($).
WHLSBEEF	Wholesale beef price. ($ per cwt.).
NONFED	Quarterly percentage of total commercial cattle slaughter that is not fed beef.
BEEFSTOR	End of quarter cold storage holdings of beef, 48 states. (1,000 lbs.).
RETPORK	The quarterly average retail price of pork. (¢ per lb.).

Table 10. Estimated Two Quarter Regression Equation For Choice Steer Price

	Coefficient	t**	Probability***
INTERCEPT	—37.756	(—3.06)	0.0041
D2	0.70112	(0.76)	0.4493
D3	—0.39613	(—0.36)	0.7168
D4	—2.98285	(—3.25)	0.0025
DFREEZE	—0.51546	(—0.32)	0.7459
FEDMAR	0.00617	(—6.92)	0.001
PORKPROD	0.00169	(—0.97)	0.3365
INCOME	0.04124	(9.27)	0.0001
WHLSBEEF	0.13647	(2.45)	0.0190
NONFED	—0.17801	(—1.63)	0.1105
BEEFSTOR	—0.0000067	(—0.91)	0.3678
RETPORK	—0.07950	(—2.28)	0.0282
R^2	.947		
STD. DEV.*	1.78		
DURBIN	1.734		

*Compared to a mean of $34.54.
**Numbers in parenthesis are calculated t-values of estimated coefficients.
***Numbers represent the probability of obtaining an equal or greater absolute value of t if B=O.

better judged by comparing actual prices with values generated by the entire forecasting procedure. Such "backcasts" are illustrated in Figure 8. The backcasted values were computed using predicted values for the current period explanatory variables rather than the actual values used in estimating the regression equations. The standard deviation increased to $3.11 per cwt., with the largest residual, —$7.46 per cwt., occurring in the second quarter of 1974. In both Figure 7 and Figure 8, the forecast

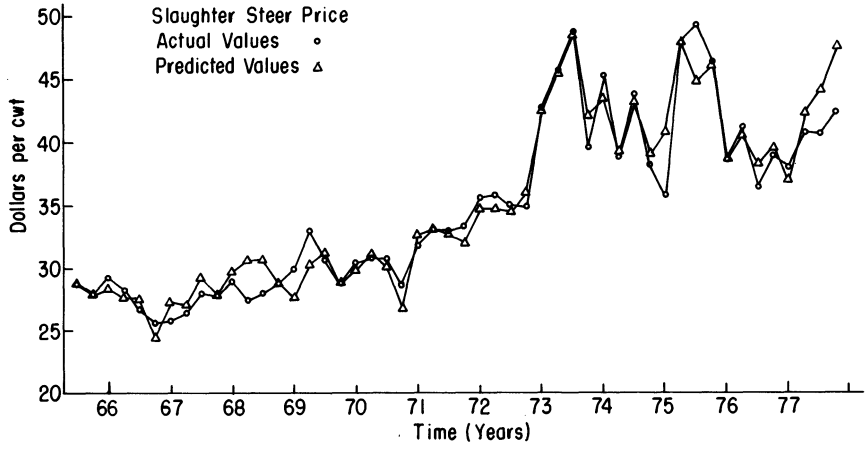


Figure 7. Actual and Predicted Quarterly Average Prices of Choice 900-1,100 Pound Steers at Omaha, 1965-1977.

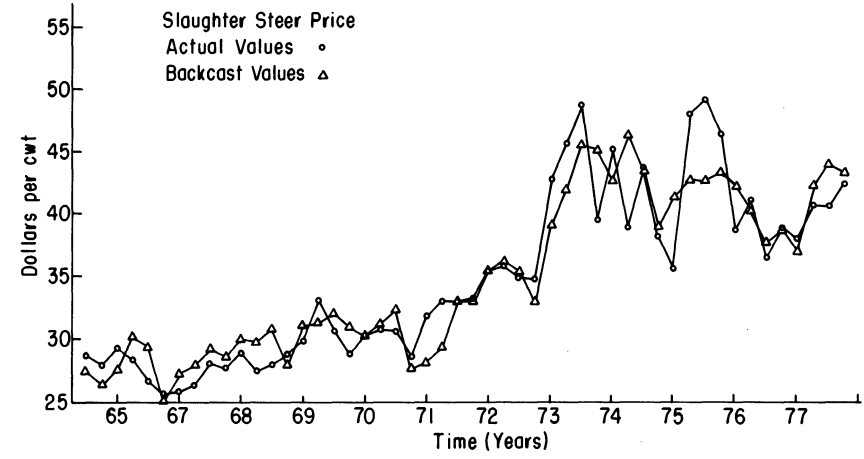


Figure 8. Actual and Backcasted Quarterly Average Prices of Choice 900-1,100 Pound Steers at Omaha, 1965-1977.

values for the third and fourth quarters of 1977 are outside the base period for the model. These values tend to overstate price partly because the fed marketing forecasts underestimated actual fed marketings for these two quarters.

Alternative Hedging Strategies

In this section, the relative effects of seven selected strategies of controlled price risk exposure for a cattle feeding operation are analyzed for the years 1965-1977. The strategies are compared by examining the effect of each on 30-day cash flow balances, total accumulated debt, mean and standard deviation of 30-day cash balances, and the range and frequency distribution of 30-day cash balances.

The Hedging Strategies

Five of the seven price risk management strategies involve the use of the fundamental and technical indicators described in previous sections. One additional strategy consists of complete exposure to cash market price risk throughout the test period. Another strategy involves the routine hedging of all cattle for the entire feeding period. In all strategies, the hedging decisions are designed to be as objective and simple as possible. The model of cattle feeding operation was described earlier. Under each strategy, total debt of $142,136.20 is accumulated before cash inflows begin in May, 1965. This accumulated cash deficit is *not* included in the cash flow pictures which start with Figure 9 below. As noted earlier, the first entry is the net for the 30-day period ending May 30, 1965.

Strategy I

This is the strategy of complete exposure to price risk and corresponds to the unhedged production and marketing activities of the feeding operation. This strategy is used to measure the relative effects of the other strategies and to illustrate the effects of complete exposure to price risk. The simulated 30-day net cash flows of the cattle feeding operation are shown in Figure 9 .The points on the graph represent the 30-day net cash transaction balances of the operation as of the last day of each 30-day period. The periods do not correspond to calendar months, so it

is possible for some years to contain 13 observations (1970 and 1976 for example). From mid-July, 1972 through early April, 1975 (Figure 9) is a period of generally sustained cash flow deficits. During this period, the total accumulated debt increased from $51,416.03 to $187,106.70.

A period of short-run improvement followed but in January of 1976, severe cash flow deficits were again present and persisted during the remainder of the test period. Total accumulated debt increased from $129,928.20 in January, 1976 to $259,242.50 at the end of the test period. The measure of the six hedging strategies will largely depend on their performance in improving the financial stability of the feeding operation in these two major periods of sustained cash deficits. In discussing each remaining strategy, these periods will be referred to as the "1972-1975 deficit period" and the "1970-1977 deficit period", respectively.

The mean 30-day cash balance for the entire test period was —$1,450.96 with a standard deviation of $5,103.35. The largest single 30-day cash net flow was $10,584.63 and the smallest 30-day cash net flow was —$17,924.60.

Strategy II

In this strategy, the cattle are hedged according to signals generated by double bottom formations on a point and figure chart with a $.20 box size and 3-box reversal requirement. The short hedge is held until a double top formation signals higher prices. The hedge is then lifted until another double bottom formation signals lower prices.

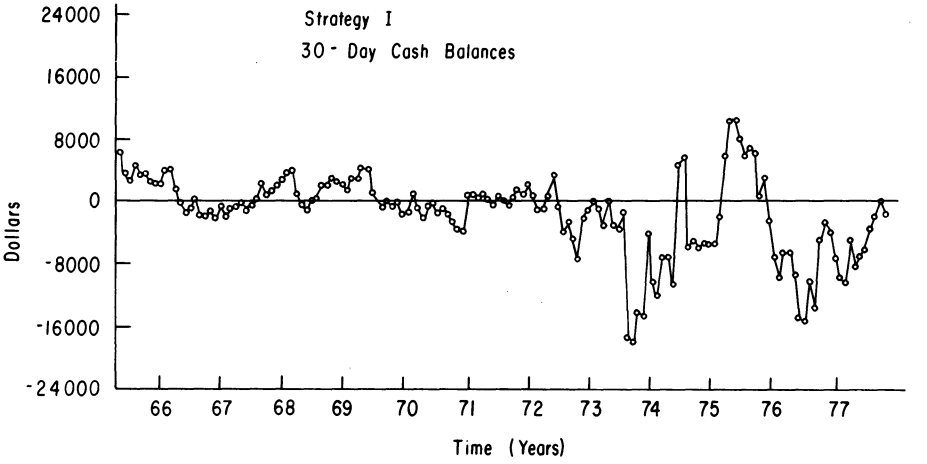


Figure 9. Simulated 30-Day Cash Balances from Strategy with No Hedging, 1965-1977.

The simulated 30-day cash balances resulting from adherence to this strategy are shown in Figure 10. The 1972-1975 deficit period (from Strategy I) was shortened by more than a year. Cash deficits were not as severe in 1972-1973 under this strategy as they were under Strategy I, but became more of a problem in 1973 than under Strategy I. In April, 1975 total accumulated debt was $176,653.49 less under this strategy than under Strategy I. The 1976-1977 deficit period was still severe under this strategy, but total accumulated debt at the end of the test period was $180,480.37 less than under Strategy I. From June, 1975 through early February, 1976 the cattle feeding operation was completely debt free under this strategy and enjoyed a maximum cash surplus of $19,113.93 in November, 1975.

The mean 30-day cash balance for the entire test period under this strategy was $19.57, with a standard deviation of $4,414.89. The largest 3-day cash net flow was $19,207.96 and the smallest 30-day net flow was —$9,878.88.

Strategy III

Strategy III combines the point and figure chart formation approach of Strategy II with the results of the price forecasting model. In an effort to eliminate the advantage of hindsight, the "backcasted" price projections described earlier are used to determine the time periods in which cattle are not hedged. The forecasted cash price is adjusted by adding the value of one standard deviation ($3.11 per cwt.) to the forecast from the estimated regression equation. If the adjusted cash forecast price is

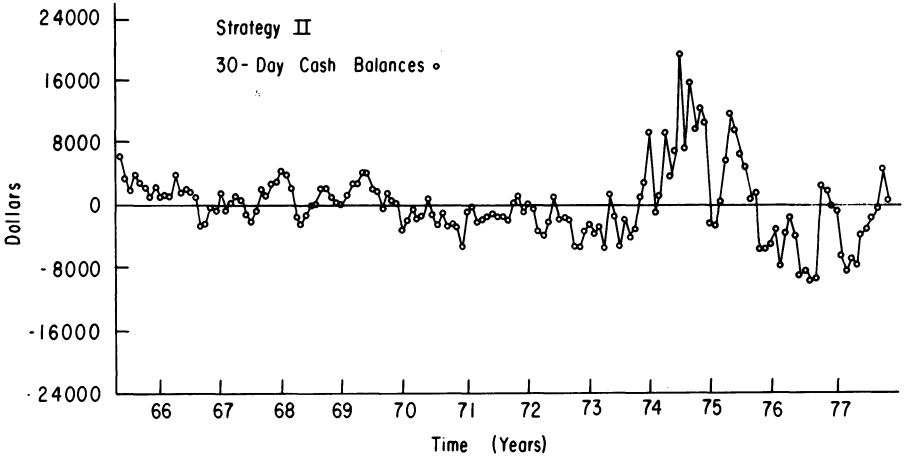


Figure 10. Simulated 30-Day Cash Balances from Strategy with $.20 x 3 Parameter Point and Figure Chart Signals, 1965-1977.

greater than the average price of the appropriate futures contract during the previous month, the cattle are not hedged. In those time periods when hedging is permitted under this procedure, the hedge is placed and lifted according to the point and figure chart signals used in Strategy II.

Figure 11 illustrates the simulated 30-day net cash balances obtained by following this strategy. The 30-day balances are exactly the same as those in Strategy I prior to December, 1973. At the end of the 1972-1975 deficit period, total accumulated debt was $106,054.57 less under this strategy than under Strategy I. The 1976-1977 deficit period is less severe than under Strategy I, but more severe than under Strategy II. At the end of the test period, total accumulated debt was $135,526.50 less under this strategy than under Strategy I.

The mean 30-day cash balance for the cattle feeding operation under this strategy was —$320.87 with a standard deviation of $5,084.79. The largest 30-day net cash flow was $18,796.06 and the smallest 30-day flow was —$17,924.60.

Strategy IV

The hedging signals are given by the crossing action of 5-day, 15-day, and 4-day-weighted moving averages. The hedge is lifted when the averages signal that price will be rising to higher levels and replaced whenever the averages again signal lower price levels.

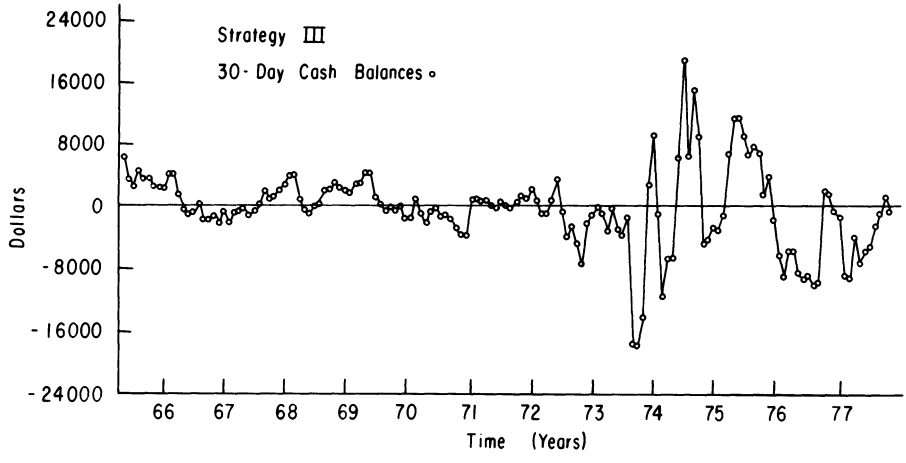


Figure 11. Simulated 30-Day Cash Balances from Strategy with $.20 x 3 Parameter Point and Figure Chart Signals Only When Forecast Price Is Favorable for Hedging, 1965-1977.

The simulated 30-day cash balances from this strategy are shown in Figure 12. It is obvious that the 1972-1975 deficit period is more favorable under this strategy than under Strategy I. However, the cash balances in 1971 and early 1972 were more favorable under Strategy I. At the end of the 1972-1975 deficit period, total accumulated debt was $159,385.33 less under this strategy than under Strategy I. By comparing the 1976-1977 deficit period for this strategy and Strategy I, it appears that cash flows were generally improved but not as dramatically as in the 1972-1975 deficit period. Total accumulated debt was $194,992.13 less under this strategy at the end of the test period than under Strategy I. Under this strategy, the cattle feeding operation was debt free from July, 1975 through July, 1976 with a maximum cash surplus of $24,740.77 in March, 1976.

The mean 30-day cash balance for the entire test period was $73.45 with a standard deviation of $4,588.63. The largest 30-day net cash flow was $19,237.89 and the smallest 30-day net cash flow was —$11,222.82.

Strategy V

Strategy V combines the results of the price forecasting model with the 5-day, 15-day, 4-day-weighted moving averages. The only difference between this strategy and Strategy III is that when cattle are hedged, moving averages signals are used rather than point and figure chart formations.

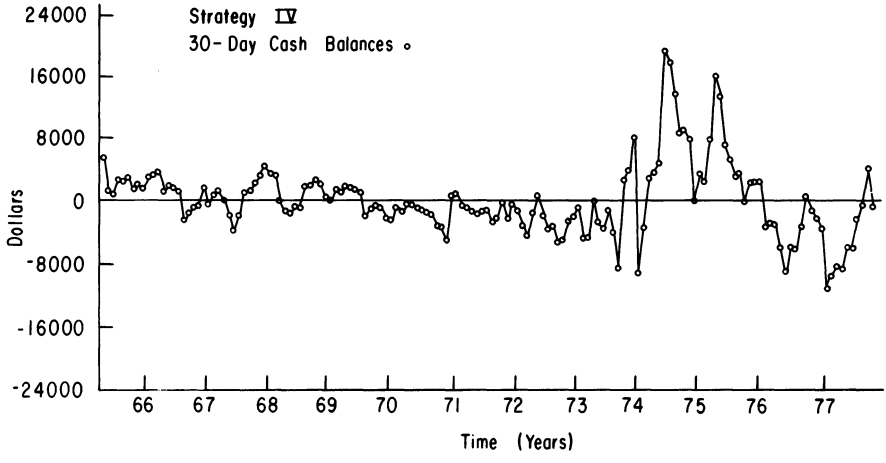


Figure 12. Simulated 30-Day Cash Balances from Strategy with 5-Day, 15-Day, 4-Day-Weighted Parameter Moving Average Signals, 1965-1977.

The simulated 30-day cash balances are plotted in Figure 13. The cash flow balances in Figure 13 and Figure 11 are different in only 18 time periods (as determined by the price forecasts), and this strategy produces results which appear to be significantly different from Strategy III in only four or five time periods. At the end of the 1972-1975 deficit period, total accumulated debt was $114,495.70 less under this strategy than under Strategy I. The total debt at the end of the test period was $145,575.30 less than under Strategy I.

The mean 30-day cash balance for the test period was —$242.25 with a standard deviation of $5,156.41. The largest 30-day net cash flow was $19,065.97, the smallest was —$17,924.60.

Strategy VI

This strategy attempts to provide complete price risk protection. All cattle are routinely hedged on the first day of the feeding period and the hedge is not lifted until the cattle are sold.

The simulated 30-day cash flows are shown in Figure 14. This strategy increased cash flow deficits from mid-1968 through most of the test period as compared to Strategy I. The primary exceptions occurred in mid-1974 and early 1977. At the end of the 1972-1975 deficit period, total accumulated debt was $115,032.40 **more** under this strategy than under Strategy I. By the end of the test period, total debt was $134,364.10 **more** under this strategy than under Strategy I.

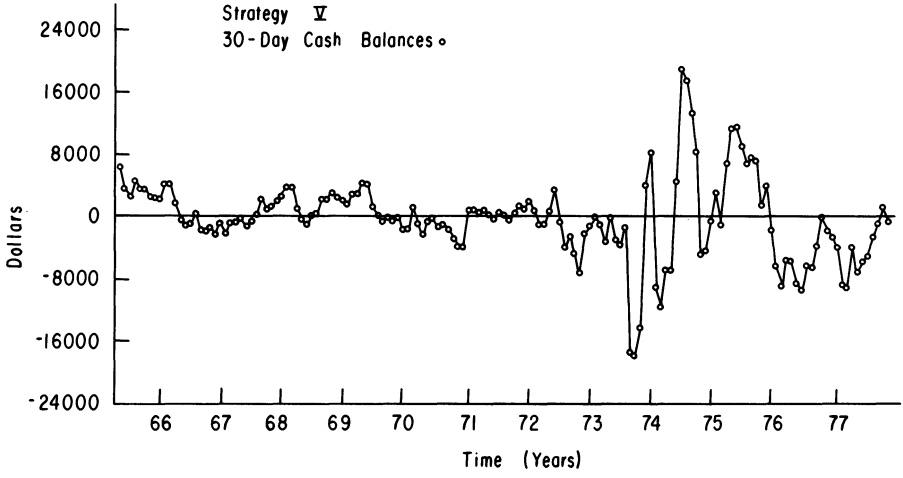


Figure 13. Simulated 30-Day Cash Balances from Strategy with 5-Day, 15-Day-Weighted Parameter Moving Average Signals Only When Forecast Price Is Favorable for Hedging, 1965-1977.

The mean 30-day cash balance for the test period under this strategy was —$3,126.78 with a standard deviation of $5,086.86. The largest 30-day net cash flow was $13,530.14, the smallest was —$20,870.68.

Strategy VII

Strategy VII combines the results of the price forecasting model and the routine hedging of cattle for the entire feeding period. The difference between this strategy and Strategy III (or Strategy V) is that, when cattle are hedged, the hedge is placed on the first day of the feeding period and held until the cattle are sold.

The simulated 30-day cash balances from this strategy are shown in Figure 15. The 30-day balances are exactly the same as those in Strategy I prior to December, 1973. The cash flows for the 1972-1975 and 1975-1977 deficit periods show improvement over Strategy I but have no definite advantage over any of the other strategies utilizing the price forecasts. At the end of the 1972-1975 deficit period, total accumulated debt was $78,632.40 less under this strategy than under Strategy I. By the end of the test period, total debt was $120,894.90 less than under Strategy I.

The mean 30-day cash balance for the test period was —$473.90 with a standard deviation of $4,897.75. The largest 30-day net cash flow was $15,730.52, the smallest was —$17,924.60.

Further Comparisons

The ability of each strategy to reduce the number of periods of cash deficits may be further analyzed by comparing the frequency distribu-

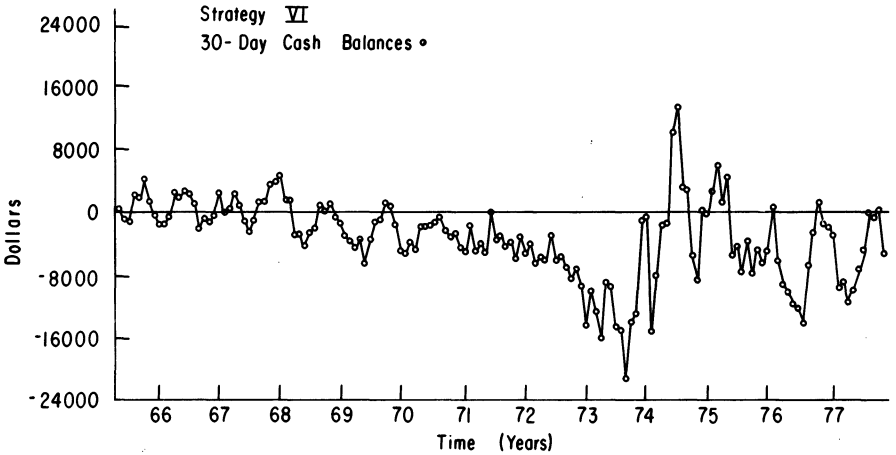


Figure 14. Simulated 30-Day Cash Balances from Strategy of Hedging All Cattle for the Entire Feeding Period, 1965-1977.

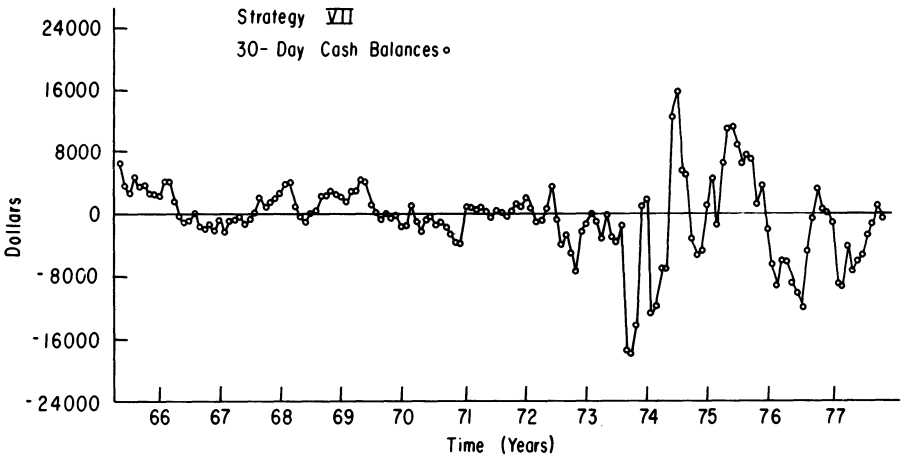


Figure 15. Simulated 30-Day Cash Balances from Strategy of Hedging Cattle for the Entire Feeding Period Only When Forecast Is Favorable for Hedging, 1965-1977.

tions in Table 11. Strategies II and IV appear to do the most to shift the 30-day cash balances toward positive dollar amounts. All of the strategies except Strategy VI seem to have a more favorable frequency distribution than Strategy I. It is interesting to note that the —$1.00 to —$2,500.00 interval has the most frequencies for all strategies. This occurs in spite of the fact that three of the seven strategies have mean balances which lie outside this interval.

One measure of the relative effect that the strategies have on the financial position of the cattle feeding operation is the total accumulated debt at various points in time. Table 12 shows the amount of simulated debt accrued in each strategy as of each 30-day period ending in November for the test period, 1965-1977. The cattle feeding operation has a debt balance of $142,136.30 in May, 1965 for all strategies before any cash inflows are received. The total debt is eliminated under only two strategies, Strategies II and IV, and then only temporarily. The strategies which reduce debt the most from 1974 to 1977 (Strategies II and IV) cause the operation to have a debt load that is generally higher from 1965 to 1973 than Strategy I. This fact may cause the strategies utilizing the price forecasts to be somewhat more appealing than other statistics indicate. The level of accumulated debt carried throughout the test period is very important because it reflects the ability of the cattle feeding operation to stand on its own and because it is inversely related to potential borrowing power.

Table 11. Frequency Distributions Of Simulated 30-Day Net Cash Flows From Alternative Hedging Strateies, 1965-1977

	Dollars													
	Less Than —17500	—15001 to —17500	—12501 to —15000	—10001 to —12500	—7501 to —10000	—5001 to —7500	—2501 to —5000	—1 to —2500	0 to 2500	2501 to 5000	5001 to 7500	7501 to 10000	10001 to 12500	Greater Than 12500
	30-Day Time Periods													
Strategy I	2	1	4	5	4	15	16	41	36	20	6	1	2	0
Strategy II	0	0	0	0	7	10	22	42	42	16	5	4	3	2
Strategy III	2	0	1	2	7	9	15	45	38	20	6	4	2	2
Strategy IV	0	0	0	1	6	8	21	49	36	19	3	5	0	5
Strategy V	2	0	1	1	6	11	16	44	37	22	4	4	2	3
Strategy VI	1	2	6	5	12	19	33	34	27	11	1	0	1	1
Strategy VII	2	0	2	3	4	10	14	44	41	22	6	1	3	1

Table 12. Simulated Total Accumulated Debt Of The Cattle Feeding Enterprise Under Alternative Hedging Strategies, 1966-1977*

Year	Strategy I	Strategy II	Strategy III	Strategy IV	Strategy V	Strategy VI	Strategy VII
				Dollars			
1965	114,066.70	118,034.20	114,066.70	123,100.10	114,066.70	131,134.00	114,066.70
1966	96,747.50	100,771.80	96.747.50	100,749.00	96,747.50	117,664.20	96,747.50
1967	94,648.50	91,829.13	94,648.50	95,939.00	94,648.50	104,573.30	94,648.50
1968	69,850.76	71,346.31	69,850.75	74,010.31	69,850.75	94,581.44	69,850.75
1969	43,501.96	48,376.63	43,501.96	60,760.78	43,501.96	113,106.60	43,501.96
1970	51,998.57	61,255.65	51,898.57	71,116.56	51,898.57	131,417.00	51,898.57
1971	56,062.53	80,377.31	56,062.53	86,657.75	56,062.53	165,707.90	56,062.53
1972	63,491.47	100,979.70	63,491.47	115,700.40	63,491.47	223,920.60	63,491.47
1973	128,714.20	142,920.70	128,714.20	157,275.50	128,714.20	363,100.60	128,714.20
1974	178,038.90	36,281.76	75,433.38	59,320.94	75,662.69	324,374.50	115,223.70
1975	133,495.80	—19,113.93	27,441.50	—18,599.43	19,000.39	316,850.50	54,863.64
1976	209,727.90	51,005.74	90,933.25	12,090.21	70,691.94	371,414.50	107,263.60
1977	259,242.50	78,762.13	123,716.00	64,250.37	113,667.20	393,606.60	138,347.60

*Total accumulated debt is figured as of the last day of the 30-day period ending in November.

Table 13.Summary Of Statistics For Simulated 30-Day Cash Flows From Cattle Feeding Enterprise By Strategies, 1965-1977*

	Mean 30-day Cash Balance	Std. Deviation of 30-Day Cash Balances	Mean of Negative 30-day Cash Balances	Std. Deviation of Negative 30-day Cash Balances	No. of 30-day Periods with Negative Cash Balances	Range of 30-day Cash Balances
Strategy I	—$1,450.96	$5,103.35	—$4,511.02	$4,417.14	88	$28,509 23
Strategy II	19.57	4,414.89	— 2,974.46	2,407.40	81	29,086.84
Strategy III	— 320.87	5,084.79	— 3,607.79	3,884.16	81	36,720.66
Strategy IV	73.45	4,588.63	— 2,824.40	2,479.05	85	30,460.71
Strategy V	— 242.25	5,156.41	— 3,556.96	3,772.46	81	36,990.57
Strategy VI	— 3,126.78	5,086.86	— 5,175 09	4,217.65	112	34,400.82
Strategy VII	— 473.90	4,897.75	— 3,717.73	4,043.27	79	33,655.12

*The analysis from 1965 to 1977 includes 153 cash flow time periods of 30 days each.

Other important statistics are summarized in Table 13. Some additional insight to strategy performance may be gained by analyzing only those 30-day periods with cash deficits. This is especially appropriate for cattle feeders who have exhausted their borrowing capacity. None of the strategies dramatically reduce the number of 30-day periods with negative cash balances (Table 13). Strategy IV has the least negative mean balance in these periods, but of all the strategies, it has the third largest number of 30-day periods with cash deficits. Strategy VII has the least number of cash deficit periods, but also has the third most negative mean (of negative periods, Table 13). Strategy VI is the only hedging strategy that does not yield a higher mean return than Strategy I.

Earlier, the distribution of profits over time was emphasized as being more important to the "high risk" cattle feeder than the long-run level of total profits. Similarly, the number of 30-day periods with negative cash balances may not be as important as the manner in which those periods are distributed over time. Looking back at Figure 9 (Strategy I), there are only two periods of positive cash balances in the 1972-1975 deficit period and one in the 1976-1977 deficit period. By comparison, Figure 10 (Strategy II) shows fifteen periods of positive cash balances in the 1972-1975 deficit period and four periods of positive cash balances in the 1976-1977 deficit period. All of the hedging strategies reduced the number of negative cash flow periods within these two major deficit periods. Close examination of Figure 10 and 12 reveals a trade-off between relatively larger cash balances in the major deficit periods and relatively smaller cash balances in other periods such as 1971. The strategies utilizing the price forecasts (Figures 11, 13, and 15) do not exhibit the trade-off, but also do not deal as effectively with cash deficiencies in the major deficit periods as do Strategies II and IV. Strategy VI tends to accentuate both the size and number of cash deficits.

Selective hedging strategies appear to offer alternative results which allow the cattle feeder to operate at lower levels of debt than would be possible under a strategy of complete exposure to price risk or a strategy involving total hedging. The choice of strategies depends upon the individual's preference and financial situation. The results indicate that cattle feeders (and lenders) may wish to assess and compare such alternative strategies of price risk exposure.

Summary and Conclusions

Cattle feeders have absorbed tremendous losses within the past five years due to unfavorable price movements. As a result, many have almost exhausted their borrowing capacity. The weakened financial position of

these producers is a cause for concern for borrower and lender. Lenders have generally been willing to refinance old debt whenever possible to help their cattle feeding customers through periods of cash flow deficits. However, such action does nothing to reduce the probability of severe cash flow problems in subsequent periods. The primary objective of this study was to develop and test hedging strategies to improve the financial positions of those cattle feeders experiencing repayment difficulties.

Selective hedging was presented as a logical management procedure for altering the level of price risk exposure in an effort to deal with the problem of extensive cash flow deficits. Simple fundamental and technical tools of price analysis were analyzed as selective hedging guides.

To evaluate the performance of the fundamental and technical tools of analysis, a computerized procedure was developed to simulate the 30-day net cash balances of a cattle feeding enterprise from 1965 to 1977. In each 30-day time period, a set of inputs was purchased and a set of finished steers was sold. Daily data were used to simulate futures transactions, costs, and returns under each of the methods of analysis. The cash market costs and returns were based on a fixed bundle of inputs and outputs with appropriate average prices throughout the test period. The net returns from cash and futures market transactions were used to calculate interest charges, changes in total accumulated debt, and net cash balances for each 30-day interval.

A quarterly price forecasting model was constructed. The price regression equation explained approximately 94 percent of the variation in the Choice steer price series. Estimates from the model were used as forecast values in deciding when to hedge in selected hedging strategies.

The relative effects of alternative hedging strategies on repayment ability and the distribution and level of 30-day cash balances were simulated for a cattle feeding enterprise. The strategies tested were:

I) No hedging. A strategy of complete exposure to price risk.

II) The hedge is placed and lifted according to signals from double bottom and double top formations on a point and figure chart with a 20-cent box size and 3-box reversal requirement.

III) The hedge is placed and lifted as in Strategy II if the average futures price for the previous month is greater than the cash price forecast for the end of the feeding period.

IV) The hedge is placed and lifted according to signals given by the crossing action of 5-day, 15-day, and 4-day-weighted moving averages.

V) The hedge is placed and lifted as in strategy IV if the average futures price for the previous month is greater than the adjusted cash price forecast for the end of the feeding period.

VI) The hedge is placed on the first day of the feeding period and held until the cattle are sold.

VII) The hedge is placed and lifted as in Strategy VI if the average futures price for the previous month is greater than the adjusted cash price forecast for the end of the feeding period.

The simulation results for each strategy were compared by examining the frequency distribution, range, total accumulated debt balance, graphic distribution over time, and mean and standard deviation of the 30-day cash, balances. All of the strategies except Strategy VI showed an increase in mean 30-day cash balances over Strategy I (the control). Only Strategy V had a higher standard deviation of cash balances than Strategy I. All strategies except Strategy VI significantly reduced the level of total accumulated debt observed at the end of the test period as compared to Strategy I.

The strategies did not differ significantly in the *number* of 30-day intervals with negative cash balances, but the *distribution* of these intervals over the test period appears to be significantly different. A trade off seems to exist between the improvement of cash flows during periods of severe cash deficits and the tendency toward less favorable cash balances during periods that would otherwise contain cash surplus. *A major conclusion* of this study is that the selective hedging strategies tested do not significantly reduce the number of deficit cash flow periods over time. But they improve financial position by reducing the severity of the deficits and by effecting a redistribution so that fewer defecit periods are observed consecutively. This helps the cattle feeder maintain a lower debt load which reduces the probability of business failure.

The choice of strategies depends upon the individual preference of the decision maker and upon his financial istuation. Following any of the selective hedging strategies appears to be better than hedging all cattle routinely or not hedging at all. Whether managed by lenders, cattle feeders, or both, this study indicates that fundamental and technical tools of analysis can be used for selective price risk exposure to improve the borrowing capacity of cattle feeders. A further implication is that the ability of a cattle feeding operation to stand on its own may be improved by the use of selective hedging, regardless of the financial position of the firm.

Selected References

Federal Reserve Bank of Dallas. 1977. Farm and Ranch Bulletin. November.

Moore, William Winfred II. 1975. "Quantitative Models to Predict Monthly Prices of Choice Steers." (Unpublished M.S. Thesis, Oklahoma State University.)

Riffe, Don A. 1978. A Simulation Analysis of the Financial Effects of Alternative Hedging Strategies for Cattle Feeders, Unpublished M.S. Thesis, Oklahoma State University, May 1978.

Teweles, Richard J., Charles V. Harlow, and Herbert L. Stone. 1974. *The Commodity Futures Game, Who Wins?, Who Loses?, Why?* New York: McGraw-Hill Book Co.

U.S. Department of Agriculture. 1965-1977b. *Livestock and Meat Situation.* Selected Issues. ERS, USDA.

U.S. Department of Commerce. 1965-1977. *Survey of Current Business.* Selected Issues.

U.S. Department of Commerce. 1977. *Business Conditions Digest.* September.

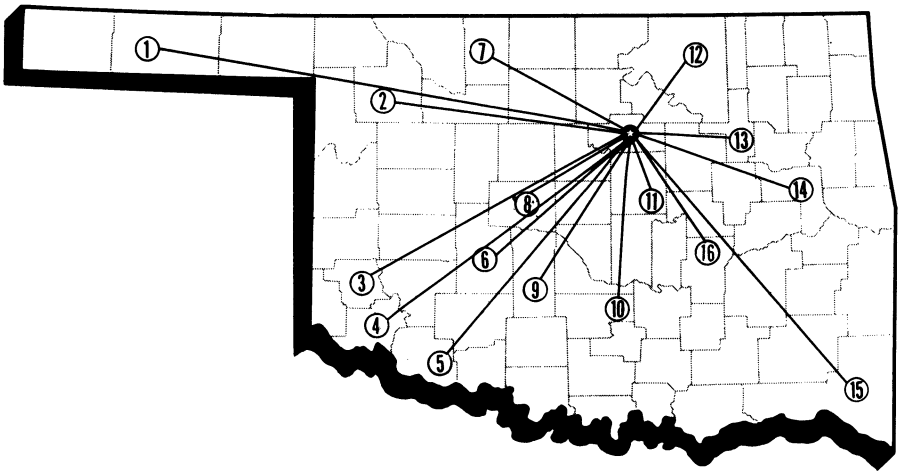
Ward, Ronald W. and Leham B. Fletcher. 1971. "From Hedging to Pure Speculation: A Micro Model of Optimal Futures and Cash Market Positions." *Amer. J. of Agr. Econ.* 53:71-78.

Working, Holbrook. 1953. "Futures Trading and Hedging." *Amer. Econ. Rev.* 33:314-343.

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***