A QUANTITATIVE PROCEDURE TO AID STOCKER OPERATORS IN SELECTING AMONG ALTERNATIVE PRODUCTION-MARKETING STRATEGIES

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PREFACE

This thesis is concerned with the development of a decision making procedure to aid stocker operators in selecting among alternative marketing strategies in order to reduce or transfer part of the risk associated with unfavorable price changes. A necessary component in the decision model was forecasts of the average monthly price of both stocker and feeder calves. The decision making procedure was tested over a pre-selected time period to judge the success of the model.

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CHAPTER I

INTRODUCTION

Nature of the Problem

Oklahoma has always been an important cattle producing state, but in recent history Oklahoma has increased in importance relative to other states. In 1958 Oklahoma ranked twelfth among states according to the number of cattle and calves on farms January 1. By 1972, according to the same criterion, Oklahoma ranked fifth (Table I).

The number of cows two years old and older on farms in Oklahoma has been increasing at a decreasing rate over the past fifteen years. The number of calves on farms has risen from 662 thousand head in 1958 to 1.750 million head in 1972. The number of heifers 1-2 years old on farms rose at a steady rate between 1958 and 1970, then rose dramatically to reach a level of 653 thousand head in 1972. Finally, the number of steers on farms has more than doubled between 1958 and 1972 (Table I).

The cattle industry in Oklahoma is also an important element in the state's agricultural economy, ranking first with a 1971 value of cattle and calves on farms of 839 million dollars. In real terms, the value of cattle and calves on farms in 1971 represents almost a three-fold increase over the estimated value in 1958.[1]

The growth patterns witnessed in the Oklahoma cattle industry over the past decade and a half are the result of a number of important

TABLE I

RANK AMONG STATES AND NUMBER OF CATTLE AND CALVES ON FARMS JANUARY 1 IN OKLAHOMA BY SEX AND AGE CLASSES, 1958-1972, (1,000 HEAD)

Year	Rank	Cows 2 Years and Older	Heifers 1-2 Years	Calves	Steers
1958	12	1,192	219	662	218
1959	11	1,292	282	797	282
1960	10	1,390	265	882	327
1961	10	1,490	273	948	300
1962	10	1,622	297	973	280
1963	10	1,736	303	1,052	300
1964	9	1,839	303	1,136	326
1965	7	1,862	333	1,250	337
1966	8	1,983	348	1,327	367
1967	7	1,942	327	1,305	389
1968	7	2,000	392	1,354	381
1969	5	2,070	404	1,408	434
1970	5	2,174	436	1,537	499
1971	5	2,188	577	1,603	468
1972	5	2,237	653	1,750	552

Source: U.S. Department of Agriculture, Livestock and Meat Statistics, Economic Research Service, Annual Statistical Bulletin 333, (Washington, D.C., 1958-1972).

developments, some of which are national in scope and importance. A strong demand for fed beef during the 1960's and early 1970's has resulted in an increase in per capita consumption of beef from 87.5 pounds in 1958 to 113.0 pounds in 1971.[2] The ability of the nation to satisfy this growing appetite for high quality beef with little increase in the real cost to consumers has been possible because of such factors as the availability of low cost feed grains, irrigated pastures, and growth in numbers of modern specialized processing facilities dispersed throughout the country, especially in the Southern Plains region.

The developments in the cattle industry take on greater significance when it is recognized that in a recent study the demand for beef is expected to increase by 8.5 million head by 1980.[3] This same study, which evaluated the competitive positions of the various regions of the nation at several production levels, indicated that the optimal production levels of calves in the Southern Plains areas can be expected to increase by 109 percent between 1970 and 1980; stocker growing should increase by 87 percent; and feeding activities should increase by 102 percent.

The developments in the cattle industry present Oklahoma's cattlemen with both a set of opportunities and a set of problems. Producers are faced with many production-marketing decisions that could mean the difference between profit or loss. If these producers possessed perfect knowledge of the outcome of each alternative production-marketing decision, they could select with certainty the decision that would maximize their satisfactions. In the real world these producers do not possess perfect knowledge of the results of alternative production-marketing decisions. The real world is one of risk and uncertainty.

Bullock and Logan define risk as those production-marketing decisions that lead to a set of possible unknown outcomes, but where each outcome occurs with a known probability distribution.[4] Uncertainty is defined as those production-marketing decisions that lead to a set of outcomes, but where the probability of any particular outcome is unknown to the decision maker.

The cattle business is a risk venture and the changes that are underway in the industry may increase the dollar value of the risks to which producers are exposed. Producers are faced with three basic types of risks: (1) risks of losses in quality, (2) risks of quantity losses, and (3) losses resulting from unfavorable changes in cash price. Quality and quantity risks are physical risks that can be dealt with through managerial techniques, adoption of new technology, and the use of fire, storm, and theft insurance. The risk associated with unfavorable price changes does not lend itself to an insurance approach. Producers can, however, use alternative marketing strategies as a means of shifting price risks. Two common alternative strategies to shift price risk are: (1) forward contracting for the purchase or sale of a specific quantity and quality of cattle at a specified price, and (2) hedging the purchase or sale of cattle using the futures market.

The Problem

Oklahoma producers of stocker and feeder calves, like all other members of the cattle industry, experience variations in the price of their products.[5] A part of the variation is the result of fluctuations in the measurable determinants of supply and demand which are predictable and, therefore, can be anticipated by the alert manager. Some

of the variation occurs as the result of undiscerned factors and random elements. To the extent that probabilities can be associated with the occurrence of such variations the stocker-feeder producer faces an element of risk.

Price fluctuations have been quite prevalent in the last ten years for both stocker and feeder calves. For example, between January 1962 and May 1972, there have been eleven months during which the price of stocker calves dropped more than one dollar per cwt. and sixteen months during which the price of stocker calves increased by more than one dollar per cwt. The average monthly price of stocker calves dropped $7.37 per cwt. between July 1963 and December 1964.[6] The largest drop of $2.17 in the average monthly price of stocker calves occurred between June and July 1969. The largest increase of $2.15 occurred between November and December 1969.

Between January 1962 and July 1972 there have been thirteen months during which the price of feeder calves dropped more than one dollar per cwt. and twenty-one months during which the price of feeder calves increased by more than one dollar per cwt. The average monthly price of feeder calves decreased $6.05 between July 1963 and May 1964 and $3.42 between June 1969 and October 1969. The largest decrease of $1.77 in the price of feeder calves occurred between April and May 1970. Price fluctuations of these magnitudes cuase producers to face large and potentially costly price risks.

Producers may choose either to bear risk from price fluctuations themselves, i.e., become speculators in the cash markets, or, they may choose to employ marketing strategies designed to reduce or transfer

price risks to other market functionaries. In order to develop these marketing strategies the cattleman needs objective estimates of the expected market price of stocker and feeder calves over alternative planning horizons and the magnitude of errors associated with such estimates.

Objectives

The overall objective of this project is to develop and evaluate selected marketing strategies available to Oklahoma stocker growers who utilize winter wheat pasture. More specifically the objectives of this study are as follows:

1. To develop a decision model to select among alternative marketing strategies for both stocker and feeder calves, and,
2. To aid in the development and evaluation of the selected marketing strategies, several price forecasting models will be developed and evaluated. The models will include a four month price forecast for the average monthly price of 400-500 pound Good and Choice stocker calves at Oklahoma City stockyard and a nine month price forecast for the average monthly price of Choice 600-700 pound feeder calves at the same market.

Review of Literature

No empirical studies were found which used price forecasting techniques to aid in evaluating and selecting between alternative buying and selling marketing strategies.

Elder attempted to develop a theoretical hedging decision model for cattle feeders. He reviewed the basic problems of risk and uncertainty in the cattle feeding industry and discussed the advantages and disadvantages of alternative ways of coping with risk and uncertainty. Unfortunately, Elder's hedging decision model in its present form does not lend itself readily to direct application by cattle feeders.[7]

Heifner used portfolio theory to determine optimal hedging level, minimum risk hedging level, and hedging effectiveness in cattle feeding. He found that for the situations studied the optimal hedging level ranges between 0.56 and 0.88 unit of short futures per unit of slaughter cattle produced. In these feeding situations about one-third to one-half of the price risk can be shifted by hedging at the optimal level. Heifner concluded that location, grade, and sex of cattle fed has little effect on optimal hedging levels and hedging effectiveness. This study did not look at the potential gains from basing production and hedging decisions on changing price expectations or price forecasts.[8]

Bullock and Logan examined the use of statistical decision theory to aid feedlot operators with the decision of whether to market a particular lot of fat cattle at their current weight or continue feeding them for one more month. The study used Bayesian analysis to combine price forecasts and a priori historical month-to-month price variations to select between the feed or sell strategies.[9]

Paul and Wesson compared futures trading in beef cattle and futures trading in storable commodities such as grains and concluded that the cash-futures price relationship represents a payment for feedlot services. They further concluded that extension of futures trading

depends on overcoming some major difficulties including (1) difficulties of adopting futures to suit different feeding situations without undue loss of precision; (2) problems of creating a larger body of informed hedgers and speculators; and (3) problems of developing hedging intermediaries to serve the smaller scale feeder--livestock dealers, packers, or others who may be in a position to offer the farmer a firm forward contract, take delivery, and make a mutually satisfactory settlement.[10]

Ehrich investigated the cash-future price relationship for live beef cattle. He found that cash prices of feeder cattle are tied by economic forces to prices of cattle futures contracts. Specifically, the cash-futures price spread is the market price for cattle-feeding services. These results indicate that the futures market facilitates more efficient adjustment of feeder-cattle prices to feeding costs and price expectations.[11]

Hayenga and Hacklander developed short-run livestock price prediction models to further the understanding of monthly fluctuations in beef and pork prices. Variables found to have a large impact on the average monthly price of Choice cattle include: (1) level of cattle slaughter relative to the number of slaughter days in the month; (2) the supply of fresh and stored pork; (3) the joint effect of per capita income and population. The authors state that the short run price predicting models provide a useful beginning tool for a market participant who is attempting to accumulate an understanding of market behavior and use it in conjunction with new market information in guiding his marketing activities.[12]

Franzmann and Walker estimated price forecasting equations for the feeder, slaughter, and wholesale sector of the cattle industry

using a trend model. Their forecasting model included a linear trend, a ten-year cycle, and seasonal component. The regression coefficients were estimated using the general Fourier form. They state that the trend models are not of sufficient quality for decision making over short planning horizons. But, they feel that the trend models would be useful for decision making when the planning horizon is more than one year, primarily because of the low cost involved in making the price forecasts.[13]

Purcell, Hague, and Holland investigated the effect of alternative hedging strategies for cattle feeders. The criteria they used to evaluate the various strategies was the mean and variance of net returns per head for the alternative strategies over the simulation period (1965-1970). They found that compared with a completely unhedged operation the strategy of hedging all cattle resulted in a substantial decrease in the variance and mean net return per animal. The selective hedging strategies that resulted in an increase in mean net return and a decrease in the variance of net return included: (1) hedging when the seasonal movement in price is downward trending; (2) hedge when the expected lock-in price is greater than or equal to the mean net return; and (3) seasonal hedge with a correction option to account for unexpected movements in price. The authors suggested that further work needs to be done to incorporate short run price forecasts into the decision model.[14]

FOOTNOTES

[1]Oklahoma Crop and Livestock Reporting Service, Cash Receipts From Marketings, Statistical Reporting Service (Oklahoma City), selected issues, 1958-1971.

[2]U. S. Department of Agriculture, Livestock and Meat Situation, Economic Research Service, Statistical Bulletin 188 (Washington, D.C., November, 1972), p. 17.

[3]Joseph Richard Crow, "Optimal Location of Beef Enterprises Under Current and Projected Conditions--An Interregional Analysis" (unpub. Ph.D. thesis, Oklahoma State University, 1972), pp. 168-173.

[4]J. Bruce Bullock and S. H. Logan, "A Model for Decision Making Under Uncertainty," Agricultural Economic Research, XXI (October, 1969), pp. 109-115.

[5]Stocker calves refer to 400-500 pound good and choice stocker steers at Oklahoma City. Feeder calves refer to 600-700 pound choice feeder steers at Oklahoma City.

[6]Unless otherwise stated all prices are in terms of $ per cwt.

[7]William A. Elder, Risk, Uncertainty and Futures Trading, Implications for Hedging Decisions of Beef Cattle Feeders, Staff Paper, University of Minnesota (August, 1969), pp. 6-45.

[8]Richard G. Heifner, "Optimal Hedging Levels and Hedging Effectiveness in Cattle Feeding," Agricultural Economic Research, XXIV (April, 1972), pp. 25-33.

[9]J. Bruce Bullock and Samuel H. Logan, "An Application of Statistical Decision Theory to Cattle Feedlot Marketing," American Journal of Agricultural Economics, LII (May, 1970), pp. 234-241.

[10]Allen B. Paul and William T. Wesson, "Pricing Feedlot Services Through Cattle Futures," American Economic Research, XIX (April, 1967), pp. 33-45.

[11]R. L. Ehrich, "Cash-Futures Price Relationships for Live Beef Cattle," American Journal of Agricultural Economics, LI (November, 1969), pp. 26-39.

[12]Marvin Hayenga and Dwane Hacklander, Short-Run Livestock Price Prediction Models, Research Bulletin 25, Michigan State University Agr. Expt. Station (1970), pp. 2-30.

[13]John R. Franzmann and Rodney L. Walker, "Trend Models of Feeder, Slaughter, and Wholesale Beef Cattle Prices," American Journal of Agricultural Economics, LIV (August, 1972), pp. 507-512.

[14]Wayne D. Purcell, Terry M. Hague, and David Holland, Economic Evaluation of Alternative Hedging Strategies for the Cattle Feeder, Bulletin B-702, Oklahoma Agricultural Experiment Station, Stillwater, September, 1972.

CHAPTER II

FORECASTING MODELS

The previous chapter indicated that forecasts of the average monthly price of both stocker and feeder calves are key components necessary for the development of the decision model used to select between alternative buying and selling strategies. In this chapter several alternative price forecasting techniques are examined to determine their price forecasting potential. Also to aid in the development and selection of the price forecasting techniques this chapter examines the seasonal, cyclical, and trend components of the stocker and feeder calf price series.

Analysis of Stocker Calf Price and Feeder Calf Price Series

Stocker Calves

The average monthly price of Good and Choice 400-500 pound stocker calves at Oklahoma City showed an upward trend during the January 1966 through May 1972 time period (Figure 1). During the first part of the series, 1966 through 1967, the slope of the trend line was relatively flat compared with the remainder of the series. The minimum price, $26.00 per cwt., for the series occurred in January 1966 and the maximum price of $41.18 per cwt. occurred in May 1972. The mean price for

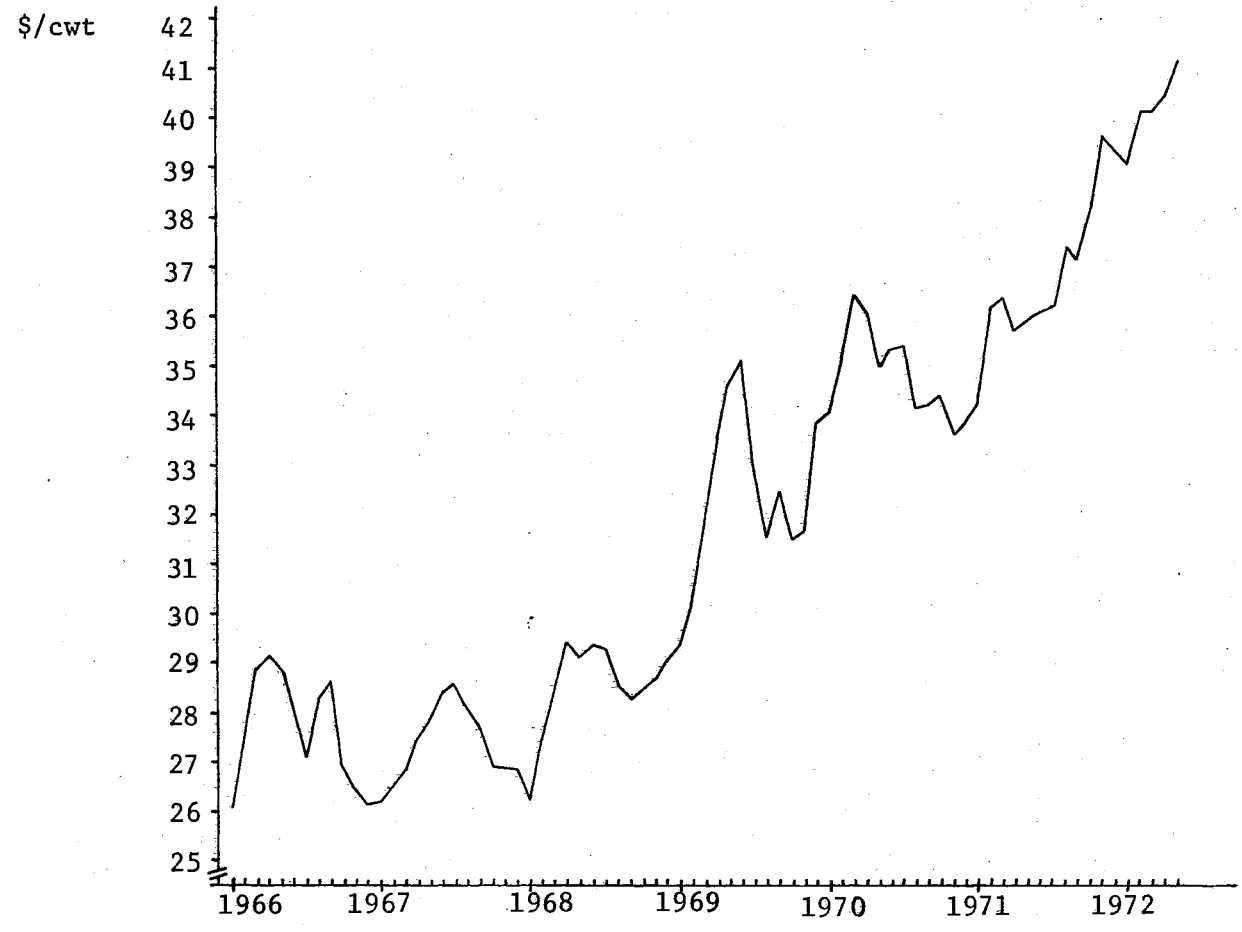


Figure 1. Average Monthly Price ($/cwt.) of Good and Choice 400-500 Pound Stocker Steer Calves at Oklahoma City, January 1966-May 1972.

the series was $31.83 per cwt. with a standard deviation of $4.35 and the median price for the series was $31.18 per cwt. The relative variation of this price series was 13.86 percent.

A twelve-month centered moving average was used to determine the seasonal influence in the stocker calf price series (Table II). The analysis indicated that during the March through July period the price series was above the annual seasonal average and during the August through February period the price series was below the annual average. The seasonal peak occurred in April, 3.54 percent above the annual average price and the seasonal low occurred in November, 4.08 percent below the annual average price.

The length of the average monthly price series for stocker calves was too short to determine the existence of any long-term cyclical influence. Because of the nature of the production process and results of a separate analysis of the complete price series, 1937-1971, it is suspected that the long term cycle may be approximately 120 months in length.

Figure 1 suggests that the stocker calf price series may presently be in the upturn phase of such a cycle. However, a definite conclusion can not be drawn as to when a cyclical peak will occur without further data and analysis.

Feeder Calves

The average monthly price of Choice 600-700 pound feeder calves at Oklahoma City showed an upward trend during the January 1966 through July 1972 time period (Figure 2). During the first part of the price series, 1966 through mid-1968, the slope of the trend line

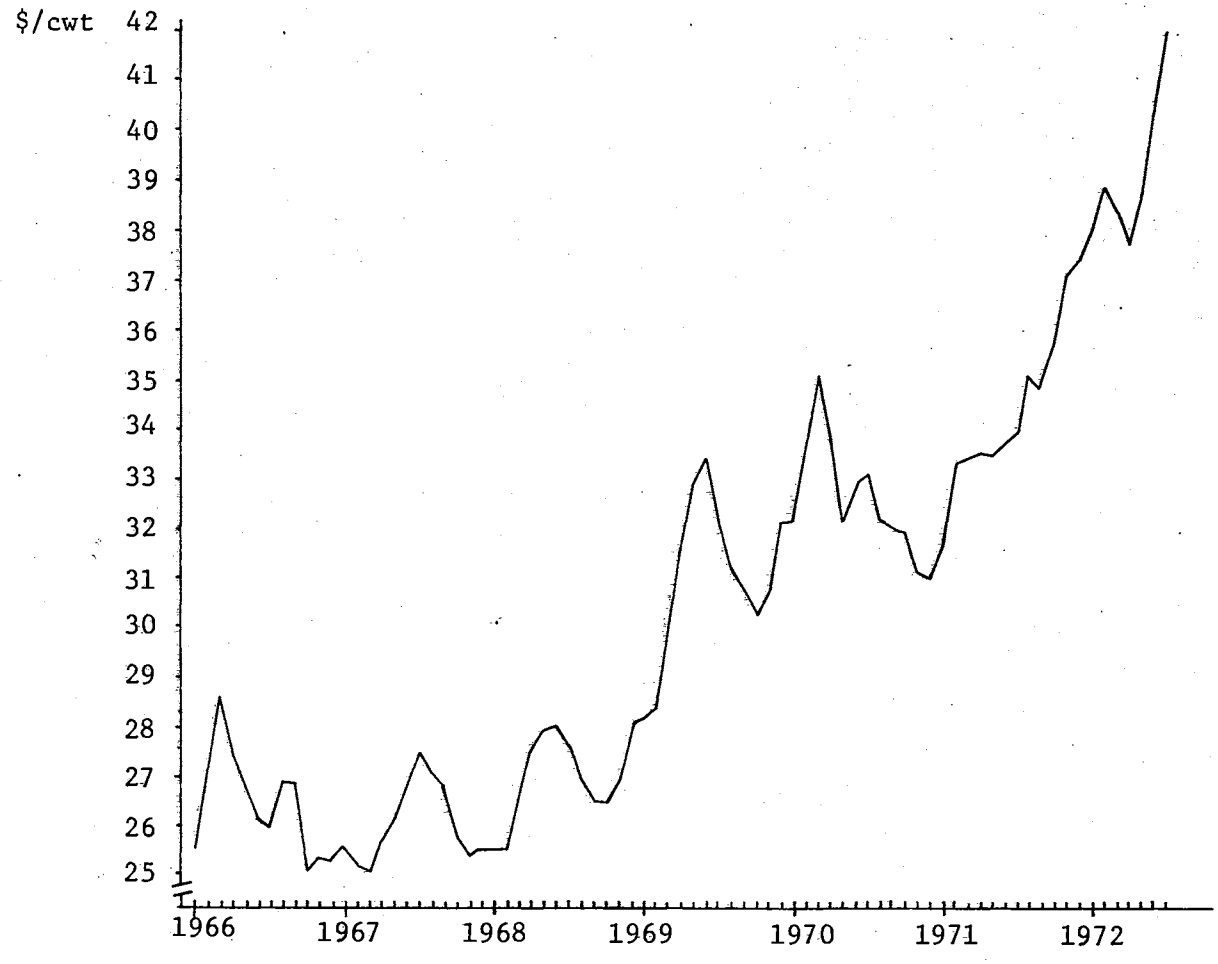


Figure 2. Average Monthly Price ($/cwt) of Choice 600-700 Pound Feeder Steers at Oklahoma City, January 1966-July 1972.

was relatively flat compared with the remainder of the price series. The average monthly price of these feeder calves ranged from a high of $42.10 per cwt. in July 1972 to a low of $24.98 per cwt. in March 1967. The mean price for this price series was $30.40 per cwt. with a standard deviation of $4.34, while the median price for this price series was $30.07 per cwt. The relative variation in the price series was 14.28 percent.

TABLE II

SEASONAL PRICE INDEXES, STANDARD DEVIATIONS, AND STANDARD ERRORS OF THE MEANS FOR 400-500 POUND GOOD AND CHOICE STOCKER CALVES AT THE OKLAHOMA CITY MARKET, 1966-1971

Month	Indexes[a]	Standard Deviation[b]	Standard Error[c]
January	96.89	2.47	1.11
February	99.96	2.88	1.29
March	102.31	2.89	1.29
April	103.54	2.69	1.20
May	103.01	3.58	1.60
June	103.45	3.91	1.75
July	101.61	2.51	1.12
August	99.62	3.09	1.38
September	99.65	3.09	1.38
October	99.93	2.14	.96
November	95.92	1.20	.54
December	97.11	1.75	.78

[a]Percent of moving average.

[b]Standard deviation of indexes.

[c]Standard error of the mean of indexes.

A twelve-month centered moving average was used to determine the influence of seasonality in the feeder calf price series (Table III). The analysis indicated that the average monthly price of feeder calves at Oklahoma City during the 1966 through 1971 time period showed definite seasonal patterns. Prices during September through February were below the annual average and March through August were above the annual average. The seasonal peak occurred in June, 3.52 percent above the annual average with a standard deviation 3.83. The seasonal trough occurred in October and November, 3.52 and 3.51 percent below the annual average with a standard deviation of 2.15 and 1.30.

TABLE III

SEASONAL PRICE INDEXES, STANDARD DEVIATIONS, AND STANDARD ERRORS OF THE MEANS FOR 600-700 POUND CHOICE FEEDER STEERS AT THE OKLAHOMA CITY MARKET, 1966-1971

Month	Indexes[a]	Standard Deviations[b]	Standard Error[c]
January	97.99	1.50	0.67
February	99.27	3.64	1.63
March	101.40	4.37	1.95
April	102.58	2.39	1.07
May	102.34	4.03	1.80
June	103.52	3.83	1.71
July	102.38	2.82	1.26
August	100.58	2.46	1.10
September	99.46	3.30	1.48
October	96.48	2.15	0.96
November	96.49	1.30	0.58
December	97.52	1.80	0.81

[a]Percent of moving average.

[b]Standard deviation of indexes.

[c]Standard error of the mean of indexes.

As was the case with the stocker price series, the length of the average monthly price series for feeder calves is too short to determine very precisely the influence of any long-term cycles. Figure 2 suggests that the price series may presently be in the upturn phase of a cycle, if one exists. But a definite conclusion cannot be drawn as to the location of cyclical troughs or peaks based on this series.

Simple Price Forecasting Procedures

So far we have examined briefly the seasonal, cyclical, and trend components of the prices of both stocker and feeder calves at Oklahoma City. With this information in mind several simple price forecasting procedures are developed and evaluated.

"Today's Price is Tomorrow's Price"

A very naive price forecasting procedure postulates that the expected price in time period t+i is equal to the price in time period t. This is a very simple technique to employ; all that is needed to forecast the price of stocker or feeder calves for some future time is a knowledge of the present price.

Because of its simplicity, this price forecasting procedure has an advantage over more complicated price forecasting procedures. But this price forecasting procedure is at a disadvantage relative to more complicated price forecasting procedures because it fails to anticipate changes in market conditions that could affect the forecasted price and the stocker operators profitability. For example, the stocker operator who plans to purchase stocker calves in time period t+i based on the price forecast in time period t might have to pay a higher than

expected price. This is possible because of an unanticipated upward move in the price of stocker calves. It is also possible that the stocker operator's selling price for feeder calves would be lower than the expected price, because of a downward move in the price of feeder calves between time period t and t+j. The results of these unexpected changes in the buying and selling prices might be an unprofitable situation for the stocker operator.

It might be argued that if stocker operators are going to use this naive price forecasting procedure actions should always be taken to protect against unfavorable price changes. Use of this technique would ensure a given price for stocker and feeder calves. But if this technique is employed in all cases the stocker operator runs the risk of a loss in potential income due to a favorable change in the buying price of stocker calves and the selling price of feeder calves.

This discussion indicates that this price forecasting procedure is not adequate for decision-making purposes. But the errors generated from using this procedure can serve as a benchmark to evaluate the price forecasting ability of more complicated procedures. The benchmark error statistic is defined as:

$$B = \frac{\sum_{t=1}^{n} (P_{t+i} - P_t)^2}{n-1} \qquad (2.1)$$

where:

B = variance of the error for the naive model;

P = average monthly price ($ per cwt.) of either 400-500 pound Good and Choice stocker calves or 600-700 pound feeder calves at the Oklahoma City stockyard;

t = month in which price forecast is made;

t+i = forecast interval; and

n = number of monthly observation.

The benchmark error statistic for the four month forecast of the average monthly price of stocker calves is 4.2131 over an inference base of January 1966 through May 1972. The benchmark error statistic for the nine month forecast of feeder calves is 7.7602 over an inference base from January 1966 through July 1972.[1]

Forecasts for the average monthly price, four and nine months into the future, for stocker and feeder calves using this naive procedure are presented in Tables IV and V. The variance of the forecasting error for stocker calves is 20.0767 and the variance of the forecasting error for feeder calves is 27.0378.[2]

Seasonal Adjustment Model

Another naive price forecasting procedure is based on the mean percentage change in the average monthly price ($ per cwt.) of either stocker or feeder calves between months t+i and t. The computational process is as follows:

$$S_{t,i} = \frac{P_{t+i} - P_t}{P_t} \times 100 \qquad (2.2)$$

$$A_{t,i} = \frac{\sum_{i=1}^{n} M_{t,i} \cdot F_i}{\sum_{i=1}^{n} F_i} \qquad (2.3)$$

$$P_{j+i}^{n} = [A_{t,i} \cdot P_j] + P_j \qquad (2.4)$$

TABLE IV

PRICE FORECASTS, ACTUAL PRICES AND ERRORS USING "TODAY'S PRICE IS TOMORROW'S PRICE" FOR STOCKER CALVES

Month	Actual Price	Forecast Price	Error
June 1972	43.22	40.10	3.12
July 1972	45.31	40.07	5.24
August 1972	44.86	40.34	4.52
September 1972	46.60	41.18	5.42
October 1972	46.47	43.22	3.25
November 1972	46.99	45.31	1.68

TABLE V

PRICE FORECASTS, ACTUAL PRICES AND ERRORS USING "TODAY'S PRICE IS TOMORROW'S PRICE" FOR FEEDER CALVES

Month	Actual Price	Forecast Price	Error
August 1972	41.06	37.07	3.99
September 1972	42.33	37.37	4.96
October 1972	43.05	38.14	4.91
November 1972	43.03	38.97	4.06

where:

P_t = average monthly price ($ per cwt.) of either 400-500 pound Good and Choice stocker calves or 600-700 pound feeder calves at the Oklahoma City stockyard;

P_j^n = forecast of the average monthly price ($ per cwt.) of either stocker or feeder calves outside of the inference base at the Oklahoma City stockyard;

$S_{t,i}$ = percent change in the average monthly price of either stocker or feeder calves between month t+i and t;

F_i = number of observed $S_{t,i}$ in each of the frequency intervals 0, $\pm$ 0.01-1.0, $\pm$ 1.1-2.0, $\pm$ 2.1-3.0, ..., $\pm$ 30.1;

$M_{t,i}$ = class midpoints for each frequency interval;

$A_{t,i}$ = coefficient to forecast the average monthly price of either stocker or feeder calves for month j+i in month j;

t = base month;

i = months after month t or j; and

j = months in which average monthly price forecast is made.

Forecasts of the average monthly price of either stocker or feeder calves are based on results obtained from equations 2.2, 2.3, and 2.4. Results from equation 2.2 are arrayed in a frequency distribution and used in equation 2.3. The forecasting coefficients obtained in equation 2.3 are used in equation 2.4 to obtain the price forecast. This price forecasting procedure allows for seasonal adjustments in the price series between month t and t+i and averages out the long-run cycle and trend in the price series. The primary shortcomings of the seasonal adjustment model are the complex computational process and the failure to account for short-run contraseasonal changes in market conditions.

Coefficients to forecast the average monthly price of stocker calves for four months into the future are presented in Table VI.[3] These coefficients indicate the long-term average relationship of the

TABLE VI

SEASONAL ADJUSTMENT FORECASTING COEFFICIENTS FOR STOCKER CALVES
FOUR MONTHS INTO THE FUTURE, 1937-1971

	Month t											
Month t+4	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
May	.08164											
June		.0343										
July			-.01301									
August				-.01891								
September					-.03256							
October						-.04000						
November							-.02306					
December								-.0229				
January									.01176			
February										.06842		
March											.09979	
April												.10554

price of stocker calves in month t+4 to the price of stocker calves in month t. For example, on the average during the period 1937 through 1971 the price of November stocker calves was 2.306 percent less than the July price of stocker calves.

Contrasting the forecasting errors generated using the seasonal adjustment procedure to the forecasting errors using the "today's price is tomorrow's price" procedure it was found that the seasonal adjustment procedure had larger forecasting errors in all months except June 1972 on variance of the price (Tables IV and VII). The variance of the price forecasting error for the seasonal asjustment procedure was 1.4 times larger than the variance of the price forecasting error using the "today's price is tomorrow's price" procedure.[4]

TABLE VII

PRICE FORECASTS, ACTUAL PRICES AND ERRORS USING SEASONAL ADJUSTMENT PRICE FOR THE FOUR MONTH PRICE FORECAST OF STOCKER CALVES

Month	Actual Price	Forecast Price	Error
	($ per cwt.)	($ per cwt.)	($ per cwt.)
June 1972	43.22	41.48	1.74
July 1972	45.31	39.55	5.76
August 1972	44.86	39.58	5.28
September 1972	46.60	39.84	6.78
October 1972	46.47	41.49	4.98
November 1972	46.99	44.27	2.72

Regression Models

A somewhat more complex price forecasting procedure postulates a price forecasting equation and uses regression analysis to solve for estimates of the equation's parameters.[5] In this section the discussion is centered around the postulation and selection of price forecasting models for both stocker and feeder calves. Consideration is given to the choice of variables, availability of data to represent these variables, the form in which the variables will enter the forecasting models, criteria for the selection among alternative model specifications, and the forecasting performance of the various models.

To successfully postulate price forecasting models for stocker and feeder calves, an understanding of how various factors affect the prices of stocker and feeder calves is needed. The prices of stocker and feeder calves are affected by two primary forces, the demand for stocker and feeder calves, and the available supply of stocker and feeder calves to meet the demand.[6] The demand for stocker and feeder calves is derived from the demand for slaughter beef which is derived from the consumer demand for beef. Changes in the derived demand for stocker and feeder calves is indicated by slaughter and wholesale beef prices. The available supply is influenced by the present and past prices of stocker and feeder calves; cow herd inventory, calf crop, death rate, replacement rate, weather conditions, price of feed grains, and, in a dynamic environment, the present and past price of slaughter cows.

Changes in the derived demand for stocker and feeder calves and the available supply of stocker and feeder valves result in adjustments in the prices of stocker and feeder calves. For example, if the slaughter and/or wholesale price of beef increased, holding the

available supply of stocker and feeder calves constant, the prices of stocker and feeder calves will most likely increase. If the available supply of stocker and feeder calves decreases, holding demand constant, the price of stocker and feeder calves will most likely increase.

The equations used to forecast the prices of stocker and feeder calves include both supply and demand variables but are not intended as structural relationships. The goal is to provide forecasts of the average monthly prices of stocker and feeder calves that can be used for decision making purposes, but employing the simplest model form. These equations do not attempt to explain the structural relationships that affect market conditions of stocker and feeder calves.

The single equation price forecasting models considered are primarily of two implicit functional forms, namely:

$$\hat{P}_{t+4} = f(X_{i,t+4}) \tag{2.5}$$

$$\hat{P}_{t+4} = f(X_{i,t}) \tag{2.6}$$

where:

$\hat{P}_{t+4}$ = the average monthly price forecast of either stocker or feeder calves;

X_i = independent variables used to forecast the average monthly price of either stocker or feeder calves; and

t = time in months.

Equation 2.5 would be expected to give a better fit to the observed price series than equation 2.6, but would necessitate separate forecasts of the values of the independent variables. The result is that 2.5 may be less efficient at forecasting the average monthly price of stocker calves than equation 2.6. In this exploratory study the implicit form of equation 2.6 is used for all stocker and feeder calf price forecasting models.

Inasmuch as there are no scientific criteria for selecting the functional form of a relationship several alternative functional forms are examined.

Four Month Forecast of Stocker Calf Prices

Feed grain variable equations. The following equations are grouped together because they contain feed grain price variables.

$$P_{s,t+4} = -3.7550 + 1.04734P_{s,t} + 0.1608P_{s,t-8} - 0.1839P_{s,t-12}$$
$$(2.6597)\quad (0.2300)\qquad (0.09032)\qquad (0.2367)$$
$$+ 1.9233S_{g,t-2}$$
$$(1.4551)$$

$R^2 = .8623$ $\qquad S^2 = 3.9438$ (2.7)

$\bar{R}^2 = .8557$ $\qquad E^2 = 10.7102$

$$\hat{P}_{s,t+4} = 0.9168 + 1.0702P_{s,t} + 0.1836P_{s,t-8} - 0.1946P_{s,t-12}$$
$$(1.7853)\quad (0.2283)\qquad (0.09268)\qquad (0.2364)$$
$$- 0.7634C_{s,t-1}$$
$$(0.5556)$$

$R^2 = .8625$ $\qquad S^2 = 3.9386$ (2.8)

$\bar{R}^2 = .8572$ $\qquad E^2 = 9.5265$

$$\hat{P}_{s,t+4} = 1.5418 + 1.1148P_{s,t} - 0.1051P_{s,t-12} - 0.5058C_{s,t-1}$$
$$(1.7810)\quad (0.2304)\qquad (0.2352)\qquad (0.5476)$$

$R^2 = .8573$ $\qquad S^2 = 4.0479$ (2.9)

$\bar{R}^2 = .8533$ $\qquad E^2 = 11.7759$

where:

$\hat{P}_s$ = four month forecast of the average monthly price ($ per cwt.) of 400-500 pound Good and Choice stocker calves at Oklahoma City;

P_s = observed average monthly price ($ per cwt.) of 400-500 Good and Choice stocker calves at Oklahoma City;

S_g = observed average monthly Oklahoma farm price ($ per cwt.) of sorghum grain;

C_s = observed average monthly Oklahoma farm price ($ per cwt.) of cottonseed;

t = time in months;

( ) = estimate of the standard error of the regression coefficients;

R^2 = coefficient of determination;

S^2 = estimate of the variance of the estimator;

$\bar{R}^2$ = adjusted coefficient of determination; and

E^2 = variance of the price forecasting error.[2]

The inference base of these equations is January 1962 through May 1972.

Equations 2.7, 2.8, and 2.9 include the lagged Oklahoma farm price of either sorghum or cottonseed and the present and lagged price of stocker calves. These variables reflect the influence of changes in the price of feed grains on the supply and price of stocker calves. Holding the demand for stocker calves constant, it is expected that an increase in the price of feed grains would decrease the supply of stocker calves and thus increase the price of stocker calves. This hypothesis is substantiated by the sorghum grain variable which enters equation 2.7 with a positive sign at the 0.20 significance level. The price of cottonseed enters equations 2.8 and 2.9 with a negative sign at a low level of significance which indicates that cottonseed probably does not play a major role in determining the supply and price of stocker calves in Oklahoma.

The present and lagged price of stocker calves in the equations account for the short-run trend adjustments in the price of stocker calves. The present and eight month lagged price of stocker calves enters all three equations with positive signs, which is expected because of the uptrend in the price of stocker calves. The twelve month lagged price of stocker calves enters the three equations at a low level of significance and with a negative sign.

Of these three equations, 2.8 does the best job of forecasting the average monthly price of stocker calves. Equation 2.8 has the lowest mean squared forecasting error of the three equations (9.5265). Also equation 2.8 has the highest adjusted coefficient of determination (0.8572) and the lowest estimate of the variance of the estimator (3.9386). The three equations were partially tested over a six month interval to determine their forecasting potential. Equation 2.8 had the smallest forecasting error in five of the six test months (Table VIII).

Inventory variable equations. The following equations are grouped together because they contain inventory of cattle-on-feed variables.

$$\hat{P}_{s,t+4} = \underset{}{-9.8270} + \underset{(2.3461)}{0.5926}P_{c,t} + \underset{(0.07948)}{0.7709}P_{s,t-8} + \underset{(0.06572)}{1.9517}\left(\frac{V_{t-1}}{V_{t-2}}\right) \underset{(1.4480)}{}$$

$$R^2 = .8933 \qquad S^2 = 2.1383 \qquad (2.10)$$

$$\bar{R}^2 = .8885 \qquad E^2 = 12.3846$$

TABLE VIII

ACTUAL OBSERVED PRICE, FORECASTED PRICE, AND FORECAST ERROR FOR ALTERNATIVE STOCKER CALF PRICE FORECASTING EQUATIONS
June 1972 through November 1972

		Equations									
		2.7		2.8		2.9		2.10		2.11	
Month	Actual Price	Price Forecast	Forecast Error	Price Forecast	Forecast Error	Price Forecast	Forecast Error	Price Forecast	Forecast Error	Price Forecast	Forecast Error
		($ per cwt)									
June	43.22	41.00	2.22	41.12	2.10	40.93	2.29	41.45	1.77	41.75	1.47
July	45.31	41.03	4.28	41.22	4.09	40.97	4.34	40.93	4.38	40.87	4.44
August	44.86	41.63	3.23	41.90	2.96	41.37	3.49	41.95	2.91	42.23	2.63
September	46.60	42.47	4.13	42.68	3.92	42.26	4.34	41.83	4.77	42.12	4.48
October	46.47	44.80	1.67	45.01	1.46	44.51	1.96	44.03	2.44	44.46	2.01
November	46.99	47.14	-0.15	47.47	-0.48	46.82	0.17	45.46	1.53	44.37	2.62

Equations											
2.12		2.13		2.14		2.15		2.16		2.17	
Price Forecast	Forecast Error	Price Forecast	Forecast Error	Price Forecast	Forecast Error	Price Forecast	Forecast Error	Price Forecast	Forecast Error	Price Forecast	Forecast Error
($ per cwt)											
42.43	0.79	41.81	1.41	42.49	0.73	40.73	2.49	40.90	2.32	42.50	0.72
41.74	3.57	41.22	4.09	41.75	3.56	41.36	3.95	42.34	2.97	41.70	3.61
43.08	1.78	41.98	2.88	42.93	1.93	42.57	2.29	42.34	2.52	42.95	1.91
42.91	3.69	42.07	4.53	42.82	3.78	42.70	3.90	42.70	3.90	42.82	3.78
45.90	0.57	44.41	2.06	45.82	0.65	45.27	1.20	44.80	1.67	45.82	0.65
47.97	-0.98	44.36	2.63	47.94	-0.95	47.74	-0.75	46.40	0.59	47.94	-0.95

$$\log\hat{P}_{s,t+4} = -0.3302 + 0.5326\log P_{c,t} + 0.7190\log P_{s,t-8} + 0.06699\left(\frac{V_{t-1}}{V_{t-8}}\right)$$
$$(0.07922)\ (0.07052)\qquad (0.06204)\qquad (0.04674)$$

$R^2 = .8928$ $\qquad S^2 = 0.0003872$ (2.11)

$\bar{R}^2 = .8879$ $\qquad E^2 = 11.9533$

$$\log\hat{P}_{s,t+4} = 0.9421 + 0.007867P_{c,t} + 0.01034P_{s,t-8} + 0.02670\left(\frac{V_{t-1}}{V_{t-8}}\right)$$
$$(0.03246)\ (0.001100)\qquad (0.0009093)\qquad (0.02003)$$

$R^2 = .8858$ $\qquad S^2 = 0.0004146$ (2.12)

$\bar{R}^2 = .8800$ $\qquad E^2 = 6.2878$

$$\log\hat{P}_{s,t+4} = -0.9546 + 0.5375\log P_{c,t} + 0.7112\log P_{s,t-8} + 0.1572\log I_{c,t-1}$$
$$(0.4074)\ (0.07070)\qquad (0.06267)\qquad (0.1004)$$

$R^2 = .8934$ $\qquad S^2 = 0.0003850$ (2.13)

$\bar{R}^2 = .8886$ $\qquad E^2 = 11.7384$

$$\log\hat{P}_{s,t+4} = 0.9710 + 0.007966P_{c,t} + 0.01017P_{s,t-8} + 0.000006932I_{t-1}$$
$$(0.02404)\ (0.001103)\qquad (0.0009203)\qquad (0.000004576)$$

$R^2 = .8860$ $\qquad S^2 = 0.0004116$ (2.14)

$\bar{R}^2 = .8809$ $\qquad E^2 = 6.5909$

where:

P_c = observed average monthly price ($ per cwt.) of Choice 900-1100 pound slaughter steers at Omaha;

V = monthly inventory of cattle on feed (1,000 head) according to the Six State Cattle on Feed Report;

I = change in the monthly inventory of cattle (1,000 head) on feed between months t-2 and t-1;

I_c = change in the monthly inventory of cattle on feed (1,000 head) between months t-2 and t-1 coded by 10,000; and

log = logarithm to the base ten.

The inference base of these equations is January 1966 through May 1972.[7]

Equations 2.10, 2.11, 2.12, 2.13, and 2.14 include the present price of Choice 900-1100 pound fat steers at Omaha, price of stocker calves lagged eight months, ratio of the inventory of cattle on feed, and the monthly change in the number of cattle-on-feed. The fat steer variable enters all five equations with a positive sign and a high level of significance. This seems to substantiate the hypothesis that the demand for stocker calves is a function of the price of fat steers.

The price of stocker calves lagged eight months indicates the trend in the price of stocker calves between months t-8 and t+4 over the inference base. This variable enters all five equations with a positive sign, which is expected because of the uptrend in the price of stocker calves.

In equations 2.10, 2.12, 2.13 and 2.14 the change in the inventory of cattle-on-feed is positively related to the stocker calf price forecast. These variables reflect changes in placement and marketing rates of cattle on and off feed. Assuming that the available supply of stocker calves is fairly constant during the forecasting interval it would be expected that a positive change in the inventory of cattle on feed relative to the previous year or month would decrease the supply of stocker calves to be placed on feed in the next few months. This would probably result in an increase in the price of stocker calves.

Of the five equations 2.12 and 2.14 do the best job of forecasting the average monthly price of stocker calves. Equation 2.12 has the lowest mean squared forecasting error of the five equations (6.2878). Equation 2.14 has the second lowest mean squared forecasting error (6.5090). Equation 2.13 has the highest adjusted coefficient of determination (0.8886) but the other equations are within 0.01 of equation 2.13. Equation 2.13 has the lowest estimate of the variance of the estimator (0.0003850). The six equations are tested over a six-month interval to partially determine their forecasting potential. Of the six equations tested, 2.14 has the smallest forecasting error in three of the six test months and 2.12 has the smallest forecasting error in the remaining months (Table VIII).

Lagged dependent variable equations. The following equations are grouped together because they contain only stocker calf price variables.

$$\begin{aligned} \log\hat{P}_{s,t+4} &= 1.07641 + 0.006465P_{s,t} + 0.004643P_{s,t-4} + 0.007411P_{s,t-8} \\ &\quad (0.02502)\ (0.001598)\quad (0.001514)\quad (0.001564) \\ &\quad - 0.004703P_{s,t-12} \\ &\quad (0.001643) \end{aligned}$$

$$R^2 = .8816 \qquad S^2 = 0.0003818 \qquad (2.15)$$

$$\bar{R}^2 = .8732 \qquad E^2 = 8.8518$$

$$\log\hat{P}_{s,t+4} = 1.0804 + 0.007051P_{s,t} + 0.006656P_{s,t-4} \qquad (2.16)$$
$$(0.02622)\ (0.001512)\quad (0.001628)$$

$$\hat{P}_{s,t+4} = 0.06923 + 0.5422P_{s,t} + 0.4958P_{s,t-4} \qquad (2.17)$$
$$(1.9650)\quad (0.1133)\quad (0.1221)$$

$R^2 = .8322$ $S^2 = 2.9848$

$\bar{R}^2 = .8264$ $E^2 = 6.5624$

The inference base is January 1966 through May 1972.

Equations 2.15, 2.16, and 2.17 include the present price of stocker calves and four, eight, and twelve month lags of the price of stocker calves. These equations are designed to reflect the influence of short-run adjustments in the trend component in determination of the price of stocker calves. The present price of stocker calves and the four and eight month lagged price of stocker calves indicate a positive influence on the future price of stocker calves. Because the twelve month lagged price of stocker calves is out of phase with the four month price forecast of stocker calves its sign is negative.

Of the three equations 2.16 does the best job of forecasting the average monthly price of stocker calves (Table VIII). Although equation 2.17 has the lowest forecasting error in five of the six test months, equation 2.16 has a more consistent error than equation 2.17. Equation 2.15 has the highest adjusted coefficient of determination and the lowest estimate of the variance of the estimator (0.0003818). Equation 2.17 has the lowest mean squared forecasting error (6.5624).

Nine Month Price Forecast for Feeder Calves

Livestock price equations. The following equations are grouped together because they contain only the present and lagged price of alternative cattle classifications.

$$\hat{\log P}_{f,t+9} = \underset{(0.02591)}{0.9987} + \underset{(0.009480)}{0.01635}\log P_{f,t} \qquad (2.18)$$

$R^2 = .7251$ $S^2 = 0.001629$

$\bar{R}^2 = .7226$ $E^2 = 1.9043$

$$\hat{P}_{f,t+9} = -7.4905 + 0.3478P_{f,t} + 0.9968P_{l,t} \quad (2.19)$$
$$(1.8541)\ (0.1494)\qquad (0.1862)$$

$R^2 = .7958$ $S^2 = 5.3184$

$\bar{R}^2 = .7922$ $E^2 = 6.0691$

$$\log\hat{P}_{f,t+9} = 0.8612 + 0.004964P_{f,t} + 0.0138C_{r,t} \quad (2.20)$$
$$(0.02926)(0.001808)\qquad (0.001483)$$

$R^2 = .8084$ $S^2 = 0.001145$

$\bar{R}^2 = .8049$ $E^2 = 2.5581$

$$\hat{P}_{f,t+9} = -10.3206 + 0.6634C_{r,t} + 0.3655P_{f,t} \quad (2.21)$$
$$(1.8684)\ (0.09466)\qquad (0.1155)$$

$R^2 = .8218$ $S^2 = 4.6432$

$\bar{R}^2 = .8158$ $E^2 = 6.0755$

$$\hat{P}_{t+9f} = -14.3847 + 0.6980C_{r,t} + 0.07264C_{r,t-3} + 0.3192P_{f,t} \quad (2.22)$$
$$(2.4279)\ (0.09343)\ (0.02863)\qquad (0.1142)$$

$R^2 = .8325$ $S^2 = 4.4286$

$\bar{R}^2 = .8269$ $E^2 = 4.9810$

where:

$\hat{P}_f$ = price forecast of the average monthly price ($ per cwt.) choice 600-700 pound feeder calves at Oklahoma City;

P_f = observed average monthly price ($ per cwt.) of choice 600-700 pound feeder calves at Oklahoma City;

P_l = observed average monthly price ($ per cwt.) of choice 900-1000 pound slaughter steers at Omaha; and

C_r = observed average monthly price ($ per cwt.) of choice 600-700 pound choice wholesale carcass beef at Chicago.

The inference base is January 1962 through July 1972.

Equations 2.18, 2.19, 2.20, 2.21, and 2.22 include the following variables: (1) the present price of feeder calves; (2) present price of slaughter steers; and (3) present and lagged price of carcass beef. Slaughter and carcass beef prices indicate changes in the demand for feeder calves. A positive change in either slaughter or carcass beef price, holding supply of feeder calves constant, has a positive influence on the price of feeder calves. The feeder calf price variable is used to indicate short-run trend changes in the price of feeder calves.

The forecasting equations are tested over a five month interval (August 1972 through December 1972) to partially determine their forecasting potential. During the test interval equation 2.20 has the smallest forecasting error in two of the five test months (August and September). Equation 2.18 has the smallest forecasting error in the remaining three months (Table IX). Although equation 2.18 has the smallest mean squared forecasting error of the group, its price forecasting potential is questioned. The equation contains a single variable, present price of feeder calves, which indicates trend. The primary reason that equation 2.18 performs well over the test period is the steady upward trend in feeder prices during and before the test period. Should the trend in feeder calf prices change in direction the equation would fail to indicate such a change for about nine months.

Commerical cattle slaughter equations. Equations 2.23 and 2.24 include: (1) present price of wholesale carcass beef; (2) the number of head of cattle commerically slaughtered; (3) the inventory of cattle on feed; and (4) the number of head of hogs slaughtered commerically.

TABLE IX

ACTUAL PRICE, FORECASTED PRICE, AND FORECAST ERROR FOR ALTERNATIVE PRICE FORECASTING MODELS FOR A NINE MONTH FORECAST OF THE AVERAGE MONTHLY PRICE OF FEEDER CALVES AT OKLAHOMA CITY
August 1972 through December 1972

		Equations									
		2.18		2.19		2.20		2.21		2.22	
Month	Actual Price	Price Forecast	Forecast Error	Price Forecast	Forecast Error	Price Forecast	Forecast Error	Price Forecast	Forecast Error	Price Forecast	Forecast Error
						($ per cwt)					
August	41.06	40.25	0.81	38.92	2.14	40.42	0.64	39.11	1.95	39.32	1.74
September	42.33	40.71	1.62	39.74	2.59	42.37	-0.04	40.44	1.89	40.61	1.72
October	43.05	41.91	1.14	41.29	1.76	44.42	-1.37	41.78	1.27	41.88	1.17
November	43.03	43.24	-0.21	42.23	0.80	44.91	-1.88	42.13	0.90	42.38	0.65
December	43.94	42.21	1.73	40.90	3.04	41.84	2.10	40.13	3.81	40.46	3.48

Equations									
2.23		2.24		2.25		2.26		2.27	
Price Forecast	Forecast Error	Price Forecast	Forecast Error	Price Forecast	Forecast Error	Price Forecast	Forecast Error	Price Forecast	Forecast Error
($ per cwt)									
38.75	2.31	38.78	2.28	39.57	1.49	39.32	1.74	39.20	1.86
40.28	2.05	40.64	1.69	40.45	1.88	40.38	1.95	40.36	1.97
42.58	0.47	42.45	0.60	41.50	1.55	41.35	1.70	41.33	1.72
41.71	1.32	42.07	0.96	41.51	1.52	41.46	1.57	41.40	1.63
40.80	3.14	41.36	2.58	39.93	4.01	39.90	4.04	39.79	4.22

$$\log\hat{P}_{f,t+9} = 0.7270 + 0.01142C_{r,t} + 0.00008044CML_{t} + 0.0003567FD_{t-3}$$
$$(0.02707)(0.0006189) \quad (0.000009797) \quad (0.0003984)$$
$$R^2 = .8766 \qquad S^2 = .0007445 \qquad (2.23)$$
$$\bar{R}^2 = .8732 \qquad E^2 = 5.3404$$

$$\log P_{f,t+9} = 0.6859 + 0.01091C_{r,t} + 0.00008157CML_{t} + 0.0000645HSL_{t-3}$$
$$(0.02755)(0.000606) \quad (0.000009217) \quad (0.00001960)$$
$$R^2 = .8866 \qquad S^2 = 0.0006839 \qquad (2.24)$$
$$\bar{R}^2 = .8835 \qquad E^2 = 3.9981$$

where:

CML = number of 1,000 head units of monthly commercial cattle slaughter in the forty-eight states;

FD = quarterly inventory of less than 500 pound cattle on feed (1,000 head) according to the twenty-three state report; and

HSL = million of pound of hogs slaughter commerically by months in the forty-eight states.

The inference base is January 1962 through July 1972.

The present price of wholesale carcass beef enters both equations at a high level of significance with a positive sign. This seems to substantiate the hypothesis that the demand for feeder calves is a function of the wholesale price of carcass beef.

The present level of commercial cattle slaughter has a positive influence on the forecasted price of feeder calves. This would be expected if it is assumed that the demand for feeder calves is held constant and the pool of available feeder calves is fairly constant over the forecasting interval. The result of an increase in commercial cattle slaughter is a decrease in the available supply of feeder calves, which results in an increase in the future price of feeder calves.

The inventory of cattle on feed in equation 2.23 indicates changes in the supply of feeder calves. Assuming that the demand for feeder calves is held constant, it would be expected that an increase in the inventory of cattle on feed in time period t-3 would indicate a possible decrease in the supply of feeder calves for time period t+9. This would result in an increase in the future price of feeder calves. In equation 2.23 the inventory of cattle on feed enters the equation with a positive sign, but a definite statement cannot be made about the influence of the inventory of cattle feed variable on the anticipated price of feeder calves because of the low level of significance.

The commercial hog slaughter variable in equation 2.24 is positively related to the price of feeder calves. This relationship is the result of a positive change in the demand for red meats over the inference base.

Although both equations 2.23 and 2.24 contain variables that are fairly consistent with economic theory, equation 2.24 is a better forecasting equation than equation 2.23. Equation 2.24 has a smaller and more consistent forecast error than equation 2.23 (3.9981) during the forecast test interval. Equation 2.24 has the smaller forecasting error in four of the five test months (Table IX).

Calf crop to cow inventory equations. Equations 2.25, 2.26, and 2.27 include the following variables: (1) the present price of wholesale carcass beef; (2) the present price of feeder calves; (3) the ratio of feeder calf price to sorghum grain price; (4) the ratio of calf crop size to cow inventory; and (5) the number of head of hogs slaughtered commercially.

$$\hat{P}_{f,t+9} = -64.8563 + 0.5694C_{r,t} + 0.1277\frac{P_{f,t}}{SGk_t} + 75.6705\frac{CACR_{t-3}}{CWIV_{t-3}}$$

$$(7.8450) \quad (0.07598) \quad (0.1461) \quad (11.004836)$$

$$R^2 = .8638 \qquad S^2 = 3.5789 \qquad (2.25)$$

$$\bar{R}^2 = .8602 \qquad E^2 = 6.6559$$

$$\hat{P}_{f,t+9} = -61.2062 + 0.08266P_{f,t} + 0.5663C_{r,t} + 71.06270\frac{CACR_{t-3}}{CWIV_{t-3}}$$

$$(8.8680) \quad (0.1124) \quad (0.08481) \quad (12.1703)$$

$$R^2 = .8636 \qquad S^2 = 3.5862 \qquad (2.26)$$

$$\bar{R}^2 = .8599 \qquad E^2 = 7.1266$$

$$\hat{P}_{f,t+9} = -63.6973 + 0.6109C_{r,t} + 73.7906\frac{CACR_{t-3}}{CWIV_{t-3}} + 0.0004033HSL_{t-3}$$

$$(8.1611) \quad (0.05978) \quad (11.8598) \quad (0.001579)$$

$$R^2 = .8630 \qquad S^2 = 3.6014 \qquad (2.27)$$

$$\bar{R}^2 = .8593 \qquad E^2 = 7.6863$$

where:

SGK = average monthly price ($ per cwt.) of No. 2 yellow grain sorghum at Kansas City;

CACR = annual calf crop (1,000 head) in the forty-eight states; and

CWIV = annual number (1,000 head) of all cows and heifers that have calved in the forty-eight states.

The estimate of the parameter of the wholesale price of carcass beef, which is significantly different from zero at the 0.05 probability level, reflects the effect of carcass been price on the demand for feeder calves. The feeder calf price variable indicates a positive trend in future price of feeder calves, but this variable is not significantly different from zero at the 0.05 probability level.

The ratio of feeder calf price to sorghum grain price indicates the relative cost of feeder calves to sorghum grain. Assuming that

the price of feeder calves is a function of the wholesale carcass beef price. It would be expected that an increase in this ratio would indicate the increased profitability from feeding calves and therefore result in an increase in the demand for feeder calves and thus an increase in the future price of feeder calves. This ratio does enter equation 2.25 as expected, but a definite statement cannot be made about the effect of this variable in equation 2.25 because of the low significance level.

The ratio of calf crop inventory to cow inventory measures the relative efficiency of the cow-calf operator. An increase in this ratio is a result of improving the productivity of the cow herd, which can be accomplished by culling unproductive cows from the herd and improving management techniques. Therefore an increase in this ratio could lead to a possible decrease in future supplies of feeder calves which could mean an increase in the future price of feeder calves. As a result it is expected that the ratio of calf crop inventory to cow herd inventory would be positively related to the future price of feeder calves.

The pounds of hogs slaughtered variable in time period t-3 in equation 2.27 indicates a positive relation to the price of feeder calves in time period t+9. The logic of this relation is the same as in equation 2.24.

Of this group of equations, 2.25 is the best forecasting equation. Equation 2.25 has the highest adjusted coefficient of determination (0.8602), the lowest estimate of the variance of the estimator, and the smallest mean squared forecasting error (6.6559). During the forecast test interval equation 2.25 has the smallest forecast error of all five test months (Table IX).

Price Forecasting Equations to be Used in the Decision Model

In this chapter several price forecasting procedures have been examined and tested. Based on the test results and economic meaning, equation 2.12 has been selected to be used in the stocker calf buying decision model and equation 2.24 has been selected to be used in the feeder calf selling decision model. The mean squared forecasting error over the test period using these two equations is smaller than the mean square error over the same period using the naive price forecasting models discussed earlier in the chapter. The price forecasts for stocker calves using equation 2.12 are presented in Table X and price forecasts for feeder calves using equation 2.24 are presented in Table XI.

TABLE X

FORECASTS OF THE AVERAGE MONTHLY PRICE OF STOCKER CALVES USING EQUATION 2.12, July 1972 - March 1973

Price Forecast for the Month of:	Price Forecast
	($ per cwt)
July	41.74
August	43.08
September	42.91
October	45.90
November	47.97
December	45.39
January	44.55
February	45.44
March	44.41

TABLE XI

FORECAST OF THE AVERAGE MONTHLY PRICE OF FEEDER CALVES USING EQUATION 2.24, August 1972 - August 1973

Price Forecast for the Month of:	Price Forecast
	($ per cwt)
August	38.78
September	40.64
October	42.45
November	42.07
December	41.36
January	37.07
February	42.24
March	47.32
April	42.13
May	41.79
June	38.48
July	38.20
August	36.04

FOOTNOTES

[1]The difference in the inference base for stocker and feeder calves is because work was initially done on stocker calves. When the work began on feeder calves the information on June and July price was available.

[2]Variance of the price forecasting error is defined as:

$$E^2 = \frac{\sum_{i=1}^{n} (P_i - \hat{P}_i)^2}{n-1}$$

where: E^2 = average squared forecasting error;

P_i = observed price of either stocker or feeder calves;

$\hat{P}_i$ = forecasted price of either stocker or feeder calves;

n = number of price forecasts.

[3]Other forecasting coefficients for stocker calves for periods other than four months have been calculated but will not be presented in this text.

[4]Because of these results and the large amount of computational time the mean percent price forecasting coefficients were not calculated for feeder calves.

[5]J. Johnston, Econometric Methods, 2nd ed., McGraw-Hill (New York, 1972), pp. 121-168.

[6]Jack H. Armstrong, Cattle and Beef: Buying, Selling and Pricing, Cooperative Extension Service, Purdue University (May, 1968), pp. 49-54.

[7]Data are not available on a monthly basis on the six state inventory of cattle and calves on feed until January 1966.

CHAPTER III

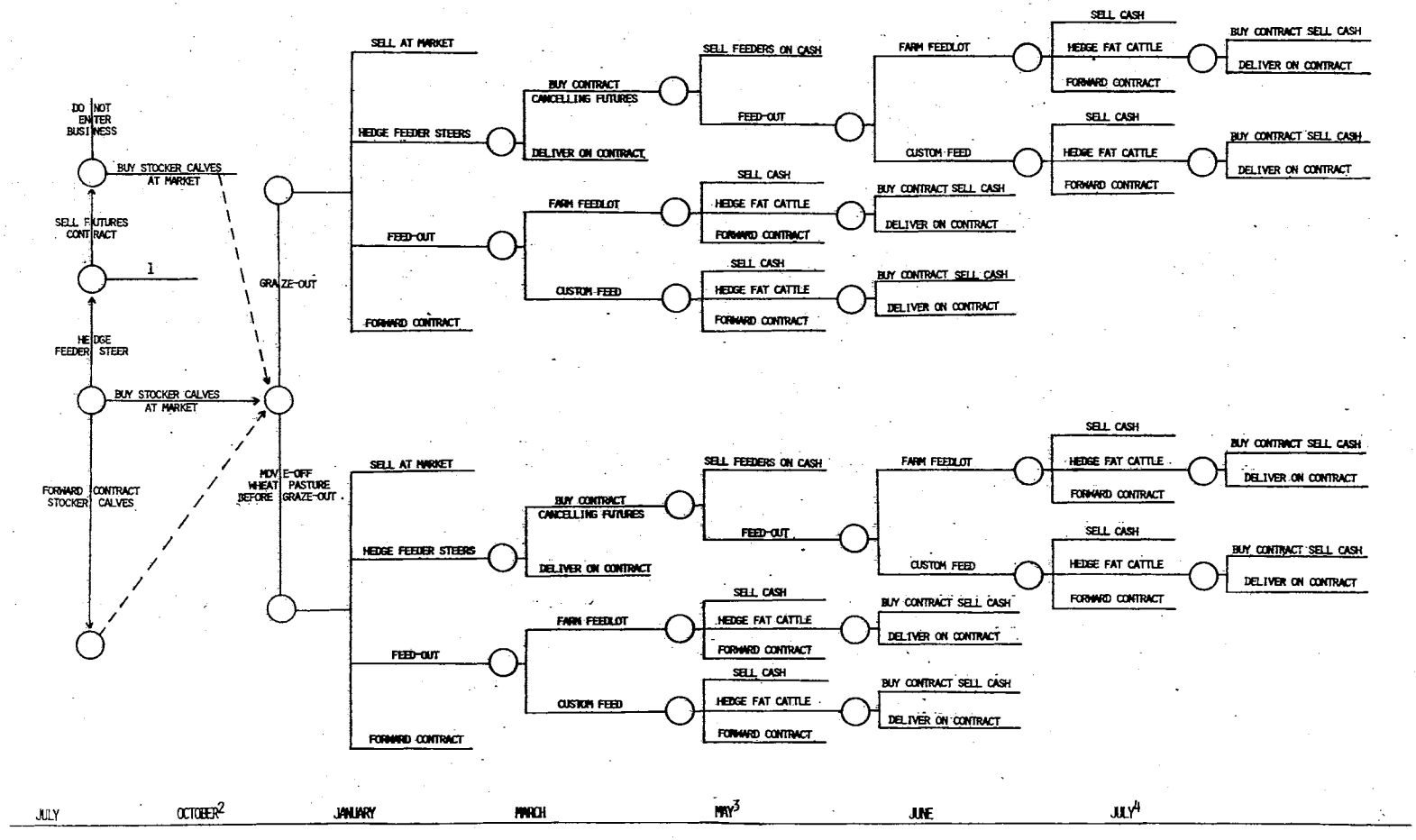
DEVELOPMENT AND APPLICATION OF MARKET STRATEGY MODEL FOR STOCKER OPERATORS IN OKLAHOMA

In the first chapter the discussion centered on the risk and uncertainty stocker operators encounter because of unfavorable changes in buying and selling prices of stocker and feeder calves. Chapter II developed and tested several alternative procedures for forecasting the price of both stocker and feeder calves.

In this chapter the alternative production and marketing decisions available to stocker operators who utilize winter wheat pasture are discussed. In addition, a decision model which utilizes the price forecasting equations developed in Chapter II is developed to aid stocker operators in selecting between the alternative buying and selling strategies. Finally the decision model is tested over a preselected time period.

Nature of Production-Marketing Decisions for Stocker Operators

The stocker operator in Oklahoma who utilizes winter wheat pasture is faced with several alternative buying, selling and production decisions that must be made before and during the production process. These decisions are presented in Figure 3 and are discussed in the following subsections. The model developed to select between these



1 TAKE DELIVER OF FUTURE CONTRACT AND OPERATE AS A FEEDER.

2 DECISIONS JULY THROUGH OCTOBER ARE FOR BUYING STOCKER CALVES.

3 DECISIONS OCTOBER THROUGH MAY ARE SELLING FEEDERS.

4 DECISIONS MARCH THROUGH JULY ARE SELLING FAT CATTLE.

Figure 3: Market Decisions Facing Stocker Cattle Operators Who Utilize Winter Wheat Pasture

buying and selling decisions can be easily adapted to other geographical regions or production processes.

Purchase Decisions

In the early summer months the stocker operator must determine whether or not to enter into the stocker business. To make this decision intelligently, the stocker operator needs to know the expected fall purchase price of stocker calves, expected spring selling price of feeder calves, and the cost of production. For this analysis assume that the stocker operator decides to enter into the stocker business. Now, the stocker operator needs to determine how to purchase stocker calves and sell feeder calves.

To select among the purchase strategies, in July, the stocker operator needs to know the expected cash market price of October stocker calves, the forward contracting price for October stocker calves, and the adjusted October feeder cattle futures prices. The October feeder cattle futures price is adjusted so as to be comparable with the cash market price of Oklahoma stocker calves.[1] The adjustment factors include differences in weight classification, non-par delivery, commission, and interest on margin funds.

Selling Decisions

After deciding which buying strategy to follow the stocker operator needs to decide on the selling strategy to follow. Before the stocker operator can select among alternative selling strategies, he should select between the production strategies of graze-out and nongraze-out. The criterion to use in making this decision is based on the concept of

partial budgeting, that is, if the additional cost of graze-out is less than the additional revenue, select graze-out. If the additional cost is greater than the additional revenue, the stocker operator should select nongraze-out.

After selecting the production process to follow the stocker operator has four alternative methods to sell his output. The first is to sell feeder calves at the cash market price in the spring. The second is to hedge the selling price of feeder calves on the futures market. The third strategy is to forward contract the selling price. The last strategy is to feed the feeder calves out to slaughter weights. The cash and forward contract strategies end the stocker operator's production marketing decision making.

If the stocker operator decides to hedge feeder calves he must choose between delivering on the futures contract or buying back the futures contract. The stocker operator would deliver on the futures contract if the net revenue from delivery is greater than the net revenue from selling on the cash market.

If the stocker operator decides to cancel the futures position then he must sell the feeder calves on the cash market or feed the calves to slaughter weight. To select between these strategies the operator needs to know the expected market price of fat cattle, the present selling price of feeder calves, and the cost of transforming feeder calves into fat cattle. If the stocker operator decides to sell feeder calves on the cash market no other decisions are needed.

Should the stocker operator decide to feed-out he needs to select between custom feeding and farm feeding. To select between these two production processes the stocker operator needs to know the cost of

custom feeding and the cost of farm feeding. After selecting the production process to follow, the stocker operator needs to decide on the selling strategy for fat cattle.

The selling strategies for fat cattle include: (1) sell fat cattle on the cash market without hedging; (2) hedge fat cattle using the fat cattle futures contract; and (3) forward contract the selling price of fat cattle. The procedure used to select among these strategies is the same as that developed to select between selling strategies for feeder cattle.

Should the stocker operator decide to follow the feedout selling strategy for feeder calves he is faced with the same set of production-marketing decisions developed in the above discussion. That is, select between the alternative production processes and selling strategies for fat cattle.

To simplify future application of the decision model assume that the stocker operator (1) decides to enter the stocker business; (2) decides to move feeder cattle off wheat pasture before graze-out; and (3) does not elect to follow the feed-out strategy.

Decision Model to Select Among Various Buying and Selling Strategies

In this section a procedure is developed to select among the various buying and selling strategies presented in Figure 3. This procedure uses the price forecasting models for stocker and feeder calves developed in Chapter II and the stocker operator's risk profile, which is measured by the Student's "t" distribution.[2] The stocker operator's risk profile is a measure of the amount of money he can lose due to an

unfavorable price change and still stay in business. If the stocker operator could not afford to lose any money due to an unfavorable price change his preferred risk level measured by the Student's "t" distribution would approach zero. As the amount of money he can afford to lose increases, his risk level approaches one.

The criterion used to select among the alternative buying and selling strategies is based on the bounds of a one-sided probability interval on the price forecast. The probability interval incorporates the stocker operator's risk profile and the variability of the forecasting equation. The following formula is used to calculate the probability interval:[3]

$$D = C' \hat{B} \pm t_{\alpha,df}\{S^2[1 + C' (X X)^{-1} C]\}^{1/2} \qquad (4.1)$$

where:

D = probability interval;

C' = row vector of the observed independent variables used to compute the predicted average monthly price for month t;

$\hat{B}$ = column vector of the estimates of the beta coefficients;

t = Student's t statistic at probability level α (one-sided test) and degrees of freedom, df;

S^2 = estimate of the variance of the estimator; and

X = column vector of the observed independent variables over the influence base.

Using the probability intervals and the relation of the buying and selling strategies to the intervals, stocker operators can select between alternative buying and selling strategies. Using this procedure the stocker operator runs the risk of a Type II statistical error.[4]

Stocker Calf Buying Decision Strategies

As indicated in Figure 3 the stocker operator has the following alternative buying strategies:

1. Buy stocker calves on a cash market basis in October;
2. Forward contract, in July, the purchase of stocker calves for a specific price and delivery in October; and
3. Buy, in July, feeder-calf futures contracts for October delivery. In October, sell contracts and buy stocker calves on the cash market.

To select among these buying strategies the stocker operator must evaluate the relation of the forward contract buying price and the adjusted feeder calf futures contract price to the upper bound of the probability interval. The upper bound is used to establish an interval in which the forecasted purchase price is expected to be at a given probability level. If the purchase price associated with the strategies of forward contracting and futures hedging are below the upper bound of the probability interval, the stocker operator is better off to use one of these strategies rather than run the risk of a Type II statistical error. If the price associated with these two strategies is greater than the upper bound, the stocker operator is better off to run the risk of a Type II statistical error.

The decision rules necessary for stocker calf buying strategies can be summarized as:

1. If the forward contract price is greater than the adjusted futures price but less than the upper bound of the probability interval, use strategy number 3;

2. If the forward contract price is less than the adjusted futures price and less than the upper bound of the probability interval, use strategy number 2; and
3. If both the forward contract price and the adjusted futures price are greater than the upper bound of the probability interval, use strategy number 1.

Feeder Calf Selling Decision Strategies

As shown in Figure 3 the stocker operator has the following alternative selling strategies:

1. Sell feeder calves on a cash market basis in March;
2. Forward contract, in July, the sale of feeder calves for a specific price and March delivery; and
3. Sell, in July, a feeder-calf futures contract or contracts for March delivery.

To select among these selling strategies the stocker operator must evaluate the relation of the forward contract selling price and the adjusted feeder-calf futures contract price to the lower bound of the probability interval. The lower bound is used to establish an interval in which the forecasted selling price is expected to be at a given probability level. If the selling strategies of forward contracting and futures hedging are above the lower bound of the probability interval, the stocker operator is better off to use one of these strategies rather than run the risk of a Type II statistical error. If these two selling strategies are below the lower bound, the stocker operator is better off to run the risk of a Type II statistical error.

The decision rules necessary for feeder calf selling strategies can be summarized as:

1. If the forward contract price is less than the adjusted futures price but greater than the lower bound of the probability interval, use strategy number 3;
2. If the forward contract price is greater than the adjusted futures and greater than the lower bound of the probability interval, use strategy number 2; and
3. If both the forward contract price and the adjusted futures price are less than the lower bound of the probability interval, use strategy number 1.

Application of the Decision Model

In this section the decision model developed in the previous section is applied to the buying and selling strategies encountered by Oklahoma stocker operators who utilize winter wheat pasture. Also in this section the decision model is simulated over a pre-selected time period to evaluate its performance.

Decision Model for Oklahoma Stocker Operators Who Use Winter Wheat Pasture

To apply the decision model, the Oklahoma stocker operator will need to know in July the predicted average monthly price of October stocker calves and March feeder calves at the Oklahoma City stockyard. He also needs to know the relation of the forward contract price and the adjusted futures price to the buying and selling probability intervals at alternative risk levels as well as the amount of loss he

can sustain due to unfavorable price changes and still remain in business.

The adjusted October 1972 feeder calf futures contract price used to select between the alternative buying strategies is the June 30, 1972, closing price for October, 1972, feeder calf futures contract. The adjusted October futures contract price is $42.42 (Table XII).

The predicted average monthly price of stocker calves in July, 1972, for October, 1972, using equation 2.12, is $45,90 per cwt. The upper bound of the probability interval ranges from $46.20 at the 0.45 risk level to $54.64 at the 0.0005 risk level (Table XIII). If the stocker operator has a high risk profile he should select a risk level that gives a wider probability interval than if the stocker operator has a low risk profile. The 0.0005 risk level has the widest probability interval and the 0.45 risk level has the narrowest probability interval. As the width of the probability interval decreases the risk level increases.

TABLE XII

AN ILLUSTRATION OF THE PROCEDURE USED TO CALCULATE THE ADJUSTED OCTOBER 1972 FEEDER CALF FUTURES CONTRACT PRICE

	($ per cwt.)
June 30, 1972 October feeder calf futures closed at	$40.15
Deduct for non-par delivery at Oklahoma City	-0.50
	$39.65
Adjusted price for weight difference[1]	$42.29
Add commission of[5]	0.10
Add interest loss on margin fund[6]	0.03
Adjusted October feeder calf futures price	$42.42

The forward contract price for October stocker calves is derived by adjusting the June cash price by the change in the seasonal indicies between June and October. Using this procedure the October, 1972 forward contract price for stocker calves is postulated to be $39.97.

Using the buying decision model to select among the various strategies the stocker operator is advised to purchase October stocker calves using the forward contract strategy at all risk levels (Table XIII), inasmuch as the purchase price of October stocker calves is $39.97 which is less than any of the other alternatives considered.

TABLE XIII

BUYING STRATEGIES PRICES FOR OCTOBER 1972 STOCKER CALVES AT ALTERNATIVE RISK LEVELS

Risk Level	Upper Bound Price Forecast	Adjusted Futures	Forward Contract
	($ per cwt.)	($ per cwt.)	($ per cwt.)
0.45	46.20	42.42	39.97
0.40	46.49	42.42	39.97
0.35	46.81	42.42	39.97
0.30	47.14	42.42	39.97
0.25	47.50	42.42	39.97
0.20	47.91	42.42	39.97
0.15	48.39	42.42	39.97
0.125	48.67	42.42	39.97
0.10	49.00	42.42	39.97
0.05	49.93	42.42	39.97
0.025	50.78	42.42	39.97
0.0125	51.55	42.42	39.97
0.01	51.77	42.42	39.97
0.005	52.49	42.42	39.97
0.0025	53.16	42.42	39.97
0.0005	54.64	42.42	39.97

The predicted average monthly price of feeder calves in July, 1972, for March, 1972, using equation 2.24, is $47.32. The lower bound of the probability interval ranges from $46.95 at the 0.45 risk level to $38.14 at the 0.0005 risk level (Table XIV).

TABLE XIV

SELLING STRATEGIES PRICES FOR MARCH 1973 FEEDER CALVES AT ALTERNATIVE RISK LEVELS

Risk Level	Lower Bound Price Forecast	Adjusted Futures	Forward Contract
	($ per cwt.)	($ per cwt.)	($ per cwt.)
0.45	46.95	43.62	42.31
0.40	46.56	43.62	42.31
0.35	46.17	43.62	42.31
0.30	45.76	43.62	42.31
0.25	45.32	43.62	42.31
0.20	44.84	43.62	42.31
0.15	44.29	43.62	42.31
0.125	43.95	43.62	42.31
0.10	43.59	43.62	42.31
0.05	42.57	43.62	42.31
0.025	41.71	43.62	42.31
0.0125	40.94	43.62	42.31
0.01	40.71	43.62	42.31
0.005	40.04	43.62	42.31
0.0025	39.43	43.62	42.31
0.0005	38.14	43.62	42.31

The adjusted March, 1973, feeder calf futures contract price used to select between the alternative selling strategies is the September 21, 1972, closing price for March, 1973, feeder calf future contracts. The September 21, 1972, price is used because this is the

earliest date that the March feeder calf futures contract was traded in 1972 even though according to the decision theory we should use the June 30, 1972, closing price.[7] On September 21, 1972, the March feeder calf contract closed at $43.75. After adjusting for commission charge, interest on margin and location difference, the adjusted March feeder calf contract price is $43.62.

The forward selling price for feeder calves is calculated using the same procedure as the forward buying price. The forward contract price for March feeder calves is $42.31.

Using the selling decision model to select between the various strategies the stocker operator is advised to sell feeder calves on the cash market if his risk level is greater than 0.10 and to use the futures selling strategy if the risk level is less than or equal to 0.10.

Application of the Buying and Selling Decision Models Over a Pre-Selected Time Period

The buying and selling decision models for stocker and feeder calves are applied to the situation facing Oklahoma stocker operators between December, 1971, and December, 1972. The application time period is determined by the availability of data on the feeder calf futures contract which began trading in December of 1971.

The buying decision model is applied to an eight-month period, April, 1972, through November, 1972. The buying decisions for this period are made between January and August, 1972, and the selling decision model is applied to a four-month period, September, 1972, through December, 1972. The selling decisions for this period are made between January and April, 1972.

Buying Decision Model. The buying decision model for stocker calves is applied to the eight-month time period to evaluate the model's performance. During this period the stocker operator selects among the alternative buying strategies for each month. At the end of eight months the results from the decision model are contrasted with the outcome from following the other alternative strategies.

The four-month forecast of the average monthly price of stocker calves is calculated using equation 2.12. The forecasted price ranges from a high of $47.97 to a low of $40.86. The trend over the eight months (April to November, 1972) is upward (Table XV).

TABLE XV

FOUR-MONTH FORECAST OF THE AVERAGE MONTHLY PRICE OF 400-500 POUND GOOD AND CHOICE STOCKER STEERS AT OKLAHOMA CITY USING EQUATION 2.12

Month t+1	April 1972-November 1972 Forecast Month (t+4)	Forecast Price
		($ per cwt.)
January	April	40.86
February	May	41.83
March	June	42.43
April	July	41.74
May	August	43.08
June	September	42.91
July	October	45.90
August	November	47.97

The forward contracting price for stocker calves is determined by adjusting the cash market price in month t by the change in the seasonal indicies between month t and t+4. The cash market price in month t, seasonal adjustment coefficients, and the forward contracting price in month t+4 are presented in Table XVI. Using this procedure the forwarding contracting price in month t+4 is greater than the cash market price in month t in the first three months of the test period and less than the cash market price in the remaining months. The forward contracting price ranges from a low of $38.76 in August, 1972, to a high of $42.73 in November, 1972.

TABLE XVI

CASH MARKET PRICE, SEASONAL ADJUSTMENT COEFFICIENT, AND FORWARD CONTRACTING PRICE FOR 400-500 POUND GOOD AND CHOICE STOCKER STEERS AT OKLAHOMA CITY
April 1972 - November 1972

Month t+4	Cash Market Price Month t	Seasonal Adjustment Coefficient	Forward Contract Price (t+4)
	($ per cwt.)		($ per cwt.)
April	39.37	0.06425	41.90
May	39.01	0.06127	41.40
June	40.10	0.03493	41.50
July	40.07	-0.006950	39.79
August	40.34	-0.03916	38.76
September	41.18	-0.03360	39.80
October	43.22	-0.07530	39.97
November	45.31	-0.05695	42.73

The feeder calf futures price and adjusted feeder calf futures price for month t+4 in month t are presented in Table XVII. The feeder calf futures price for month t+4 is based on the closing price of the futures contract the last trading day of month t. No feeder calf futures contracts are traded for the months of June, July, December, January, and February. Therefore, for purposes of analysis assume the feeder calf futures contract price to be the futures contract price for the closest trading month. For example, the June futures contract price is the May futures contract price and the July contract price is the August futures contract price.

TABLE XVII

FEEDER CALF FUTURES AND ADJUSTED FEEDER CALF FUTURES CONTRACT PRICES
April 1972 - November 1972

Month t	Month t+4	Futures Prices	Adjusted Futures Prices
		($ per cwt.)	($ per cwt.)
December	April	38.25	40.35
January	May	37.50	39.53
February	June	37.75	39.81
March	July	36.40	38.34
April	August	37.10	39.10
May	September	39.00	41.17
June	October	40.15	42.42
July	November	39.80	42.04

The feeder calf futures price is adjusted for differences in weight classification, location differences, commission charge, and loss of interest due to margin funds. The adjusted feeder calf futures contract price ranges from a high of $42.42 in October, 1972, to a low of $38.34 in July, 1972.

The upper bounds of the probability interval for stocker calf price forecasts at alternative risk levels are presented in Table XVIII. The risk levels range from 0.45 to 0.0005. As the risk level decreases the upper bound gets larger. For example, in June the upper bound increases from $42.70 at the 0.45 risk level to $50.35 at the 0.0005 risk level.

TABLE XVIII

UPPER BOUND OF THE PROBABILITY INTERVAL FOR STOCKER CALF PRICE FORECASTS AT ALTERNATIVE RISK LEVELS, April 1972 - November 1972

Risk Level	Simulation Months							
	April	May	June	July	Aug.	Sept.	Oct.	Nov.
	($ per cwt.)							
0.45	41.11	42.09	42.70	42.00	43.35	43.18	46.20	48.28
0.40	41.37	42.34	42.96	41.98	43.62	43.45	46.49	48.61
0.35	41.64	42.64	43.25	42.54	43.90	43.73	46.81	48.92
0.30	41.93	42.93	43.55	42.84	44.21	44.04	47.14	49.27
0.25	42.24	43.25	43.88	43.15	44.55	44.36	47.50	49.66
0.20	42.60	43.61	44.25	43.51	44.92	44.74	47.91	50.12
0.15	43.00	44.04	44.69	43.93	45.35	45.18	48.39	50.59
0.125	43.24	44.29	44.95	44.18	45.61	45.44	48.67	50.90
0.10	43.53	44.59	44.25	44.47	45.92	45.73	49.00	51.24
0.05	44.33	45.42	46.09	45.29	46.77	46.58	49.93	42.74
0.025	45.05	46.16	46.85	46.03	47.53	47.35	50.78	53.11
0.0125	45.71	46.84	47.54	46.71	48.23	48.04	51.55	53.93
0.01	45.90	47.03	47.75	46.90	48.44	48.25	51.77	54.18
0.005	46.52	47.68	48.41	47.53	49.09	48.90	52.49	54.93
0.0025	47.10	48.27	49.01	48.13	49.70	49.51	53.16	55.64
0.0005	48.36	49.57	50.35	49.42	51.05	50.85	54.64	57.19

In all of the months tested either the futures strategy price or the forward contracting strategy price is below the forecasted price for stocker calves (Table XIX). The result is that at all risk levels the stocker operator purchases stocker calves using either the futures or forward contracting strategies. Using the buying decision model the stocker operator purchases stocker calves in April, May, June, July, and November using the futures strategy. In August, September, and October the stocker operator purchases stocker calves using the forward contracting strategy.

TABLE XIX

PRICE FORECASTS, ADJUSTED FUTURES, AND FORWARD CONTRACT PRICES FOR 400-500 POUND GOOD AND CHOICE STOCKER STEERS April 1972 - November 1972

Decision Month (t+1)	Action Month (t+4)	Forecasted Price	Adjusted Futures Price	Forward Contract Price
		($ per cwt.)	($ per cwt.)	($ per cwt.)
January	April	40.86	40.35	41.90
February	May	41.83	39.53	41.40
March	June	42.43	39.81	41.50
April	July	41.74	38.34	39.79
May	August	43.08	39.10	38.76
June	September	42.91	41.17	39.80
July	October	45.90	42.42	39.97
August	November	47.97	42.04	42.73

Table XX presents the purchase price using the decision model strategies, cash market price, and profit or loss for the purchase of stocker calves using these strategies. In all of the test months the stocker operator is able to decrease the purchase price of stocker calves by following the strategy suggested by the decision model. The estimated average decrease in the purchase price over the simulation period is $3.51 per cwt.

TABLE XX

CASH MARKET PRICE, STRATEGY PRICE, PROFIT OR LOSS FROM FOLLOWING BUYING DECISION MODEL FOR STOCKER CALVES, April 1972-November 1972

Action Month (t+4)	Cash Market Price	Strategy Price	Profit (+) or Loss (-)
	($ per cwt.)	($ per cwt.)	($ per cwt.)
April	40.34	39.97	0.37
May	41.18	40.41	0.77
June	43.22	42.70	0.52
July	45.31	40.64	4.67
August	44.86	38.76	6.10
September	46.60	39.80	6.80
October	46.47	39.97	6.50
November	46.99	44.67	2.32

In Table XXI the forward contracting and futures strategies are contrasted with the cash market strategy to determine the profit or loss from following these strategies. The profit or loss for the forward contracting strategy is the difference between the cash market

price and the forward contracting price. The futures strategy profit or loss is the amount of profit or loss made on the futures trade adjusted for commission charge and loss of interest due to margin fund requirement. The futures trading price is the closing price of the feeder calf futures contract on the third Friday in the purchase month.

TABLE XXI

CASH MARKET PRICE, FORWARD CONTRACTING PRICE, AND FUTURES PRICE CONTRASTED TO DETERMINE PROFIT OR LOSS
April 1972-November 1972

Action Month (t+4)	Cash Market Price	Forward Contracting Price	Futures Price	Forward Contracting Profit (+) or Loss (-)	Futures Profit (+) or Loss (-)
			($ per cwt.)		
April	40.34	41.90	38.75	-1.56	0.37
May	41.18	41.40	38.40	-0.22	0.77
June	43.22	41.50	38.40	1.72	0.52
July	45.31	39.79	41.20	5.52	4.67
August	44.86	38.76	41.55	6.10	4.32
Sept.	46.60	39.80	44.25	6.80	5.12
Oct.	46.47	39.97	44.12	6.50	3.84
Nov.	46.99	42.73	42.25	4.26	2.32

The forward contracting price is less than the cash market price in all months of the test period except April and May. By using the forward contracting strategy over the test period the average monthly purchase price of stocker calves is reduced by $3.64 per cwt.

The futures strategy price is less than the cash market price in all months of the test period. By using the futures strategy the stocker operator is able to reduce the purchase price of stocker calves an average of $2.74 per cwt. over the test period.

During the test period the decision model proved to be an effective tool to transfer the risk associated with unfavorable changes in the price of stocker calves. Using the strategies suggested by the decision model the stocker operator was able to reduce the purchase price of stocker calves in all eight months of the test period. If the stocker operator would have used the forward contracting strategy to purchase stocker calves he would have paid more than the cash market price in the first two months of the test period (Table XXI). If he would have used the futures strategy to purchase stocker calves during the test period, the stocker operator would have reduced the purchase price in all eight months, but the reduction was not as large as the reduction from following the decision model (Table XXI).

Selling decision model. The selling decision model is tested over a four-month period to evaluate the model's performance. During this period the stocker operator selects between the alternative selling strategies for each month. At the end of the four months the results from the decision model are contrasted with the outcome from following the other alternative strategies.

The four month forecast of the average monthly price of feeder calves is calculated using equation 2.24. The forecasted price ranges from a high of $42.45 in October, 1972, to a low of $40.64 in September, 1972. The length of the test period is too short to determine a trend (Table XXII).

TABLE XXII

NINE-MONTH FORECAST OF THE AVERAGE MONTHLY PRICE OF 600-700 POUND CHOICE FEEDER STEERS AT OKLAHOMA CITY USING EQUATION 2,24
September 1972 - November 1972

Month t+1	Forecast Month t+9	Forecasted Price ($ per cwt.)
January	September	40.64
February	October	42.45
March	November	42.07
April	December	41.36

The forward contracting price for feeder calves is determined by adjusting the cash market price in month t by the change in the seasonal indices between month t and t+9. The cash market price in month t, the seasonal adjustment coefficients, and the forward contract price in month t+9 are presented in Table XXIII. The forward contracting price ranges from a high of $38.10 in September, 1972, to a low of $36.84 in December, 1972. This represents a decrease of $1.26 in the forward contract price of feeder calves over the four-month simulation period.

The feeder calf futures price and adjusted feeder calf futures price for month t+9 in month t are presented in Table XXIV. The feeder calf futures prices for month t+9 are determined by the same procedure used in the buying decision model. For the selling decision model the feeder calf futures price is adjusted for location difference, commission charge, and loss of interest on the margin fund. The range in the adjusted feeder calf futures price is $0.75, the high

TABLE XXIII

CASH MARKET PRICE, SEASONAL ADJUSTMENT COEFFICIENT, AND FORWARD CONTRACTING PRICE FOR 600-700 POUND FEEDER STEERS AT OKLAHOMA CITY, September 1972-November 1972

Month t+9	Cash Market Price Month t	Seasonal Adjustment Coefficient	Forward Contract Price
	($ per cwt.)		($ per cwt.)
September	37.37	0.01943	38.10
October	38.14	-0.01505	37.57
November	39.97	-0.02783	37.89
December	38.33	-0.03885	36.84

TABLE XXIV

FEEDER CALF FUTURES AND ADJUSTED FEEDER CALF FUTURES CONTRACT PRICES, September 1972-December 1972

Month t	Month t+9	Futures Price	Adjusted Futures Price
		($ per cwt.)	($ per cwt.)
December	September	34.50	33.84
January	October	35.05	34.49
February	November	35.25	34.59
March	December	35.25	34.59

price for the test period is $34.59 occurring in November and December and the low price for the test period is $33.84 occurring in September.

The lower bound of the probability interval for feeder calf price forecasts at alternative risk levels are presented in Table XXV. The risk levels range from 0.45 to 0.0005, as the risk level decreases the lower bound of the probability interval approaches zero. For example, in November the lower bound of the probability interval ranges from $41.73 at the 0.45 risk level to $33.92 at the 0.0005 risk level.

If the stocker operator's risk level is greater than 0.30, he is advised to sell feeder calves on the cash market in all four months of the test period. If the stocker operator's risk level is equal to or less than 0.30 and greater than 0.05, the stocker operator is advised to sell feeder calves using the forward contracting strategy in September and the cash market strategy in the three remaining months. If the stocker operator's risk level is less than or equal to 0.05 but greater than 0.025, he is advised to sell feeder calves using the forward contracting strategy for all four months (Table XXVI).

Table XXVII contrasts the forward contracting and futures strategies with the cash market strategy to determine the profit or loss from following these strategies. The profit or loss for the forward contracting strategy is the difference between the cash market price and the forward contracting price. The profit or loss for the futures strategy is the amount of profit or loss on the futures trade adjusted for commission charge and loss of interest due to margin fund requirement. The futures trading price is the closing price of the feeder calf futures contract on the third Friday of the selling month.

TABLE XXV

LOWER BOUND OF THE PROBABILITY INTERVAL FOR FEEDER CALF PRICE FORECASTS AT ALTERNATIVE RISK LEVELS, September 1972-December 1972

Risk Level	Month			
	September	October	November	December
	($ per cwt.)			
0.45	39.29	42.11	41.73	41.03
0.40	38.86	41.77	41.40	40.71
0.35	38.42	41.43	41.05	40.37
0.30	37.96	41.06	40.68	40.02
0.25	37.46	40.67	40.30	39.65
0.20	36.92	40.24	39.87	39.23
0.15	36.30	39.75	39.37	38.75
0.125	35.94	39.46	39.08	38.48
0.10	35.52	39.13	38.75	39.15
0.05	34.40	38.23	37.85	37.28
0.025	33.45	37.45	37.09	36.53
0.01	32.37	36.78	36.45	35.88
0.005	31.64	35.97	35.60	35.10
0.0025	30,99	35.42	35.06	34.57
0.0005	29.63	34.28	33.92	33.47

TABLE XXVI

LOWER BOUND OF THE PROBABILITY INTERVAL FOR FEEDER CALF PRICE FORECASTS AT FOUR ALTERNATIVE RISK LEVELS, FORWARD CONTRACT PRICE, AND ADJUSTED FUTURES PRICE, September 1972-December 1972

Month	Risk Levels				Forward Contracting Price	Adjusted Futures Price
	0.45	0.30	0.05	0.025		
	($ per cwt.)					
September	39.29	37.96	34.40	33.45	38.10	33.84
October	42.11	41.06	38.23	37.45	37.57	34.39
November	41.73	40.68	37.85	37.09	37.89	34.59
December	41.03	40.02	37.28	36.53	36.84	34.59

TABLE XXVII

CASH MARKET PRICE, FORWARD CONTRACT PRICE, AND FUTURES PRICE CONTRASTED TO DETERMINE PROFIT OR LOSS, September 1972 - December 1972

Month	Cash Market Price	Forwarding Contract Price	Futures Price	Forward Contracting Profit (+) or Loss (-)	Futures Profit (+) or Loss (-)
			($ per cwt.)		
Sept.	42.33	38.10	44.25	-4.23	-10.42
Oct.	43.05	37.57	44.12	-5.48	- 9.74
Nov.	43.03	37.89	42.25	-5.14	- 7.67
Dec.	43.94	36.84	42.25	-7.10	- 7.67

In each month of the test period the forward contracting and futures strategies results in a loss. If the stocker operator follows the futures strategy, the average reduction in the selling price of feeder calves if $8.88. If the stocker operator follows the forward contracting strategy, the average reduction in the selling price of feeder calves over the test period is $5.49.

Over the test period a reduction in the level of risk from unfavorable price changes reduces the average selling price of feeder calves. Between the 0.30 and 0.05 risk levels the average reduction in the selling price of feeder calves compared with the strategies suggested for a risk level of greater than or equal to 0.30 is $1.06. Between the 0.05 and 0.025 risk levels the average reduction in the selling price of feeder calves is $2.34. The average reduction in the selling price of feeder calves with a risk level of less than or equal to 0.025 compared with the 0.30 to 0.45 risk levels is $5.49.

Over this test period a reduction in risk from unfavorable price changes results in reduction in the selling price, which can be viewed as the premium paid by the operator for the price insurance. It should be noted that in a strong uptrending market, operators may need to reassess the risk profile they adopt.

FOOTNOTES

[1]Adjust for price differential between weight groups by

$$P_{fR} = \underset{(0.3404)}{0.8096} + \underset{(0.01147)}{0.9184}\ P_{4-5}$$

$R^2 = .9807$ $\quad S^2 = 0.4112$

$\bar{R}^2 = .9805$

$$P_{4-5} = -0.8815 + \frac{P_f}{0.9184}$$

where:

P_{fR} = feeder-calf futures prices adjusted for difference in market delivery points; and

P_{4-5} = cash equivalent price ($ per cwt.) of good and choice 400-500 pound stocker calves at Oklahoma City.

[2]Henry L. Alder and Edward B. Roessler, Introduction to Probability and Statistics, Fourth Edition, W. H. Freeman and Company (San Francisco, 1968), pp. 136-148.

[3]J. Johnston, Econometric Methods, Second Edition, McGraw-Hill (New York, 1972), p. 43.

[4]William C. Merrill and Karl A. Fox, Introduction to Economic Statistics, John Wiley and Sons (New York, 1970), p. 272.

[5]Commission charge on a feeder contract (42,000 pounds) is $40.00 which is $0.095 per cwt. For purposes of demonstration the commission charge per cwt. is rounded to $0.10.

[6]Represents a simple rate of interest of six percent per year.

[7]In this situation the stocker operator can either remain unhedged between July and September or hedge this period with the November feeder calf futures contract.

CHAPTER IV

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

Summary

Producers within the cattle industry are faced with three major types of risks: (1) risks of losses in quality, (2) risks of quantity losses, and (3) losses resulting from unfavorable changes in cash prices. Quality and quantity risks are physical risks that can be dealt with through managerial techniques, adoption of new technology, and the use of fire, storm, and theft insurance. The risk associated from unfavorable price changes does not lend itself to an insurance approach. Producers can, however, use alternative marketing strategies as a means to shift price risks.

The overall objective of this project was to develop a decision making procedure for Oklahoma stocker operators who use winter wheat pasture to reduce or transfer part of the risk associated with unfavorable price changes. To meet this objective it was necessary to develop and evaluate several alternative price forecasting procedures. The price forecasting models needed included a four-month forecast of the average monthly price of stocker calves and a nine-month forecast of the average monthly price of feeder calves at the Oklahoma City stockyard.

The price forecasting procedures explored were: (1) a naive procedure where "tomorrow's price is today's price," (2) a seasonal

adjustment model, and (3) several alternative single equation forecasting models. It was found that the single equation price forecasting model was better able to forecast the average monthly price of stocker calves and feeder calves over a pre-selected test period than either of the other two procedures. On the basis of their forecasting performances and economic meaning, two equations were selected to be used in the decision models. One equation was used to forecast the average monthly price of feeder calves nine months into the future and the other equation was used to forecast the average monthly price of stocker calves four months into the future.

The decision model developed to select among the alternative marketing strategies for stocker and feeder calves consisted of the stocker operator's risk profile and the results from the forecasting equations. These two factors were combined to calculate a one-sided probability interval. The relationship of the various marketing strategy prices to the upper or lower bounds of the probability interval, depending on whether the decision was buying or selling, was used to select among the various strategies. The buying strategies used in the buying decision model included:

1. Buy stocker calves on a cash market basis in October;
2. Forward contract, in July, the purchase of stocker calves for a specific price and delivery in October; and
3. Buy, in July, feeder-calf futures contracts for October delivery. In October, sell contracts and buy stocker calves on the cash markets.

The selling strategies used in the selling decision model included:

1. Sell feeder calves on a cash market basis in March;

2. Forward contract, in July, the sale of feeder calves for a specific price and March delivery; and
3. Sell, in July, a feeder-calf futures contract or contracts for March delivery.

Results of the Decision Model

For the situation facing Oklahoma stocker operators in 1972 who used winter wheat pasture the decision model recommended that October stocker calves be purchased using the forward contracting strategy. By using the purchase strategy suggested by the decision model the stocker operator was able to reduce the October purchase price of stocker calves $6.50 per cwt. as compared to the October cash market price of stocker calves.

For this same operator the decision model suggested that he sell his feeder calves in March, 1973, using the cash market strategy if his risk level is greater than 0.05, and to use the futures selling strategy if his risk level is less than or equal to 0.05.

The buying and selling decision models were tested over a preselected time period to evaluate their performance. The buying decision model was tested over an eight-month period, April through November, 1972, and the selling decision model was tested over a four-month period, September through December, 1972. During each month of the test period the stocker operator selected among the various buying and selling strategies. At the end of the test period the results of the strategies suggested by the decision model were compared to the results from the alternative strategies.

Compared with the cash market strategy the stocker operator was able to reduce the purchase price of stocker calves in all eight months of the test period by following the decision model. The average reduction in the price of stocker calves by using the decision model was $3.51 per cwt.

Over the test period, stocker operators who had risk levels greater than 0.05 were advised to follow the cash market selling strategy. Stocker operators whose risk levels were less than 0.05 forward contracted the sale of feeder calves. The result of a reduction in the level of risk associated with unfavorable price changes was a decrease in the average monthly selling price of feeder calves over the test period.

Conclusions

This study has demonstrated that price forecasting techniques and measures of the stocker operator's risk profile can be effectively combined in a decision model to reduce the risk associated with unfavorable price changes. Over the test period the buying decision model proved to be effective in an uptrending market. During this period the buying decision model recommended that stocker operators employ selected buying strategies to lock-in the purchase price of stocker calves. Although the buying decision model was not tested over a downtrending market, it is expected that the decision model would recommend that the stocker operator purchase stocker calves on the cash market. By incorporating the price forecasting technique into the decision model the stocker operator should be able to anticipate major changes in the direction of stocker calf prices.

The selling decision model also proved to be an effective means of transferring the risk associated with unfavorable price changes. During the uptrending market the selling decision model recommended that stocker operators, who had high risk levels, sell feeder calves using the cash market strategy. As the stocker operator's risk level decreased the selling decision model recommended that stocker operators transfer the price risk by employing strategies other than the cash market selling strategy. In the case of an uptrending market this would result in a reduction in the selling price of feeder calves, but this reduction can be viewed as the cost of transferring the price risk. As was the case with the buying decision model, the selling decision model was not tested over a downtrending market, but it is expected that the decision model would recommend that the stocker operators sell feeder calves using either the futures or forward contracting market strategy.

Several alternative price forecasting techniques, the results of which served as inputs into the decision model, were tested and evaluated. The technique providing the best results was the single-equation regression model which included the following variables: (1) price of either slaughter or carcass beef, (2) a price trend variable, and (3) inventory variables that relate the effect of changes in supplies of stocker and feeder calves on the future price of either stocker or feeder calves. These price forecasting equations tend to underestimate the actual price in an uptrending market. Although the price forecasting equations were not tested over a downtrending market it is suspected that these models will tend to overestimate the

actual price. This should not present a major problem to the alert stocker operator or researcher.

These forecasting models used the implicit functional form where the price forecast is a function of the lagged independent variables. Another functional form that has been used in other price forecasting work would be where the price forecast in time t is a function of the independent variables in time t.[1] The primary shortcoming from using this approach is that the values of the independent variables must be forecasted in order to arrive at a price forecast.

To evaluate and select between the price forecasting models it was found that the common statistical measure of goodness of fit served as rough guidelines. But, to make the final selection among the forecasting models it was necessary to test the performance of the forecasting models outside of the estimation period. A combination of the statistical measure of goodness of fit, results from the test period, and economic logic of the forecasting models provided a workable procedure to select the best price forecasting model.

Implications

This study developed a procedure that stocker operators can apply to their operations, according to their own risk profile, to select among alternative buying and selling strategies. Also, the stocker operator could use the decision model to more effectively bargain for a forward contracting price. In addition, the procedure developed can easily be adapted to other sectors within the cattle industry. To make the adaptation it would be necessary to develop price forecasting models

to meet the needs of the operators within the other sector, but the basic logic of decision models would not change.

In addition the decision model and price forecasting models can be used by agricultural extension economists as an input into farm management systems. For example, the price forecasting model could be incorporated into a linear programming system, used to determine resource inputs necessary for a given level of profitability.

Further research is needed to incorporate additional marketing strategies into the decision model. For example, additional marketing strategies might include the selective hedging strategies developed by Hague.[2] Also an information feedback system is needed in the decision model to relate changing marketing conditions to the decision maker. With such a system the stocker operator would be better able to evaluate his position and to take corrective action.

The development of an information feedback system would require that additional price forecasting models be developed. These models would be used to forecast the prices of stocker and feeder calves over alternative intervals. Also these models would need to incorporate variables to readjust price forecasts as additional information becomes available.

In addition, further work is needed to adapt the decision model to other sectors within the livestock industry or other regions of the country. By using the decision model these sectors would be better able to plan production and marketing strategies to meet the goals of the firm.

FOOTNOTES

[1]Walter M. Myers, "An Application of a Model to Forecast Slaughter Cattle Price," (unpublished Ph.D. Thesis, Oklahoma State University, 1973), p. 125.

[2]Terry Milton Hague, "Economic Evaluation of Alternative Hedging Strategies for the Cattle Feeder," (unpublished M.S. Thesis, Oklahoma State University, 1972), pp. 37-54.

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