SIMULATED COMPLETE MULTIPLE HEDGING PROGRAMS EMPLOYING OPTIMIZED MOVING AVERAGE COMBINATIONS FOR USE BY CONTINUOUSLY OPERATED FEEDLOTS

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PREFACE

The undertaking of a project as important and demanding as a Master's thesis can not be completed by one individual. This author is in debt to Oklahoma State University and the Department of Agricultural Economics for the financial support and rewarding educational experience received during the time spent at OSU.

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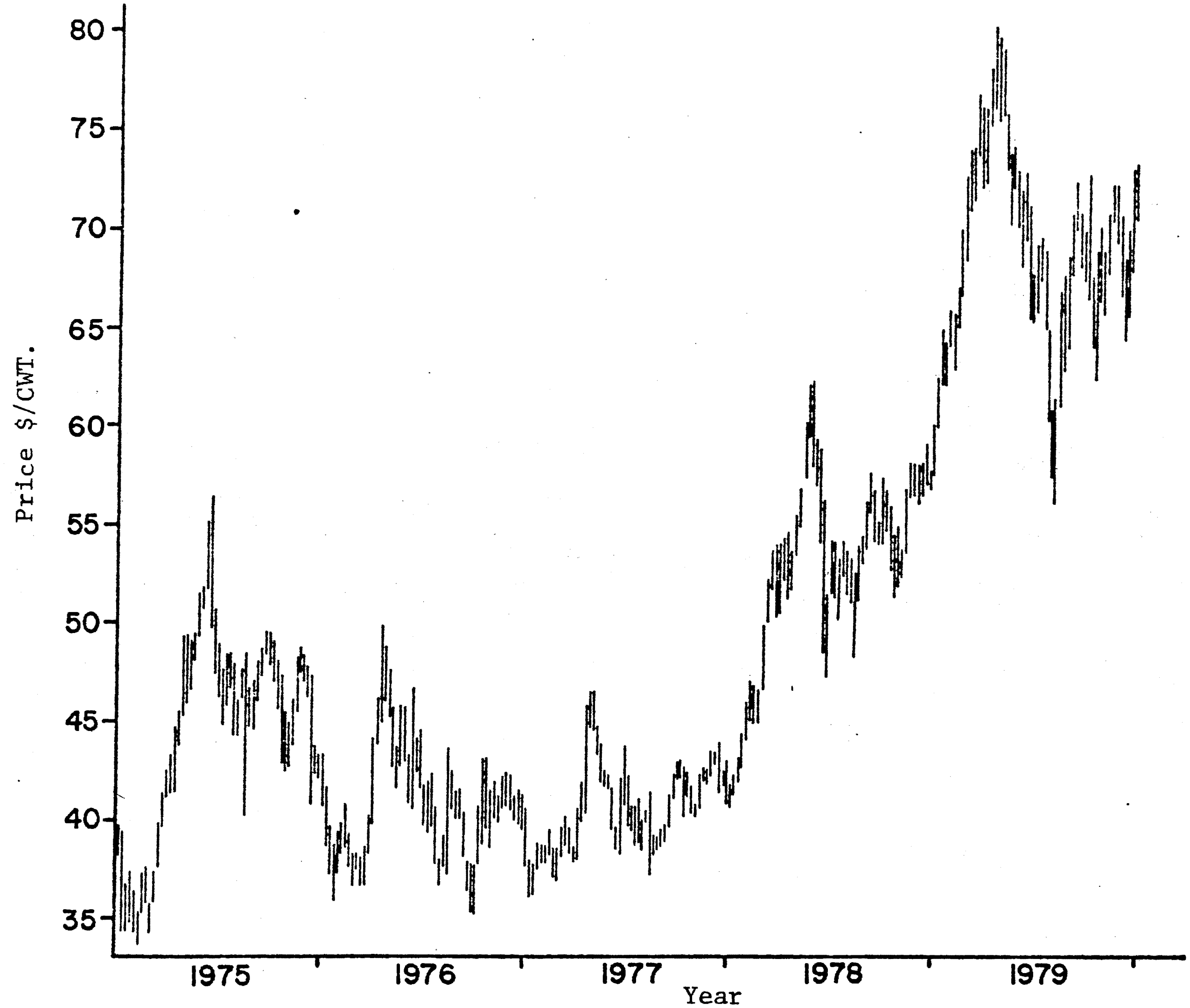
CHAPTER I

INTRODUCTION

This thesis is part of a continuous effort by the Department of Agricultural Economics to determine and develop marketing strategies for the cattlemen of Oklahoma. While progress has been made, we are reminded almost daily that not all of the questions of this dynamic industry are answered or fully understood.

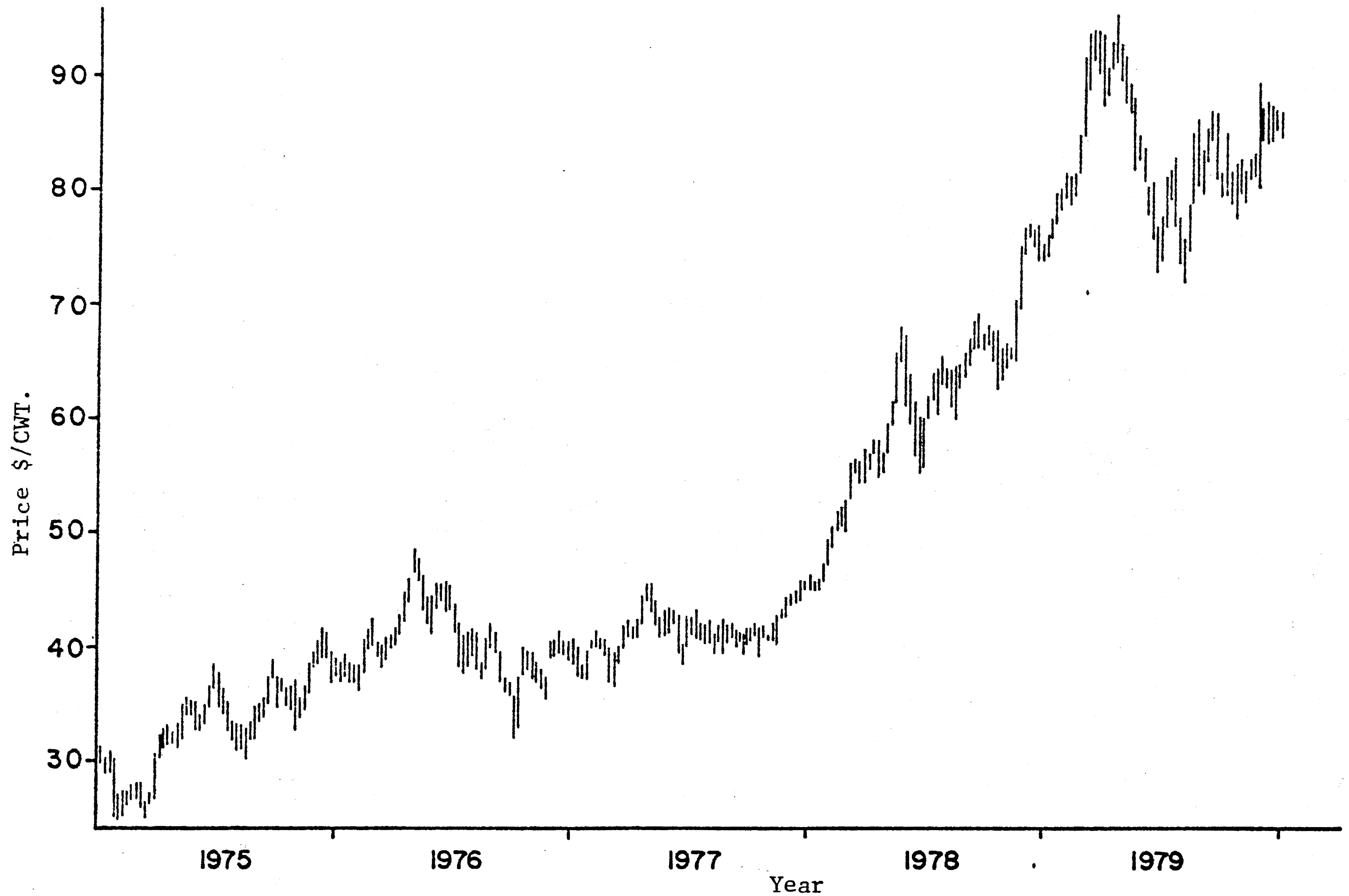
The livestock sector is the largest agricultural industry in Oklahoma. The cattle inventory report for January 1980, shows that Oklahoma ranks fifth in total number of cattle and calves and third in both the number of beef cows and the calf crop. The gross value of Oklahoma's beef production increased from 1.44 billion dollars in 1978 to approximately 1.8 billion dollars in 1979. The cattle industry is indeed big business in Oklahoma.

During 1979 Oklahoma stockmen saw record prices for both feeder cattle and fat cattle. Feeder cattle prices reached $95 per hundredweight and fat cattle prices neared $80 per hundredweight. Yet with record prices in the early Spring, by late Summer feeder cattle and fat cattle prices had decreased by 20 percent and losses of $100 per head or more were incurred on many slaughter steers and heifers (Figures 1 and 2). The volatility of the cattle market emphasizes the need for sound marketing practices that reduce the burden of the large price risk faced by the decision maker, yet maximize his monetary returns.



Source: Commodity Price Charts (1979).

Figure 1. Weekly High and Low Price Range of the Nearest Futures Contract for Live Cattle, 1975-1979



Source: Commodity Price Charts (1979).

Figure 2. Weekly High and Low Price Range of the Nearest Futures Contract for Feeder Cattle, 1975–1979

Some decision makers, realizing this inherent price risk, have turned to the futures market to advert price risk by employing marketing decisions involving hedging.[1] A futures contract is a firm legal agreement between a buyer (or seller) and an established commodity exchange or its clearing house in which the trader agrees to deliver during a designated period, a specified amount of a certain commodity that adheres to the particular quality and delivery conditions prescribed by the commodity exchange on which that commodity is traded. The contractual obligation is satisfied by an offsetting transaction in the futures market or, if allowed to run to its termination, fulfilled by a cash payment on the delivery date based on the settlement price for that day in return for delivery of that commodity.

The feeder cattle futures market can serve the risk management needs of both the feeder cattle producer and the cattle feeder. The feeder cattle producer can use the futures market for short hedging anticipated production of feeder cattle while the cattle feeder can use it to place long hedges in anticipation of a need for feeder cattle. The live cattle futures market then can be used by the cattle feeder to short hedge his anticipated production of fattened cattle. It is evident that the futures market provides the opportunity for cattlemen to transfer price risk to some other party willing to take that risk.

The futures market in both live cattle and feeder cattle have matured into liquid, functional markets since their inception in 1965

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[1]Hedging involves taking opposite positions in the cash and futures market. Short hedging involves the selling of futures contracts in order to reduce adverse price declines in the cash market. Long hedging involves the buying of futures contracts in order to reduce adverse price advances in the cash market.

and 1972 respectively. Trading volume in both markets has continued to increase every year. Trading volume of live cattle for 1979 increased 43 percent over the 1978 volume to a level of 7,214,846 contracts. Feeder cattle volume increased 72 percent above the 1978 level to 979,619 contracts. Deliveries against the live cattle contracts increased from 3,309 in 1978 to 6,284 in 1979. These figures indicate that the feeder cattle and live cattle futures markets now provide viable and feasible marketing alternatives.

Considerable merit exists in developing hedging strategies that will aid feeder cattle producers as well as cattle feeders in effectively managing price risk. By early 1980 it is more evident that the cattle cycle has bottomed out and significant herd rebuilding is imminent. The January 1, 1980, U. S. cattle inventory figures show that all cattle and calves are equal to the 1979 levels and that the number of heifers kept for beef cow replacement are 8 percent above last year. Initially this rebuilding process will keep cattle supplies tight, thus supporting cattle prices. However, as the cattle inventory increases, eventually more cattle will be placed on the market and prices will trend downward. Both long and short hedging strategies will be needed by the cattle feeder and producer to protect against forthcoming adverse price fluctuations. Since cattlemen, as a group, represent varying levels of understanding and ability, objective marketing and hedging decisions are the goal of this project.

The Problem

Feeder and fat cattle prices have shown great price volatility over the last several years. As an example, in a 32 week period in

1979, live cattle futures prices increased $22 per hundredweight and promptly decreased by $24 per hundredweight. This represents huge potential or actual profit or losses. To complicate the problem of increasing price risk, the cattle feeding industry is becoming more concentrated (Table I). The number of feedlots in the 23 major cattle-feeding States between 1962 and 1978 declined from 236,163 to 127,425 lots, while the number of fed cattle marketed increased from 14.5 million to 26.6 million head. Only one to two percent of the feedlots in the 23 States have capacities of 1,000 head or more, yet these businesses marketed 68 percent of the total 1978 fed-beef production. As the feeding industry becomes more concentrated, the burden of price risk associated with 1,000 cattle on feed, whereas the price risk associated with 2,000 cattle on feed might be too great.

Farmer feedlots in the Midwest have higher production costs than the commercial feedlots in the West (Gee 1979). Production costs per 100 pounds marketed by farmer feedlots were $47.99 in 1976 and $48.77 in 1977. Commercial feedlots costs were $43.50 and $40.76 for 1976 and 1977 respectively.[2] Cash costs for both regions are similar; however, noncash costs were considerably higher for farmer feeders. Total direct costs in 1977 for such items as replacement feeder cattle, feed, veterinary services, marketing and labor were similar for both farmer and commercial fed-beef producers. Major differences occur in depreciation, interest, taxes, insurance and management changes. These costs were $5.81 per 100 pounds marketed for farmer feedlots and $.77 per

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[2] Commercial feedlots are lots with 1,000-head or more one-time capacity. Farmer feedlots are lots with less than 1,000-head, one-time capacity.

TABLE I

NATIONAL FEEDLOT STRUCTURE, SELECTED YEARS

Lot Capacity in Head	Number of Lots				Cattle Marketed (000 head)			
	1962	1968	1973	1978	1962	1968	1973	1978
Under 1,000	234,646	197,247	141,587	125,523	9,045	11,775	8,968	8,542
1,000-1,599	1,512*	1,876	1,834	1,704	5,142*	6,803	7,406	7,868
16,000-31,999	1,512*	77	137	133	5,142*	2,443	4,124	5,081
32,000 and over	5	19	69	65	314	1,215	4,833	5,154

Note: Calculated from statistics in Cattle on Feed, USDA-SRS.

*Reported as one category, 1,000-31,999.

100 pounds marketed for commercial feedlots. Economies of size that exist in the feeding industry are such that costs per 100 pounds marketed decrease for commercial feedlots compared to farmer feedlots. Given these figures, the movement from smaller lots (under 1,000 head) to the larger commercial lots is understandable.

With the prospect that price risk in the cattle feeding industry will continue and in all probability increase, the operator may decide that decreasing the size of operation is the logical way to combat the effects of risk. However, this is contrary to the economic fact that economies of size exist in the feeding industry. Therefore, the decision maker who has profit maximization high among his goals realizes that he must reduce risk by some other alternative such as hedging. By taking opposite but equal position in the cash and futures market he is able to transfer price risk. To maximize profit, however, the decision maker must have a hedging program that achieves optimal timing of the placement and lifting of the hedges.

Objectives and Procedures

The broad objective of this thesis is to contribute to the knowledge and development of marketing strategies within the framework of profit maximization and risk management for a continuous feedlot operation. The specific goals of this research project are to increase profits and reduce price variability (price risk) of a continuous feedlot operation. This will be accomplished by employing a marketing strategy known as multiple hedging[3] with the utilization of a technical tool called

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[3]Multiple hedging, as the name implies, means to hedge the same commodity more than once.

moving averages to obtain optimal timing in the placement and lifting of the hedges. Optimal moving average combinations will be derived for the feeder cattle, corn, and live cattle futures markets prices by employing a computer program known as the Box Complex Procedures. Finally a simulation of a continuous feedlot operation in Northwest Oklahoma will be used to test the alternative marketing strategies. To accomplish these objectives the following specific procedures were used:

1. Solve for optimal moving averages for the live cattle futures contracts.

2. Solve for optimal moving averages for the feeder cattle futures contracts.

3. Solve for optimal moving averages for the feedgrain (corn) futures contracts.

4. Compare the profitability and reduction in price risk of a fully integrated multiple hedging program for a cattle feeder with traditional marketing strategies.

Literature Review

The background literature relevant to this study falls into two major categories: (1) multiple hedging alternatives for agricultural products with effective techniques for the timing of futures market exist and entry; and (2) the role of the futures market and risk management in today's farm marketing decisions.

Hedging Alternatives with Emphasis on Effective Techniques for the Timing of Futures Market Exit and Entry

Holland, Purcell, and Hague (1972) found that marketing decisions involving hedging can be used successfully by the manager of cattle feeding operations. Short hedging can be an efficient management tool even during periods of upward trending prices. Results show that hedging strategies are available which may not only decrease the variability of net returns, but also increase the mean net returns, something that is not usually expected. The hedging strategies 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.

Purcell (1977) discussed different hedging alternatives other than the simple "hedge everything" strategy. One alternative is to place a hedge on when a predetermined lock-in margin can be hedged. However, Purcell found that through the period 1972 to February 1976, there were not very many opportunities to place hedges at profitable levels. For the year-round feeder this approach will simply not work. Purcell suggested learning to read charts and looking at such things as trend lines and daily trading volume. Realizing this approach is subjective, he also suggested using a more objective form of technical analysis called moving averages.

McCoy and Price (1975) analyzed seven selling alternatives over a period of 1965 to 1974. They were: (1) unhedged; (2) routine hedge; (3) hedge when hedge price is greater than or equal to break even price; (4) hedge when hedge price is greater than or equal to cash price; (5) hedge when hedge price is greater than or equal to break even and greater than or equal to cash price; (6) hedge only lots that would be sold during September, October, November, or December; and (7) cash contract cattle at a price equal to current cash price. Alternative 5 yields the greatest average profit but only 29 percent of the lots are hedged. Had cattle not been placed on feed when those criteria were not met, average profits would have dropped. Routine hedging reduced instability but reduced average profits to 18 cents per head.

Brown (1977), utilizing moving averages and cash price forecasts from a monthly forecasting model, tested alternative hedging strategies for feeder steers. Hedging reduced the risk of the cash operation in all cases while the "hedge everything" strategy was the only hedging strategy with a lower mean return than the unhedged cash operation. The author suggests that different managers, depending upon their degree of financial independence, might choose different degrees of risk associated with differing rates of return.

Lehenbauer (1978) suggested that the volatile feeder cattle prices during the 1970's will continue. Therefore, marketing decisions involving the selling and buying of feeder cattle will continue to be a very important factor affecting the financial condition of the feeder cattle producer and cattle feeder. His study assumed a primary goal of profit maximization with reduction of risk as a secondary goal. Lehenbauer optimized point-and-figure parameters along with moving averages to obtain maximum net profits from the futures market. Selective hedging strategies effectively increased returns and these larger returns were accompanied by lower variability, i.e., less risk, when compared with the "no hedge" alternative. Lehenbauer suggested further research into the usefulness of other technical price analysis tools and expansion to other agricultural commodities.

Riffe (1978) presented selective hedging as a logical management procedure for altering the level of price risk exposure in an effort to deal with the problem of extensive cash flow deficits. A computerized procedure was developed to simulate the 30-day net cash balances of a cattle feeding enterprise from 1965 to 1977. Actual daily futures data was used in algorithms designed to simulate futures transactions, costs, and returns under each of the methods of analysis. Riffe concluded that the tested selective hedging strategies do not significantly reduce the number of deficit cash flow periods over time, but improve the financial position by reducing the severity of the deficits and by redistributing them so that fewer deficit periods are observed consecutively. Further research was recommended in the area of portfolio analysis to determine an optimal mix of strategies for feeders with more than one contract of cattle and the effects of a fully integrated program of selectively hedging feeder cattle, feed grain and fat cattle.

Russell (1978) working with a technical tool known as oscillators, derived a combination of two crossing oscillators to generate buy and sell signals. The selective hedging of feeder cattle based on this oscillator technique increased the average returns and reduced the variance of returns for the feeder producer when compared to the no hedge marketing strategy. Russell also tested this hedging technique for long hedging of feeder cattle to reduce the cost of feeder cattle and the variance of this cost as faced by cattle producers. Russell concluded that selective hedging based on oscillators, which have been optimized, can increase the average returns and reduce the price risk for both the feeder cattle producer and cattle feeder.

Role of the Futures Market and Risk Management in Today's Farm Marketing Decisions

Ward and Fletcher (1971) devised a theoretical model of optimal firm decisions in cash and futures markets that includes both primary product producers and marketing firms. The generalized model of production and marketing decisions under risk is applied to both short and long hedging and speculation. Speculation according to the authors, exists when a firm's futures position exceeds the 100 percent hedging level or when it does not provide hedging possibilities in conjunction with the cash market position. Using live beef futures, comparison between hedging on futures markets and forward contracting are made. The futures model developed in this article uses a set of price expectations, a probability distribution for this set, and a preference function for risk aversion as the essential elements. Within this framework optimal futures and cash market positions were established for producers. The authors suggested that a beef feeder who completely hedges both his inputs and outputs and has expectations of zero gain or loss in the futures markets could be compared to a feedlot operator feeding cattle on contract. Both sell a service at a fixed price and give up the possibility of higher income (or loss) to avoid risk.

Peck (1975) used a portfolio-type analysis to formalize the problem of variability in egg prices in describing the role of futures markets in facilitating the management of risk. She said that futures markets can be a useful tool for the producer attempting to control income variability. Optimal hedging strategies derived from a portfolio approach, reduced markedly the producer's exposure to unpredictable price variation. Hedging all output over the production period appeared to be a reasonable method of stabilizing revenues. Peck suggested more work should be done on extending the model to include possible uncertainty about actual production and allowing the producer to revise his hedging position as successive forecasts become available.

Gray (1976) discussed the role of commodity futures markets in a risk management framework. He emphasized that firms relying upon futures hedging are not so much risk averters as they are risk selectors. Gray pointed out the need for education and the need for firms to develop internal competence or to contract with a firm that provides competence in operating a hedge program.

Oster (1979) stressed that one of the tough decisions on today's farms is determining when and how much to hedge. Oster explained that there are three new reasons why farmers need to look for ways to pass risk on to speculators--the people who specialize in taking risk: (1) capital managers are more vulnerable than labor managers; (2) there are more dollars at stake; and (3) markets are more violent today. He then set up several guidelines on what to look at in deciding how much risk can be handled by the manager: (1) get a good handle on your personal risk philosophy; (2) look at your balance sheet, then decide how much risk you can afford; (3) look at your management ability and track record over the past five years; and (4) the liquidity of the business. Oster concluded that producers who carry too much risk not only flirt with financial disaster but usually set off a chain of internal discomforts that can result in worry, fear and sleepless nights.

Ikerd (1978) believes that livestock producers are risk takers because they, like other businessmen, take risks because they know that there is no other legal way to make a profit. Without risk there is no possibility of a profit, for profit is a reward for taking risk. However, risk implies the possibility of losses. Therefore, managing risk is the very essence of decision making and hedging in the commodity futures markets is a tool for managing risk. Ikerd emphasizes that the individual decision maker must decide if they are risk takers, risk averters or fall some point in between.

Ikerd (1980) suggested that there are two basic types of risk that must be managed, production risk and market risk. The total risk exposure of a given cattle feeding operation depends on three basic factors. Accordingly to Ikerd they are: (1) the potential variability of production costs and marketing prices facing the feeder at a given point in time; (2) the number of cattle on feed or level of production; and (3) the "expected" level of profits. Ikerd then examined four basic risk management strategies. In the first strategy he varied the number of cattle on feed to maintain an acceptable level of total risk exposure. This program allows more cattle to be fed at lower levels of risk and lesser amounts at higher levels. The second strategy is forward pricing. By forward pricing market risk exposure for a given number of cattle becomes much less. Combining forward pricing with a flexible level of production is the third alternative. Once cattle are forward priced, total risk exposure is less, therefore, the opportunity exists to put more cattle on feed without increasing total marketing risk. The final strategy is called multiple hedging. This requires the cattle feeder to lift hedges when prices are increasing and placing hedges when prices are decreasing in order to obtain a higher price.

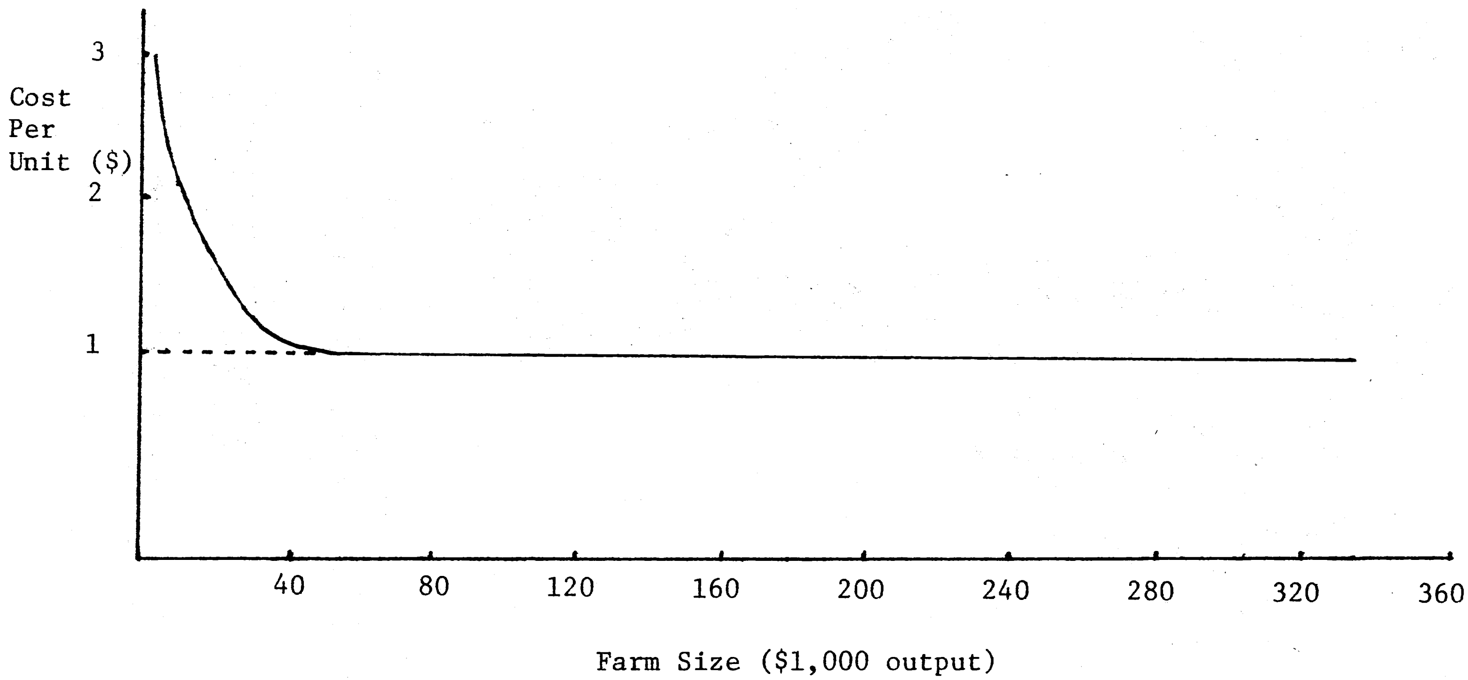
No empirical work was found displaying the effects of a fully integrated program of multiple hedging feed grains, feeder cattle, and slaughter cattle or using optimal control theory techniques to optimize moving averages. Therefore, a need exists to fill this void. The objectives and procedures stated in this chapter are designed to accomplish this need.

CHAPTER II

RISK MANAGEMENT

The livestock sector, and farming in general, have undergone immense changes in the last decade. The preponderant changes of the 1970's--devaluation of the dollar, the Russian grain purchase, consumer boycotts, OPEC, and inflation--have affected and will continue to affect the food producing sector in the 1980's. As world population continues to increase, the importance of food production will be second to none. The era of the early 70's with large price depressing grain stocks and cheap animal feed are unlikely to reoccur. Whereas in 1970 it was virtually impossible to make a costly marketing mistake, the 1980's will be a decade of marketing and risk management decisions. The successful food producers in the 1980's will be the decision makers that are best able to handle and control the marketing and price risk decisions that they will have to face.

As previously mentioned, economies of size exist in the cattle feeding industry. Tweeten (1979) illustrates the existence of decreasing average costs and increasing returns to size of whole farm firms (Figure 3). This expansion in the farm firm is generally characterized by increasing the proportion of capital to labor, and of variable capital to fixed capital. These changes result in a sizeable reduction in cost per unit of production. This substitution of capital for labor and variable capital for fixed capital results in farm managers becoming



Source: Tweeten (1979).

Figure 3. Long-Run Marginal Cost of Farm Production, by Economic Class of Farms in 1970

capital managers which inherently involves more vulnerability. Today's farmers have learned how to leverage an hour of labor through machines and chemicals. Thus, when a severe price drop hits today, it means a loss of repayment ability or a loss of the capital borrowed to make the hour of labor go further.

In the "old days" farmers survived price drops and production failures by belt tightening. They would simply earn less return on their management and labor, but still survive. However, with the substitution of capital for labor there is a smaller proportional amount of labor to tighten upon and it is hard to convince the firm's financier to tighten his belt for the firm. Then, how can a farm firm, faced with more violent markets, and financially leveraged to achieve economies of size in order to compete with "the Jones'", avoid financial disaster in the 1980's? It becomes imperative that farmers learn how to pass some of the risk along to the market place; to someone or something willing to take that risk. Producers will never be able to take all the risk out of the production and marketing of food, yet few producers will be able to survive and reap financial returns generated by their operations during the 1980's unless they are able to take some of the risk out of the operation by sound, intelligent decisions.

Theoretical Model of Optimal Positions in the Cash and Futures Market

A theoretical model dealing with the questions of how much price risk a decision maker is able to afford or personally handle is examined in this section of the study. A theoretical model of optimal futures and cash market positions developed by Ward and Fletcher (1971) is incorporated with realistic questions that a manager must answer in order to successfully solve this problem.

The derivations of optimal hedged positions follow from the assumption that producers wish to minimize risk, where risk is defined as the variance of net income. Ward and Fletcher's model shows: (1) the alternative futures and cash market positions; (2) the role of income, risk, cost, and expectations in the decision process; and (3) optimal positions in the futures and cash markets.

The example for this set of theoretical questions will be one of a livestock feeder. The feedlot operator must decide in period t the optimal number of feeder cattle to purchase and the optimal futures position. The feeding period is length k, at which time the futures positions are off-set and the fat cattle are sold for slaughter. The expected net income equation is defined as:

$$E\pi = EX_c[P_{t+k} - P_t] - EX_f[F_{t+k} - F_t] - |X_c|C_c - |X_f|C_f$$

where EX_c and EX_f are the two choice variables representing quantities in the cash and futures markets respectively and where:

X_c = quantities in cash position;

X_f = quantities in futures position;

P_t = price of feeder cattle;

P_{t+k} = expected price of slaughter cattle at the end of the feeding period;[1]

F_t = futures price per unit of X_f in period t for contract maturing nearest, but not before, period t+k.

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[1]This price can be derived by using probabilities of expected cattle prices in t+k period and then choosing the most probable price for that period.

F_{t+k}[2] = futures price per unit of X_f in period t+k for contract maturing nearest, but not before, t+k period;

C_c = average cost of transforming feeder cattle to slaughter weight; and

C_f = average cost of futures position in X_f.

As stated, risk is measured by variations in net income. Each operator is assumed to be a risk averter in the sense that he will choose those market positions that minimize his risk for a given expected net income. Then, given the combinations of expected net income and risk, and shape of the manager's preference function relating risk to expected net income, the determination of optimal market positions can be made.

Each and every decision maker will have a different preference function relating risk to expected net income. Many factors influence the individuals preference function concerning risk and expected net income. The balance sheet of the firm may show that a large price drop would create a financial disaster. If so, then a larger proportional amount should be hedged compared to a firm that has cash reserves to weather a short-term set back. The personal psychological make-up of the manager will affect the preference function. Some decision makers thrive on risk while others spend sleepless nights as prices rise and fall. Managers who have a proven history of profits are generally considered to be better able to bear risks than an inexperienced manager. Long term goals such as growth influence the preference function relating risk to expected net income. A highly capital leveraged firm striving to achieve growth inherits an increasing amount of production risk, thus finding a need to lower total risk by decreasing price risk. All of

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[2]This value will be P_{t+k} plus the average basis for period t+k.

these factors influence the individual's preference function relating risk to expected income.

Taking the variance of net income as a measure of risk, a theoretical risk function is written as follows:

$$\mathrm{Var}(\pi) = X_c^2\ \sigma p^2 + X_f^2\ \sigma f^2 - 2X_c X_f\ q\sigma_p\sigma_f$$

where:

$\sigma_p^2 = \mathrm{Var}(P_{t+k} - P_t) = \mathrm{Var}(P_{t+k}|P_t)$

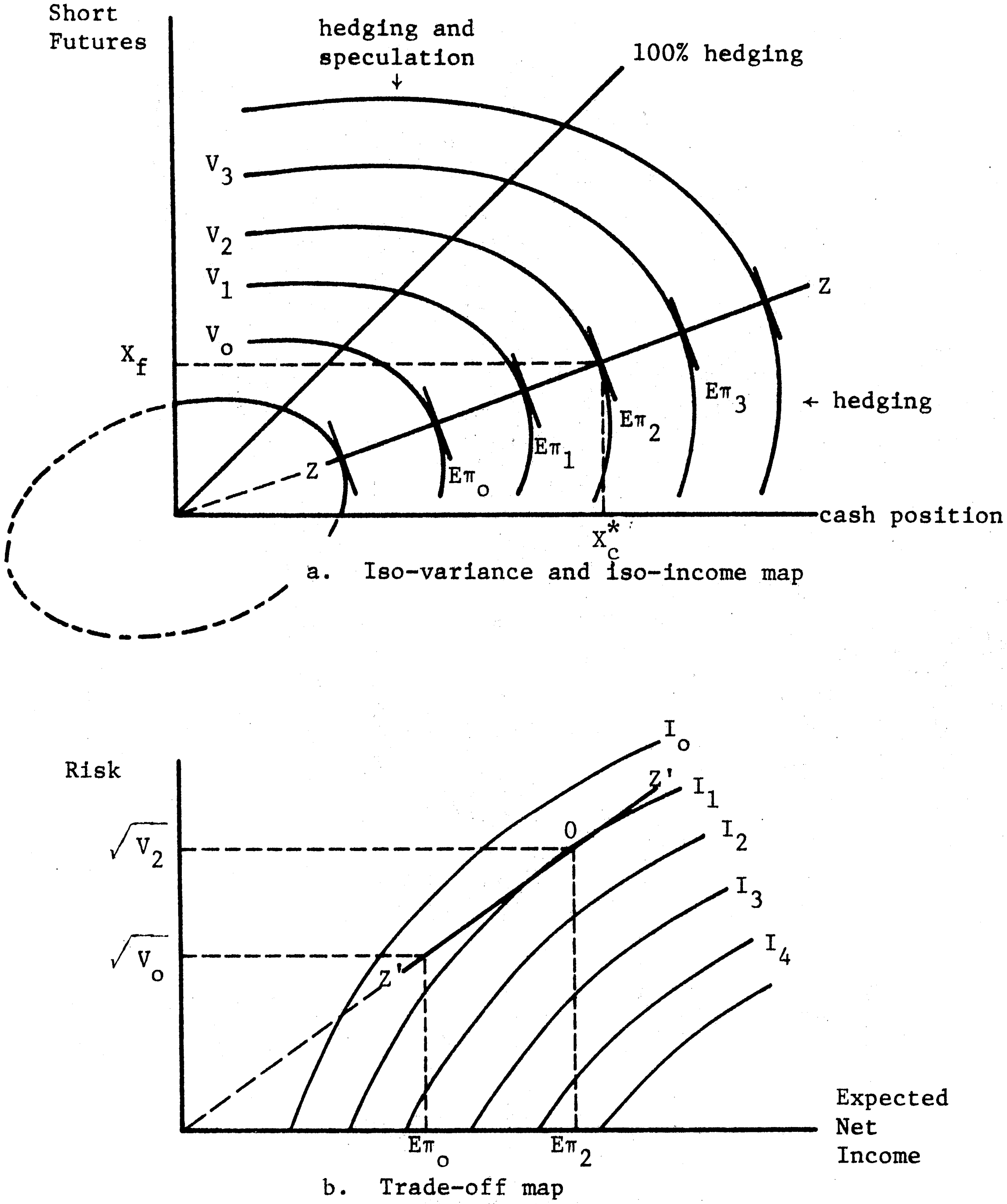
$\sigma_f^2 = \mathrm{Var}(F_{t+k}) = \mathrm{Var}(F_{t+k}|F_t)$

$q = \sigma_{pf}|\sigma_p\sigma_f$; correlation between $(P_{t+k} - P_t)$ and $(F_{t+k} - F_t)$.

This function assumes that σ_p^2, σ_f^2, and q are known and constant for the given decision maker. The greater the positive correlation between cash and futures prices the smaller risk will be. Risk also decreases as the variance of cash and futures prices decrease.

In Figure 4a, the horizontal axis shows the cash position (X_c), and the vertical axis indicates the futures position (X_f). Positions on the vertical axis are purely short speculative positions; those on the horizontal axis involve no futures positions. The 100 percent hedging line (the 45° line) represents a cash position with an equivalent short hedge.

Each iso-variance curve (V) includes all combinations of cash and futures positions yielding a constant risk value. Each iso-net income equations ($E\pi$) defines the combinations of X_c and X_f that sum to $E\pi$. The expected net income equations ($E\pi$) are drawn over the iso-variance map as shown in Figure 4a.



Source: Ward and Fletcher (1971).

Figure 4. Risk, Income, and Trade-off Maps When Hedging is Potentially Profitable

The decision maker's iso-variance map is assumed constant, but his iso-net income map will vary according to his price expectations. Thus, if the manager's expectations are such that $E[F_t - F_{t+k}] - C_v > 0$ (Figure 4a), hedging is not only used for its risk-shifting capacity, but also for its profit potential.

The combination of all possible tangency points gives the line ZZ of Figure 4a. Then plotting all the coordinates of ZZ on a tradeoff map between expected net income and risk, the line Z'Z' is derived (Figure 4b). Any combination along Z'Z' is a possible choice, but the manager maximizing his utility will select the point that places him on his highest indifference curve (0). In this example X_c^* and X_f^* indicates the optimal cash and short hedge position. Optimization has resulted in a futures position less than the cash position (not fully hedged). A fully hedged position in this example, would result in less expected net income at the same level of risk.

Referring to Figure 4a, the concept of multiple hedging would theoretically lie in the area between the 100 percent hedging line and the horizontal cash position. Multiple hedging potentially involves periods of 100 percent hedged positions and other periods of completely unhedged cash positions. Therefore, a completed marketing period involving a multiple hedge strategy would possibly resemble line ZZ. However, it is the objective of this thesis to shift the expected net income equations ($E\pi$) and the iso-variance curves (V) by the use of multiple hedging such that profits will be increased for a given level of risk or risk will be decreased for a given level of profit.

In summary, this theoretical model developed by Ward and Fletcher is designed to illustrate the process by which managers could hypothetically derive what they believe is the best combination of cash and futures positions for their operation. This is accomplished by analyzing the manager's set of price expectations, a probability distribution for this set, and a preference function for risk adversion. Factors influencing the trade-off between expected net income and risk are discussed; indicating how each and every firm and its respective manager might possibly derive differing utility functions. Within this framework the optimal cash and futures market positions are derived.

Concepts and Strategies of Risk Management for Cattle Feeders

There are two basic types of risk associated with cattle feeding, production risk and marketing risk (price risk). Production risks are linked with the possibility that production efficiency will be less than expected, resulting in unexpected losses. Market risks are associated with the possibility that market prices in the future might be less favorable than expected during the initial stage of production, resulting in unexpected high death loss. All of these factors are able to increase the cost of gain of the cattle on feed, therefore increasing total costs. Price risks in cattle feeding originates from fluctuating input prices as well as an unexpected decline in the fat cattle market price.

Since neither production efficiency nor market prices can be perfectly anticipated the risk of loss will always be present. However, were it not for this risk there would never be "pure" profit in the highly competitive cattle feeding industry. If all prices are known and the efficiency of production is constant, then input prices would be bid up until the final market value of the cattle would just cover the costs involved in transforming feeders to slaughter weight cattle. Therefore, it can be deduced that profit is the return for bearing risk.

Today's cattle feeding industry, as illustrated earlier, does not need to concern itself with the lack of risk, be it either production or marketing. Rather, it is the goal here to derive and test risk reducing alternatives for managers involved in the cattle feeding industry. Because of this lack of certainty at any given point in time, inputs may be relatively high or low as measured by the end product. Pure profits in cattle feeding come from purchasing inputs that are undervalued relative to the end product, slaughter cattle. However, on the other hand there is the risk of losses from buying inputs that are overvalued due to the uncertainty of future costs and prices. The existence of a possible profit is accompanied by the risk of loss. The successful cattle feeder, over time, is one who has learned to manage risk.

Risk Management Strategies

A sufficient argument has been presented to justify research into the area of risk management. This last section of this chapter will briefly discuss three viable and realistic strategies that are open to the cattle feeder to effectively reduce risk. The three general risk management alternatives for cattle feeders presented here are: (1) production flexibility; (2) forward pricing; and (3) multiple hedging.

The most common risk management strategy is most likely one of production flexibility. Decision makers increase production levels when they are optimistic regarding future profits and reduce production when they are pessimistic towards forthcoming profits. A cattle feeder, as his financial position improves, may increase production due to his improved risk bearing capacity. Conversely, a weakened financial position may require a reduction in production.

Exposure to risk is directly proportional to the level of production (excluding economies of size). As production is cut 10 percent, total risk is reduced by 10 percent. The probabilities of losing a smaller or larger amount of profit is equal to the amounts in relationship to smaller or larger numbers of cattle on feed, i.e., the odds of losing $1,000 on 100 head of cattle is equivalent to losing only $900 on 90 head of cattle.

The advantage of production flexibility as a risk management device is that there is a one to one correlation between the amount of reduced production and the resulting decrease in total risk. However, this may be true only to a certain degree. As previously mentioned, economies of size exist in the cattle feeding industry. It becomes infeasible for cattle feeders with large fixed costs to decrease production beyond some point because the increase in average fixed costs will off-set any beneficial gains due to reduced risk.

The second risk management tool discussed is called forward pricing (forward contracting). The objective of forward contracting is to reduce risk and uncertainty associated with price levels in the future. Forward pricing involves the establishment of a price for a product before it is physically ready for delivery. Forward contracting is generally accomplished by private contract between individual buyers and sellers. It is also possible to forward contract through the use of some sort of public market system such as the live cattle futures market.

The advantages of forward contracting to reduce risk is that production levels need not be lowered and the producer is assured of a price. The disadvantages are that a producer must search out a willing buyer to enter a contract unless a public market is used. Prices negotiated in private are not generally public knowledge, thus a "fair market price" may be difficult to derive. Finally, a catastrophe might occur, such as a production failure, making it hard for the producer to fulfill his contract and the mechanism for settling disputes with this type of contract is through the court system which is expensive and time consuming.

Forward pricing does nothing to alleviate production risk and in most cases, does not completely eliminate price risk. Most often provisions for discounts or premiums are contained in the contract. Forward pricing using the futures market introduces the concept of basis. Basis is the difference between a local cash price and the futures price at the time of delivery of the finished product. However, the basis is typically much more reliable, thus predictable, than the absolute level of cash prices in the future. The cattle feeder is effectively trading price risk for a much smaller basis risk.

A simple example of a cattle feeder forward pricing his production, using the futures market, would be to short hedge live cattle futures to off-set his long position in the cash market. Assuming a fixed basis, as futures prices rise and fall so does the cash price; the future position would be bought back and the finished product is sold in the cash market. If the closing price is above the "hedged price" the loss in the futures position will be off-set by the additional value of the cash position. If the closing price is below the "hedged price" then the loss in the cash position is equalized by the gain in the futures position. As this example illustrates, the difference between the realized hedged price and the expected hedge price is the marketing risk associated with forward contracting. Thus price risk in forward pricing is reduced, in essence, to basis risk.

The final risk management strategy discussed is known as multiple hedging. Multiple hedging, as the name implies, means to hedge the same commodity being produced many times. This risk management device takes advantage of the futures markets, due to the ease of access and high degree of liquidity. In contrast with forward pricing, the multiple hedge, using some sort of decision criteria (price expectations), places and lifts hedges any number of times as dictated by the decision criteria with the hope of obtaining a more favorable price. Even though, initially, multiple hedging may seem a bit like speculating it does fit the definition of hedging. The multiple hedger uses the futures market to alleviate risk, but never takes an initial position in the futures market that is not offsetting an already existing open risk position in the cash market. The maximum risk that a multiple hedger takes is when he is completely out of the futures market and is taking the ordinary cash market risk on his cattle.

Problems may arise with multiple hedging due to a lack of discipline on the part of the manager. The temptation to speculate may overcome the sense of control of the manager and he will ignore his carefully pre-planned set of decision criteria that dictate the placing and lifting of hedges. It is easy to see that the decision criteria concerning price expectations is very important. These decisions of when to place and lift hedges are the very essence of multiple hedging.

As important as they are, there are an unlimited number of combinations and sources of information that a cattle feeder may use. It is possible to base trading plans on systems ranging from highly sophisticated econometric models to a friend's "feel" for the market. Finding the right decision criteria can be a real problem. A final disadvantage is that an operator, when out of the futures market, is exposed to risk in the same manner as the ordinary cash market position.

The advantage of multiple hedging is that it provides the opportunity for larger profits. The cattle feeder is able to take advantage of windfall profits, yet flexible enough to hedge when prices are declining. Multiple hedging allows the practice of hedging or not hedging accordingly to price expectations, thus reducing marketing risk.

Summary

This chapter dealt with the theory, justification, and brief applications of risk management in today's cattle feeding industry. Important changes and developments that took place during the 1970's were noted, with their implications for the 1980's including the reasoning behind the need for greater understanding of risk management. A theoretical model, developed by Ward and Fletcher, was discussed illustrating the hypothetical process by which the best combination of cash and futures positions for a firm could be derived. A section dealing with the concepts and strategies of risk management for cattle feeders was presented. Risk was defined as either originating from production or marketing. The three risk management strategies discussed were: (1) production flexibility; (2) forward pricing; and (3) multiple hedging. Advantages and disadvantages were presented for each of the strategies.

The next chapter of this thesis deals with the development of a search technique to obtain optimized moving average parameters for a given set of price data. Then, using actual feeder cattle futures market prices, trading simulations using selected moving average combinations will be tested to achieve maximum profit.

CHAPTER III

OPTIMIZATION OF MOVING AVERAGE PARAMETERS FOR FEEDER CATTLE

Moving averages are a technical price analysis tool which can assist the feeder cattle hedger in deciding when to place and lift a hedge. Moving averages are an objective device free from the user's subjective judgments. Moving averages work on the assumption of Issac Newton's first law of motion, applied to price action: "A price trend once established is more likely to continue than to reverse." If this concept is accepted as true, then a successful trading or hedging strategy can be built on the principle of buying strength and selling weakness. All that remains is to optimize the parameters with which to carry it out.

Moving averages are a simple technical tool, easy to calculate, and do not require extensive data sets. Because of these reasons and the ones cited in the preceding paragraph moving averages should appeal to potential hedgers. However, the real test for any selective hedging technique relies upon its ability to aid the hedger in obtaining a more favorable price. This chapter, after a brief explanation of the moving average technique itself, will optimize the moving average parameters according to a procedure to be described later.

The Moving Average Technique

An average is defined as the quotient of any sum divided by the number of its terms. A moving average of prices is a progressive average in which the number of prices used, as indicated by the divisor, remains the same, but a new price is added to the end of the series each day as a price is simultaneously dropped from the beginning of the series. Linearly weighted moving averages consists of giving the oldest price in the series a weight of one, the second oldest a weight of two, and continuing until the most recent price has a weight equivalent to the number of price observations used in the average. The divisor for a linearly weighted moving average is the sum of the weights.[1]

Buy and sell signals are generated by the "crossing over" of one moving average with respect to another moving average. Then any day that the shorter length moving average crosses the longer length moving average from below a buy signal (or lifting of a sell hedge) is generated. Conversely, when the shorter average penetrates the longer average from above a sell signal (or placement of a short hedge) is generated (Figure 5).

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[1]Illustration of the calculation of a 4-day linearly weighted moving average. Let n be the most recent closing price.

Day	Closing Price		Weight		Product
n	63.00	x	4	=	252.00
n-1	62.42	x	3	=	187.26
n-2	63.27	x	2	=	126.54
n-3	64.10	x	1	=	64.10
			10		629.90

The 4-day weighted average is 629.90 ÷ 10 = 62.99

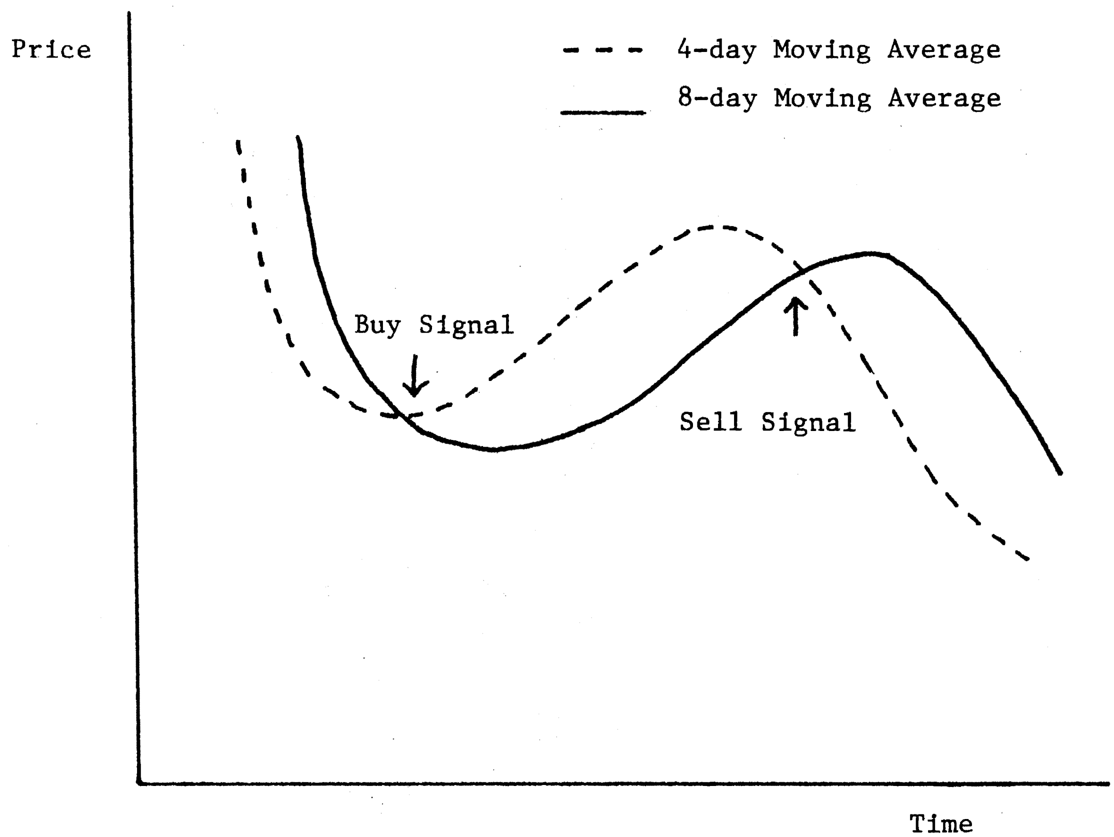


Figure 5. Crossing Action of Two Moving Averages

Three moving averages can also be used to generate buy and sell signals. The three moving averages consists of a short, medium, and long moving average. The shortest average confirms the signal, i.e., in order for the signal to be confirmed in the case of a long trade the shortest moving average must be above the medium length moving average and for a confirmation of a sell signal the shortest average must be below the medium length average. The medium length and longest moving averages generate buy and sell signals in the same manner as the two combination moving average example (Figure 6).

There are two basic variations in the arrangement of moving averages: (1) the length of time used in computing the moving average; and (2) the kind and amount of penetration required. The length of time used in computing the moving average involves an important trade-off. The shorter the length of time, the more sensitive the moving average will be to any change in trend. However, the more sensitive the moving average the greater the number of trades and the greater the possibility of whipsaw losses. A longer moving average will reduce the number of trades and the number of whipsaw losses, but will signal new trends much later-with the possibility of the trend closer to completion than initiation.

The penetration rule used with moving averages is an option used in an effort to reduce false signals. Technicians may demand more than just a simple "crossing over" of the moving averages. Before a trade is initiated a penetration of some fixed amount must take place before the technician will act. Again a trade-off exists, too small a penetration results in whipsaws and excess trades, too large a penetration has the effect of cutting down profit on successful signals.

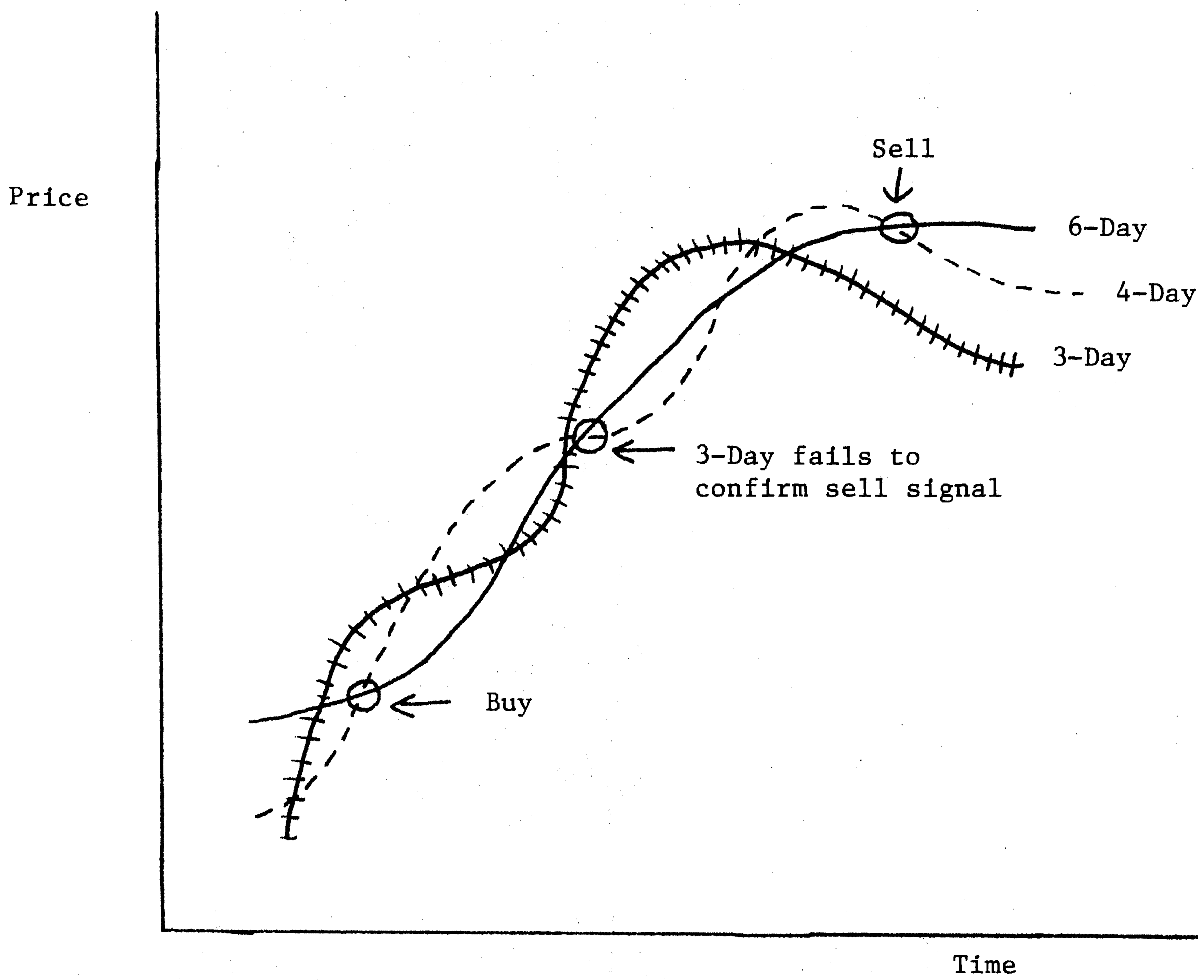


Figure 6. Illustration of Buy and Sell Signals Generated from Three Moving Averages

By changing the length of the moving averages and the minimum penetration requirement, an optimal moving average combination for the feeder cattle contracts will be developed. By determining the optimal moving average combination for the feeder cattle futures market a feeder cattle producer or cattle feeder will be better able to place and lift hedges.

Procedure

In determining the optimal moving average parameter combinations, actual futures market price series were used. The feeder cattle futures market began in 1972. The first several years of this market were typified by relatively low volume and little price volatility, thus price risk was minimal. However, since 1975 price volatility (price risk) has increased so the optimization process will cover the period 1975 through 1979. Due to the high cost of the optimization process four contract months (March, May, August, and October) per year were used. This should not effectively change the optimal solution set of parameters.

The moving average simulator, used as a sub-routine in the optimization program in this study, was developed by Meg Kletke, Department of Agricultural Economics, Oklahoma State University. This program is designed to test moving average combinations on actual futures market prices stored on a magnetic computer tape. This simulator is capable of using either a two or three combination moving average, a minimum penetration requirement, and a stop value above or below the entry price. With the correct notation the simulator is also able to compute linearly weighted moving average combinations.

Using a moving average combination inputted into the program it computes the daily moving average from the given price data. Then as buy and sell signals are generated it takes the appropriate positions by buying and selling one contract at the closing price for that particular day.

In order to simulate the real world as closely as possible, certain trading rules are incorporated into the moving average trading program. They are:

1. No trades are executed on days when the high and low are equal. This is based on the assumption that no trading occurred for this day.

2. No trades are executed on days when the closing price is up or down the daily limit.

3. Due to the threat of delivery, no new buy signals were honored after the first of the delivery month.

4. A charge of $50 per trade is assessed for commission cost.

Detailed output from the trading activity generated by a given moving average combination is given by this program. The date, followed by the opening, high, low, and closing prices are all given on the day a trade is executed. The transaction (buy or sell), the transaction price, and the profit for that trade are also given. The number of trades and the running totals of both long and short trades are monitored. Next a summary of total net profits generated over one contract is given. Finally a yearly and ending summary printout gives a detailed breakdown of total profits for long and short trades, the number of trades executed, and the percentage of profitable trades. This simulator can test any set of moving averages and minimum penetration requirement specified, but it can not select the best set.

Selection of Optimal Moving Average Lengths

The process used to find the best moving average set is called optimal control theory. Optimal control theory is a mathematical technique for analyzing systems under different sets of controls (Richardson, Ray, and Trapp 1979). Optimal control theory is a technique to determine the optimal values for control variables in a system. It was originally developed for application only to continuous time systems described with differential equations, however, most models used in Agricultural Economics do not fall into this category, but rather are discrete time models.

To facilitate the problem of finding a moving average combination that maximizes the objective function (profit) a direct-search technique known as the Box Complex Procedure is employed. The Complex Procedure, developed by Box, is capable of solving for the optimal set of controls in a multi-variable model (Box, 1965). The Box Complex Procedure is a hill climbing procedure that utilizes a systematic method of searching the surface of the performance measure for its global maximum. The control mechanism selects values for the control variables and determines their impact on the system's output variables and evaluates the performance measure based on the values of the relevant output variables. This process is repeated until a change in the control variables results in a maximization of the value of the objective function.

In this problem the objective function is total profit generated on futures contracts traded as a result of sell and buy signals from a moving average combination. The goal of Box's Complex Procedure is to maximize this objective function. The control variables are the moving average lengths and minimum penetration requirement that comprise a moving average combination. Upper and lower boundary constraints are put on the control variables combined with commands that require a chronological order of moving average lengths, i.e., short, medium, and long moving averages must be generated and identified in a proper sequence. This is to eliminate combinations of moving averages that would be illogical, i.e., a 9-4-3 day combination or a 4-4-4 combination. Using past personal experience and looking at past empirical work with moving averages as a technical trading tool, the following boundaries were used as constraints on the parameters: (1) the shortest moving average can range in length from one to eight days; (2) the second moving average must be longer than the first with an upper limit of 18 days; and (3) the longest moving average must be longer than the other two moving averages with a maximum of 24 days in length. In all cases the option exists that the moving average can be either conventional or a linearly weighted moving average. The minimum penetration requirement has a range of zero to 50 cents.

To the best of the author's knowledge this is the first attempt to use a direct-search technique to optimize moving average parameters. The Box Complex Procedure was designed to operate with continuous control parameter functions, whereas the moving average parameters are integers, i.e., a 3.659 day moving average is impossible because the price data is given as daily closing prices. Alterations of the Box Complex Procedure had to be made to allow it to work with integers only. Several alternatives were tried, but the alternative selected was simply to truncate all real parameters derived by the Box Complex Procedure to integer parameters. However, it appears that, after working with the Box Complex Procedure and analyzing the results, this method is useful, less time consuming and a superior search method for optimal parameters than a manual "trial and error" approach.

Analysis of Results

Several computer runs were made with the Box Complex Procedure to find the optimal combination of moving average parameters that derive maximum total profit generated by the buying and selling of one feeder cattle futures contract during the period 1975 through 1979 of the March, May, August, and October contracts. The direct-search technique produced significant results. Theoretically the surface of the profit function would be a smooth hill shaped surface with one or maybe a few similar moving averages that generate the largest total profit. Given a smooth sloping surface to a global maximum, the Box Complex Procedure would be able to locate the optimal parameters for the most profitable combination of moving averages. However, after several runs of the Box Complex Procedure using the feeder cattle futures price data, it became apparent that the profit function surface is not a smooth surface with a single global maximum. The direct-search method found several moving averages that differed in composition yet derived approximately the same amount of profit. A list of some of the most profitable moving average combinations derived from the Box Complex Procedure for the feeder cattle futures price data over the period 1975 through 1979 is a given in Table II. The 3w-4w-14 day moving average combination with an 8 cent minimum penetration generated the most profit, $80,981 followed closely by the 3-4-6 day with a 3 cent minimum penetration. The least

TABLE II

NET PROFITS IN DOLLARS FROM THE BEST TEN MOVING AVERAGES SELECTED BY THE BOX COMPLEX PROCEDURE USING FEEDER CATTLE FUTURES MARKET PRICES, 1975-1979

Lengths of Moving Averages[a]	Minimum Penetration Required[b]	Total Net Profit	Total Number of Trades	Average Profit per Trade
3w-4w-14	.08	80,981	173	468
3-4-6	.03	78,885	405	195
2w-3-14	.05	78,324	219	358
3-4w-9	.00	77,613	343	226
3w-4w-14	.05	77.514	220	352
4w-5w-16	.00	74,504	168	443
2w-3-14	.00	73,792	286	250
3w-4w-13	.08	73,521	192	383
2w-3-12	.10	72,732	223	326
3-4-8w	.01	72,404	360	201

[a]Length is in days. w denotes a linearly weighted moving average.

[b]Minimum penetration required is in $/cwt.

profitable combination shown in Table II generated $72,404 or 10.6 percent less than the 3w-4w-14 day combination with an 8 cent minimum penetration.

Looking at the column of moving average combinations from Table II, interesting results can be noted. Of the ten moving average combintaions, six of them have a three and four (conventional or linearly weighted) day moving average composition for the shortest and medium length average. All but one contain a three or three day linearly weighted moving average as one of the components. Eight moving average combinations contain a four or four day linearly weighted average as one of the components. These results indicate that some form of the three and four day combination seem to be in the locality of the optimal, with the longest moving average varying over a wide range.

This information indicates that the profit function surface is not a well rounded hill with a global maximum. Rather, it seems to be a surface with many roughly contoured shaped mounds varying in size. The Box Complex, given an initial point to start from, randomly picks four other points. The search procedure would start from these points, then proceeding through its search process an optimal solution would be located. The search process would locate a maximum, but it is difficult, if not impossible, to say whether it is a local or global maximum. The reasoning behind this logic is that several runs resulted in a particular "optimal" moving average combination generating a total profit figure in the mid $60,000 range. Table II reveals that total profits in this range are not a global maximum at all, but rather only a local maximum.

Two separate runs provided the most profitable sets of results during this study. One run derived the 3-4-6 day combination with a

3 cent penetration, while the 3w-4w-14 day moving average combination with a 5 cent penetration was derived in another separate run. Other results were disappointing as most of the moving average combinations listed in Table II were obtained from these two runs.

A systematic manual search procedure was employed to check the two most profitable moving average combinations that were derived by the Box Complex Procedure (3-4-6 day with a 3 cent penetration and 3w-4w-14 day with an 8 cent minimum penetration). Any changes in the parameters by either weighting the average, deleting the linearly weighted portion, or increasing or decreasing a paraemter by one day in length reduced total profits. However, changes in the minimum penetration requirement resulted in increased total profits for both of the moving average combinations (Table III). The 3-4-6 day with a 7 cent minimum penetration requirement increased total profits by $2,195 to $81,080, while the 3w-4w-14 day combination with a 6 cent penetration increased total profits by $4,065 to $85,046. The reason the Box Complex Procedure did not pick up the optimal minimum penetration requirement is that it would check on both sides of the parameters and if that did not generate greater profits it would search no further. Table III shows that this is what happened in this case. Therefore, a systematic check of a 20 cent range around the optimal parameter, as given by the Box Complex Procedure, was made to see if greater profits could be obtained.

While the purpose of a penetration rule is to increase total net profits by reducing the number of false signals, profits can also be increased by reducing the dollar loss of the unprofitable trades. An ordinary stop based on the entry price of a trade was tested in an attempt to keep losses small on losing trades. However, this type of

TABLE III

NET PROFITS IN DOLLARS FROM SELECTED MOVING AVERAGES USING FEEDER CATTLE FUTURES MARKET PRICES, 1975-1979

Length of Moving Average[a]	Minimum Penetration Required[b]	Total Net Profit
3-4-6	.02	77,892
3-4-6	.03	78,885
3-4-6	.04	72,150
3-4-6[c]	.07	81,080
3w-4w-14	.07	80,981
3w-4w-14	.08	80,981
3w-4w-14	.09	72,582
3w-4w-14[c]	.06	85,046

[a]Length is in days. w denotes a linearly weighted moving average.

[b]Minimum penetration required is in $/cwt.

[c]Most profitable minimum penetration for the appropriate combination of moving averages.

stop loss technique caused an increase in the total number of trades and increased the number of whipsaw losses, thus reducing total net profits.

Figure 2 in Chapter I shows that the feeder cattle futures market has been in a generally uptrending market since 1975. Therefore, profit from long trades is much greater than from short trades. It is very encouraging that the best combination of moving averages, as measured by total profits, not only generated the highest profit from long trades but also generated the largest amount of profit from short trades (Table IV).

The percent profitable trades that a moving average combination provides is also a very important factor. A trader or hedger could become very discouraged if the majority of trades lost money, even through over a period of time profits would be generated. Table III shows the percentage of profitable trades for long, short, and the total number of trades executed. The 3w-4w-14 day combination with a 6 cent minimum penetration has a 50.5 percent profitable trade average over the period 1975-1979. Compared to other empirical work done in this area, this is an excellent percentage of profitable trades for a moving average combination. As previously mentioned, the period under study is of generally increasing feeder cattle prices, therefore, the percentage of profitable short trades is not nearly as high as the percentage of profitable long trades. The 3-4-6 day combination with a 7 cent minimum penetration requirement has a 44 percent profitability of all trades. This percentage is comparable to previous empirical work done over long period of time.

Lehenbauer (1978) using a systematic manual search method found that the 4-8w moving average combination with a 5 cent minimum penetration

TABLE IV

NET PROFITS IN DOLLARS FROM SELECTED MOVING AVERAGES USING FEEDER CATTLE FUTURES MARKET PRICES, 1975-1979

Length of Moving Average[a]	Net Profit from Long Trades	Net Profit from Short Trades	Total Net Profits	Percent Profitable Long Trades	Percent Profitable Short Trades	Percent Profitable Trades	Total Number of Trades
3w-4w-14 (.06)	71,640	13,406	85,046	60.9	41.1	50.5	182
3-4-6 (.07)	67,726	13,355	81,080	49.7	38.5	44.0	307
3w-4w-14 (.08)	69,572	11,409	80,981	56.6	41.1	48.6	173
3-4-6 (.03)	67,144	11,742	78,885	48.2	39.4	43.7	405
4-8w (.05)	59,899	1,584	61,481	50.0	37.4	43.5	416

[a]Length is in days. w denotes a linearly weighted moving average. The number in parenthesis is the minimum penetration required.

generated the greatest amount of profit using feeder cattle futures price data during the period, 1972-1977. Table IV indicates that the 4-8w (.05) combination derived a total of $61,481 during the period of 1975-1979, much less than the most profitable combinations found in this study.

A check of how the 4-8w (.05), 3w-4w-14 (.06), and 3-4-6 (.07) moving average combinations compare for the entire life of the feeder cattle futures market is the final objective of this chapter. The March, May, August, and October contracts for the period of 1972-1979 are used (Table V). The 4-8w (.05) moving average combination generated more profit than the two moving average combinations derived in this study for the period 1972-1977. However, the 4-8w (.05) combination did not generate near the income that the other two moving average combinations did for the years 1978 and 1979. In fact the 4-8w (.05) did a very poor job of signaling correct buy and sell signals in 1979. The 3-4-6 (.07) moving average combination derived the most profit for the entire period as well as creating the most profit for both long and short trades. This combination also made a profit for each signal year within the period.

A more detailed analysis and comparison of the three moving average combinations is contained in Table VI. The 3w-4w-14 (.06) has the highest percent profitable trades overall (49.0 percent), but both the 3-4-6 (.07) and 3w-4w-14 (.06) combination have exactly the same percentage of profitable short trades (38.6 percent). The 3-4-6 (.07) combination executed 406 trades for an average of 12.7 trades per option or about once every calendar month.

TABLE V

YEARLY DISTRIBUTION OF PROFITS IN DOLLARS FROM SELECTED MOVING AVERAGES USING FEEDER CATTLE FUTURES MARKET PRICES, 1972-1979

Combination[a]		1972	1973	1974	1975	1976	1977	1978	1979	Total
4-8w	(.05)	5,956	22,082	18,101	8,421	14,987	11,028	21,936	5,110	107,621
3-4-6	(.07)	5,893	22,218	17,234	6,460	13,677	6,295	28,554	26,096	126,427
3w-4w-14	(.06)	5,128	22,024	8,607	11,988	12,683	-2,239	33,298	29,318	120,807

[a]Length is in days. w denotes a linearly weighted moving average. The number in parentheses is the minimum penetration required.

TABLE VI

SUMMARY ANALYSIS OF THE PROFITABILITY WITH NET PROFIT IN DOLLARS OF SELECTED MOVING AVERAGE COMBINATIONS USING FEEDER CATTLE FUTURES MARKET PRICES, 1972-1979

Combination[a]	Net Profit from Long Trades	Net Profit from Short Trades	Total Profit Per Trade	Percent Profitable Long Trades	Percent Profitable Short Trades	Percent Profitable Trades
4-8w (.05)	90,790	16,831	196	50.0	36.8	43.1
3-4-6 (.07)	98,841	27,586	311	51.5	38.6	44.8
3w-4w-14 (.06)	98,477	22,330	474	60.2	38.6	49.0

[a]Length is in days. w denotes a linearly weighted moving average. The number in parentheses is the minimum penetration required.

Summary

The use of the Box Complex Procedure to optimize moving average parameters for the feeder cattle futures market provided results that are satisfactory. The optimization process involved price data from 1975 to 1979. The two best moving average combinations, as derived in this study, are a 3-4-6 day combination with a 7 cent minimum penetration and a 3w-4w-14 day moving average combination with a 6 cent minimum penetration requirement. The 3w-4w-14 (.06) combination generated $85,046 for the period 1975-1979 trading one contract for the contract months of March, May, August, and October, while the 3-4-6 (.07) moving average combination generated $81,080. However, for the life of the feeder cattle futures market (since 1972) the 3-4-6 (.07) combination generated the greatest amount of total net profit. Both averages are superior to the 4-8w (.05) combination derived by Lehenbauer (1978).

Problems are discussed in this chapter with respect to the Box Complex Procedure and locating a "global" profit maximum. Potentially there are an infinite number and combinations of moving averages, therefore the possibility exists that some other combination, not found in this study, could generate more total profits. Yet the results from this optimization process definitely indicate that the Box Complex Procedure is a practical method of finding "good" sets of moving averages and that a significant potential exists for using moving averages in the development of a multiple hedging strategy for the cattle producer and feeder by determining the proper time to place and lift a hedge for a manager whose primary goal is to obtain a more favorable price.

CHAPTER IV

OPTIMIZATION OF MOVING AVERAGE PARAMETERS OF LIVE CATTLE AND CORN FUTURES MARKETS

This chapter is devoted to the procedures and results of optimizing the moving average parameters for the live cattle and the feedgrain (corn) futures markets. The results provide the ground work for a fully integrated program of multiple hedging feeder cattle, feedgrains, and slaughter cattle based upon their respective optimal moving average combinations. The same basic optimization procedure will be used in this chapter as was used in the previous chapter. The first section of this chapter will be devoted to the live cattle futures market with the second section devoted to the corn futures market.

Optimization of Live Cattle Moving Average Parameters

Procedure

The live cattle futures contract begin trading in November 1964. It was a revolutionary idea since before this time futures contracts existed for commodities that were seasonally produced and storable. This represented a new concept of futures contracts for a commodity produced year round with a limited storage life.

As previously mentioned, the live cattle futures market has been a successful venture. The contract size consists of 40,000 pounds of live steers, or approximately 40 head of slaughter weight animals. Actual live cattle futures price data is used in the optimization process. The time period over which the optimization procedure was conducted is equal to that period used in the feeder cattle procedure, 1975 through 1979. The direct-search method employed is the Box Complex Procedure adapted to operate on the live cattle price data. Due to the expensive computer costs of this procedure four contracts per year were used. They are the February, April, August, and December options.

The same trading rules are incorporated as described in Chapter III to simulate the real world as closely as possible. Detailed output from trading activity generated by a given moving average combination is in the same format as the feeder cattle output.

Analysis of Results

The Box Complex Procedure, after several runs originating from different starting moving average combinations, produced some interesting results (Table VII). The total net profits shown in Table VII are generated by the buying and selling of one futures contract during the period 1975 through 1979 of the February, April, August, and December contracts. The surface of the profit function, generated by all possible moving average combinations, appears to have the same general surface shape as did the profit surface generated by feeder cattle futures prices.

Looking at Table VII, it is interesting to note that the 3 and 4 day combinations again make up the majority of the most profitable moving average combination derived by the direct-search technique. Except for the 2w-7-13 day moving average combination with a minimum penetration

TABLE VII

NET PROFIT IN DOLLARS GENERATED FROM MOVING AVERAGE COMBINATIONS DERIVED BY THE BOX COMPLEX PROCEDURE USING LIVE CATTLE FUTURES MARKET PRICES, 1975-1979

Lengths of Moving Averages[a]	Minimum Penetration Required[b]	Total Net Profit	Total Number of Trades	Average Profit per Trade
3-4-7w	.00	57,325	545	105.18
1-3-5w	.09	50,734	216	240.45
3-4-6w	.00	50,220	587	85.56
3-4-6	.09	48,332	354	136.33
3-5w-7	.02	45,131	514	87.80
3-5w-7	.00	44,383	566	78.42
2w-7-13	.13	43,939	175	251.03
3-4-8w	.01	43,451	524	82.92

[a]Length is in days. w denotes a linearly weighted moving average.

[b]Minimum penetration required is in $/cwt.

requirement of 13 cents, all of the combinations are relatively short, as measured in days by the longest moving average. The 3-4-7w day combination is the most profitable moving average combination for live cattle during the period 1975 through 1979 derived in this study with $57,325 in net profit.

A systematic manual search procedure was conducted to check the minimum penetration requirement of the four most profitable combinations to see if net profits could be increased. Profits could not be increased beyond those generated by the moving average combinations derived by the Box Complex Procedure.

Figure 1 in Chapter I indicates that live cattle were in a sideways market from 1974 until late 1977 when the bull market began, and continued until a sharp drop occurred in May of 1979. Since then the futures markets have been quite volatile in both directions. Table VIII points out that a greater amount of profit is generated from the long side of the market since 1975, yet the most profitable moving average combination (3-4-7w) produced the more profit on both the long and short sides of the market than any other moving average combination.

As expected, the percentage of profitable long trades is higher than that of short trades. Percent profitability of all trades (Table VIII), ranged from 42.3 percent to 49.8 percent. The combination with the highest percentage of profitable trades is the 1-3-5w (.09) combination. This combination has the highest percentage of profitable trades than any other combination derived in this study. This combination also generated the fewest number of trades of any combination listed in Table VIII. Even though total profit is 11 percent lower than the 3-4-7w combination, a trader or hedger may wish to substitute this

TABLE VIII

NET PROFIT IN DOLLARS FROM SELECTED MOVING AVERAGES USING LIVE CATTLE FUTURES MARKET PRICES, 1975-1979

Length of Moving Average[a]	Net Profit from Long Trades	Net Profit from Short Trades	Total Net Profit	Percent Profitable Long Trades	Percent Profitable Short Trades	Percent Profitable Trades	Total Number of Trades
3-4-7w	43,145	14,180	57,325	45.7	39.5	42.6	545
1-3-5w (.09)	40,319	10,415	50,734	51.9	47.7	49.8	216
3-4-6w	40,437	9,783	50,220	47.0	39.7	43.3	587
3-4-6 (.09)	38,350	9,982	48,332	50.3	41.9	46.0	354
4w-5-15	35,710	1,347	37,057	47.7	37.2	42.3	307

[a]Length is in days. w denotes a linearly weighted moving average. The number in parentheses is the minimum penetration required.

loss in potential profit for fewer trades and the increase in the percentage of profitable trades.

Past empirical work done by Purcell (1977) concluded that the 4w-5-15 is the "best" moving average combination for the period 1965-1976. As Table VIII indicates, this moving average combination generated far less total profits than did the most profitable combinations derived by the Box Complex Procedure for the period 1975 through 1979.

Profits from long and short trades generated by selected moving averages are given in yearly summaries for the period 1975 through 1979 (Table IX). This break down enables the trader or hedger the opportunity to visualize what he would have encountered in any given year using these moving averages to indicate buy and sell signals. As Table IX indicates, 1975 proved to a very profitable year for moving averages, with large profits from both long and short trades. However, 1977 proved to be unprofitable with yearly totals ranging from a negative $10,326 to a negative $160 in net profits.

Cattle feeders are most concerned with a decrease in value of the end product, fat cattle; therefore, the profits generated from the short side of the market are of utmost importance. Looking at only profits from the short trades for all of the combinations indicates no clear solution as to the "best" moving average combination. As stated, the 3-4-7w day moving average produced the greatest profit, but a significant amount of that profit is from one year, 1975. The second most profitable combination, as measured by profit from short trades, is the 1-3-5w (.09) combination. Its yearly distribution is less variable with respectable profits in three of the five years. 1979 is the only year when net short

TABLE IX

YEARLY DISTRIBUTION OF PROFITS IN DOLLARS FROM SELECTED MOVING AVERAGES USING LIVE CATTLE FUTURES MARKET PRICES, 1975-1979

Combination[a]		1975	1976	1977	1978	1979	Total
4w-5-15	Long	11,444	5,120	-6,332	12,544	12,934	35,710
	Short	11,056	5,296	-532	-3,002	-11,470	1,347
	Total	22,500	10,416	-6,864	9,542	1,464	37,057
3-4-6 (.09)	Long	14,269	4,216	-8,467	13,109	15,221	38,350
	Short	17,171	3,300	-1,861	-1,870	-6,758	9,982
	Total	31,440	7,516	-10,326	11,239	8,463	48,332
1-3-5w (.09)	Long	6,558	1,688	-3,580	17,634	18,019	40,319
	Short	7,882	162	3,420	3,552	-4,601	10,415
	Total	14,440	1,850	-160	21,186	13,418	50,734
3-4-7w	Long	13,252	3,100	-5,614	16,656	15,750	43,145
	Short	16,600	1,960	1,156	884	-6,420	14,180
	Total	29,852	5,060	-4,458	17,540	9,330	57,325

[a]Length is in days. w denotes a linearly weighted moving average. The number in parentheses is the minimum penetration required.

profits are negative. This combination has a much higher percentage of profitable short trades, 47.7 percent, versus 39.5 percent for the 3-4-7w combination. Individual hedgers must decide what moving average combination for live cattle would best suit their needs and goals in deciding which combination to use.

Optimization of Corn Moving Average Parameters

The importance of corn in the state of Oklahoma is not as a cash crop, but rather as a feed ingredient for Oklahoma's livestock industry. A 650 pound feeder steer placed on feed will consume approximately 55 bushels of corn by the time it reaches a slaughter weight of 1,050 pounds. Gee (1979) states that for commercial feedlots the feed costs comprise 35 percent of the total cost of an animal ready for slaughter. Table X shows a normal feed ration with current ingredient prices for an Oklahoma cattle producer. Using these figures, the feed ration is analyzed in terms of individual feed ingredients in order to derive their respective percentages of the total feed cost. Corn constitutes 73 percent of the feed ration and accounts for 85 percent of the total feed bill. These figures will vary somewhat as feed ingredient prices fluctuate. However, the potential for substitution among feed ingredients tends to keep these prices generally in line with one another.

As Table X indicates, approximately 85 percent of the total feed cost originates from corn. Therefore, an effective hedging program involving corn potentially eliminates the majority of adverse price risk originating from fluctuating feed costs. By optimizing the moving average parameters for the corn futures market some of this price risk faced by cattle feeders may be alleviated.

TABLE X

COMPOSITION AND PERCENTAGES OF TOTAL COST OF A TYPICAL CATTLE RATION

Ingredient	Percent of Composition	Price in Dollars/lb.	Cost of Ration	Percent of Total Cost
Corn Silage	20	.01	.20	4.8
Alfalfa Hay	3	.035	.105	2.5
Protein Supplement	4	.08	.32	7.6
Corn	73	.049	3.577	85.1
	100		4.202	100.0

Source: Animal Science Department, Oklahoma State University.

Procedure

Actual corn futures market price data are used in this optimization process. This simulation begins with the March 1975 contract, continuing until the end of 1979. All corn contracts are used. They are the March, May, July, September, and December contracts. The contract size consists of 5,000 bushels of number two yellow corn.

The moving average program was altered to accommodate the corn futures prices and the corn contract specifications. Corn futures prices are restricted to a 10 cent per bushel a day price advance or decline and have a minimum price fluctuation of a quarter of a cent per bushel. The same trading rules are incorporated as described in Chapter III to simulate the real world as closely as possible. Detailed output from trading activity generated by a given moving average combination is in the same format as described in Chapter III.

Optimal moving average parameters are derived by the Box Complex Procedure. Very little empirical work associated with the derivation of optimal moving average combinations for the corn futures market was found. The available previous research seemed to suggest that the length of the moving averages, as measured in days, are of longer periods than those for the cattle complex. Therefore, the limiting boundaries within the Box Complex Procedure were increased. The length of the shortest moving average was increased to a maximum of 14 days and the longest moving average increased to a maximum of 40 days in length. The minimum penetration requirement has a range of zero to one and a half cents.

Analysis of Results

Results of selected moving average combinations derived by the Box Complex Procedure are given in Table XI. The total net profits shown in Table XI are generated by the buying and selling of one corn futures contract during the period 1975 through 1979 of the March, May, July, September, and December contracts. As hypothesized, the more profitable moving average combinations for corn are of longer lengths than those combinations found acceptable for the cattle complex.

The direct-search technique was initialized using relatively short combinations such as those combinations derived for the cattle complex. As the Box Complex Procedure begins to optimize the parameters it moved to relatively long moving average parameters such as those in Table XI. The least number of days in the longest moving average shown in Table XI

TABLE XI

NET PROFIT IN DOLLARS FROM MOVING AVERAGE COMBINATIONS DERIVED BY THE BOX COMPLEX PROCEDURE USING CORN FUTURES MARKET PRICES, 1975-1979

Lengths of Moving Averages[a]	Minimum Penetration Required[b]	Total Net Profit	Total Number of Trades	Average Profit per Trade
7w-15-26	.009	70,299	151	465.56
7w-15-26	.007	69,649	165	437.65
13-22-30	.002	64,287	168	382.66
7w-14-25	.009	64,274	167	384.88
13-22-30	.004	62,750	154	407.47
13-21-30	.004	61,262	154	397.81
13w-33	.001	57,163	185	308.98
7-13-27	.008	56,450	148	381.42

[a]Length is in days. w denotes a linearly weighted moving average.

[b]Minimum penetration required is in $/bushel.

is 25 days with the shortest moving average beginning 7 days in length.

The most profitable moving average combination for corn derived by the Box Complex Procedure is a 7w-15-26 (.009) combination. This moving average combination generated $70,299 from 151 trades. The second most profitable combination with different parameter lengths is the 13-22-30 (.002) combination, generating $64,287 in total profits. The number of trades are relatively few because of the length of the moving average combination, with combinations in Table XI averaging six to seven trades per life time of the contract.

The boundaries of the Box Complex Procedure were set for one run such that it would optimize a two moving average combination. (The third moving average was eliminated.) The direct-search method derived a 13w-33 (.001) combination which generated $57,163 in total profits. This profit figure is less than that of the three moving average combinations (Table XII). This example supports the use of a third moving average as a confirmation signal to help eliminate false buy and sell signals.

Again a systematic manual search procedure was employed to check the minimum penetration requirement of the three most profitable combinations to check if net profits could be increased. Profits could not be increased beyond those generated by the moving average combination derived by the Box Complex Procedure.

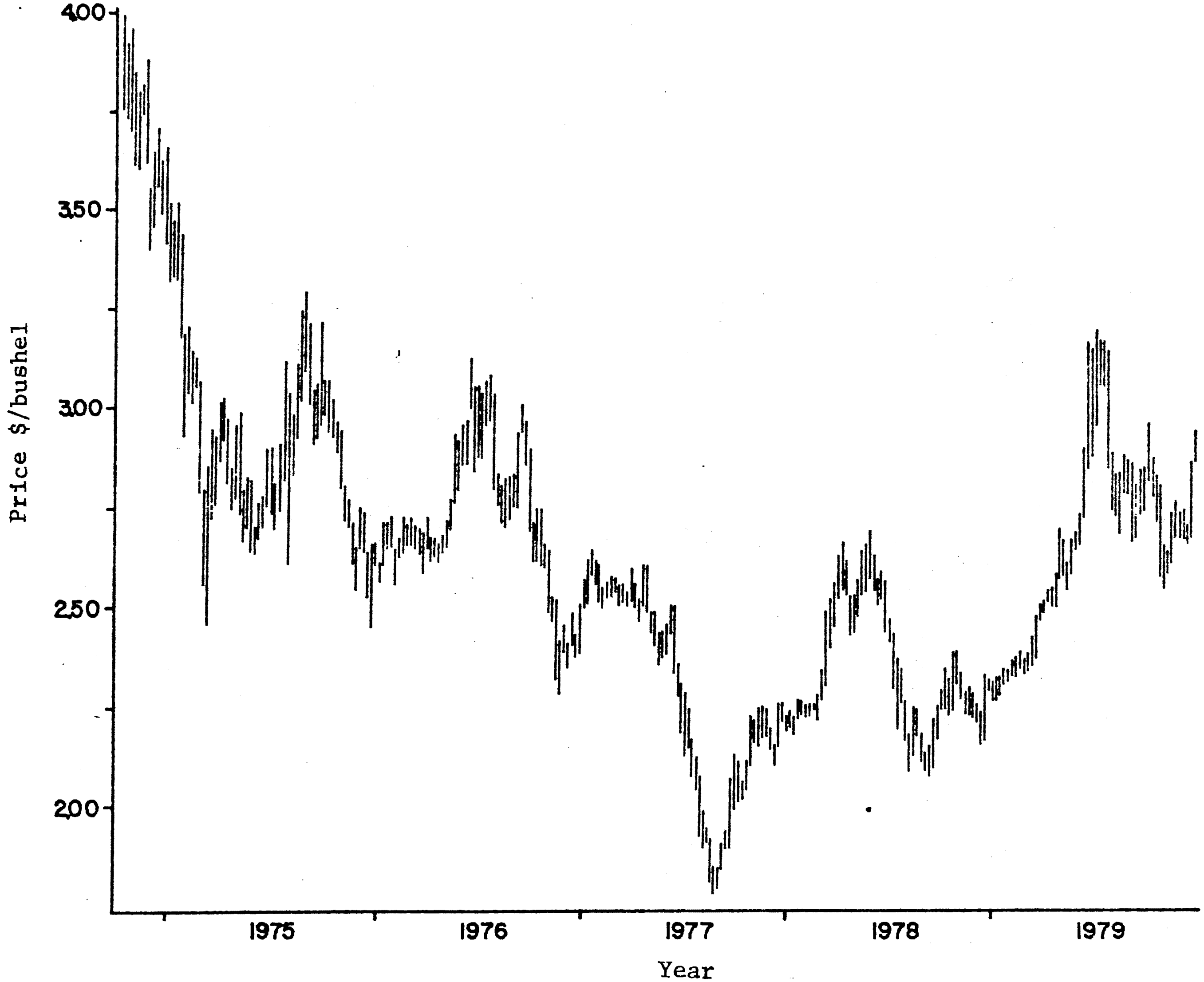
Corn reached $4 per bushel in October of 1974. A three year bear market developed after this peak, finally ending in September of 1977 at about $1.80 per bushel (Figure 7). For this reason net profits from short trades are greater than those from long trades (Table XII). It

TABLE XII

NET PROFIT IN DOLLARS FROM SELECTED MOVING AVERAGES USING CORN FUTURES MARKET PRICES, 1975-1979

Moving Average[a]	Net Profit from Long Trades	Net Profit from Short Trades	Total Net Profit	Percent Profitable Long Trades	Percent Profitable Short Trades	Percent Profitable Trades	Total Number of Trades
7w-15-26 (.009)	23,637	46,662	70,299	54.2	44.3	49.0	151
13-22-30 (.002)	21,150	43,137	64,287	58.7	53.4	56.0	168
13w-33 (.001)	17,163	40,000	57,163	47.2	40.6	43.8	185
12-48 (.00)	13,000	36,712	49,712	44.6	42.7	43.6	156
4-9-18 (.00)	-762	23,525	22,763	38.5	29.4	39.0	336

[a]Length is in days. w denotes a linearly weighted moving average. The number in parentheses is the minimum penetration required.



Source: Commodity Price Charts (1979).

Figure 7. Weekly High and Low Price Range for the Nearest Futures Contract for Corn, October, 1974-1979

is intereating to note however, that the 7w-15-26 (.009) and 13-22-30 (.002) combinations have a higher percentage of profitable long trades than short trades even though short trades generate about twice as much as did the long trades. The 13-22-30 (.002) combination has a very good percent profitable trade figure of 56 percent.

As mentioned, little empirical work was found in this area of optimal moving average combinations for corn prices. Two combinations were found that are recommended by a commodity price chart service and a brokerage house. They are a 4-9-18 day combination and a 12-48 day moving average combination. Table XII indicates that neither combination generated near the amount of total profits as did those combinations derived in this study.

Profits from long and short trades generated by selected moving averages are given in yearly summaries for the period 1975 through 1979 (Table XIII). As Table II indicates neither the 7w-15-26 (.009) combination nor the 13-22-30 (.002) moving average combination generated negative total net profits in any given year. The most profitable year for both combinations is 1975, with 1979 being the least profitable year.

Cattle feeders can obtain price protection from increasing feed costs by long hedging their corn requirements. Even though corn prices trended downward from 1975 through 1977, Table XIII indicates that multiple hedging of corn based upon buy and sell signals generated by the 7w-15-26 (.009) moving average combination should provide an opportunity to reduce feed costs.

TABLE XIII

YEARLY DISTRIBUTION OF PROFITS IN DOLLARS FROM SELECTED MOVING AVERAGES USING CORN FUTURES MARKET PRICES, 1975-1979

Combination[a]		1975	1976	1977	1978	1979	Total
7w-15-26 (.009)	Long	12,987	2,363	-113	3,413	4,987	23,637
	Short	24,012	2,637	12,900	7,525	-412	46,662
	Total	36,999	5,000	12,787	10,938	4,575	70,299
13-22-30 (.002)	Long	10,375	5,725	1,125	325	3,600	21,150
	Short	22,337	6,388	12,987	3,800	-2,375	43,137
	Total	32,712	12,113	14,112	4,125	1,225	64,287

[a] Length is in days. w denotes a linearly weighted moving average. The number in parentheses is the minimum penetration required.

Summary

The use of the Box Complex Procedure to optimize moving average parameters for the fat cattle and feed grain (corn) futures markets provided satisfactory results. Using actual futures price data from 1975 through 1979, optimized moving average combinations, as derived by this study, were found. The two most profitable combinations derived in this study for live cattle are the 3-4-7w and the 1-3-5w (.09) combinations. The 3-4-7w moving average combination generated the most profit, but the 1-3-5w (.09) combinations has a higher percentage of profitable trades and a less variable yearly net profits figure. Both combinations are superior to the 4w-5-15 combination derived by Purcell (1977).

The most profitable moving average combination derived in this study involving corn futures price data is the 7w-15-26 (.009). This combination generated $70,299 in profits for the period 1975-1979. Little empirical work could be found in this area, however this combination proved itself far superior to moving average combinations recommended by a chart service and a brokerage house.

The next chapter will employ the results of Chapters III and IV in order to utilize the potential usefulness of moving average combinations in the development of a complete hedging strategy for the cattle feeder. Margins as well as price risk (variability) will be analyzed in detail for the different marketing strategies.

CHAPTER V

SIMULATIONS AND TESTING OF ALTERNATIVE FED-CATTLE MARKETING STRATEGIES

As stated in previous chapters, a need exists to effectively reduce price risk in the cattle feeding industry without adversely effecting profits. The cattle feeding industry in the 1970's was characterized by periods of boom and bust. A sound, viable cattle feeding industry is not only in the best interest of cattle feeders, but all beef consumers in general. A competitive cattle feeding industry, with profit as the incentive, will insure the continued search and use of new knowledge and technology to reduce production costs and increase the final profit margin for their product. It is this competition, of a viable industry, that in the long run accomplishes the consumers wich of a stable, reliable supply of beef at the lowest possible price.

Optimal moving average combinations derived in this thesis have proved to be profitable in simulations using historical futures market price data. Based upon the preceding statement, hedging strategies employing a technical tool known as moving averages to generate buy and sell signals can decrease input prices and increase output prices with the possibility of decreasing price variability (risk). These marketing alternatives will be tested for their performance in a real world simulation of a continuous feedlot operation. The objective of this chapter is to simulate the real world as closely as possible as it pertains to the cattle feeding industry, then test different marketing strategies involving multiple hedging using the methods derived in this study. The concepts of risk and risk management as well as profitability of these market alternatives will be dealt with in detail.

Table XIV depicts the composition of total costs in percentage for fed-beef production in western commercial feedlots. As Table XIV indicates, 54 percent of the total cost of fed-beef originates from the feeder cattle with feed costs constituting 35 percent. Corn constitutes 85 percent of the total feed bill (Chapter IV), thus hedging feeder cattle and corn potentially covers 84 percent of the total fed-beef production costs in western commercial feedlots. By long hedging feeder cattle and corn, a cattle feeder can potentially protect himself from rising production costs. Then by employing short multiple hedges of fat cattle (live cattle), the feeder is able to protect himself from declining output prices. This chapter will test various hedging combinations against a control situation of all cash positions (no hedge) in order to develop an effective, comprehensive hedging strategy for the feedlot operation. The method of analysis, the strategies, and the results will all be examined and discussed in the remainder of the chapter.

Method of Analysis

No two feedlot operations are exactly alike nor managed in the exact same manner, making it impossible to create a single simulation that is similar to all feedlot operations. However, this simulation is meant to be as typical as possible of actual feeding operations in Northwestern Oklahoma.

TABLE XIV

COMPOSITION OF TOTAL COSTS OF FED-BEEF PRODUCTION IN PERCENTAGES

Cost Components	Commercial Feedlots
Feeder-Cattle	54
Feed	35
Other Direct	9
Total Direct	98
All Other	2
Total	100

Feeder steers are placed on feed beginning the first of January, 1975, and appropriate dates thereafter so as to insure that one lot of cattle is marketed in each and every month through December 1979. This results in 56 lots of cattle being fed and marketed during the entire simulation period. The average weight of the feeder cattle at the time they are placed on feed is assumed to be 650 pounds. A feeding period of 140 days with an average daily rate of gain of 2.85 pounds is assumed. The resulting slaughter weights are assumed to be 1,050 pounds. Each feeder steer requires 7.75 pounds of corn per pound of gain or 55 bushels to reach 1,050 pounds. A one percent death loss is assumed for the steers placed in the feedlot for the 140 day period.

In order to equate feeder cattle, live cattle, and corn futures markets contract sizes, as determined by their respective usage and size, a combination of five contracts of live cattle (190 head), three contracts of feeder cattle (192 head), and two contracts of corn (10,000 bushels) are used for this simulation.

Actual futures price data and cash price data are used in this simulation. Actual futures market prices for all 1975 through 1979 contracts of the feeder cattle, corn, and live cattle are used. Actual cash market prices are obtained for corn in the form of monthly average Oklahoma farm prices as published by the United States Department of Agriculture. Daily cash prices for Good to Choice 600-700 pound feeder steers in Oklahoma City and Good to Choice 1,000 to 1,100 pound slaughter steers in Guymon, Oklahoma are obtained from the Weekly Livestock Report, Oklahoma City, Oklahoma. These daily prices are then used to calculate weekly average cash prices for both feeder cattle and live cattle.

The same trading rules and signals described in Chapters III and IV are followed to place and life hedges for feeder cattle, corn, and live cattle A $1,200 per contract initial margin requirement for live cattle and feeder cattle was arbitrarily selected for the simulation period. A $1,000 initial margin requirement for each corn contract was selected. Interest on the margin money is charged at a rate equal to the average annual prime interest rate charged by banks as reported in the Economic Indicators (United States Government Printing Office, December, 1979) plus one percent.

Long hedges are placed and lifted as directed by the selected moving average combinations for feeder cattle and corn. Buy and sell signals are calculated by computer using the same program as used in Chapters III and IV. Long hedges for feeder cattle and corn can be initiated 140 days prior to the placement of the feeders in the feedlot, depending upon their respective signals from the moving average combinations. For example, if the moving average combination for feeder cattle is signalling an upward trend then the buy hedge is placed on the close of that day. The same procedure would hold for corn too. However, if the moving average combination is indicating a downward market, buy hedges would not be placed until the moving average generated a buy signal. Hedges are then lifted and placed as dictated by the moving average combination until the futures contracts are closed out and cash positions in feeder cattle and corn are taken.

Short hedging of live cattle can be initiated on the first day feeder cattle are placed in the feedlot, depending upon the moving average signal. If the moving average combination indicates a downward market the day the cattle are placed on the close of trading on that particular day. However, if the moving average signals an upward trending live cattle futures market, the hedge is not placed until a sell signal is generated. The hedges are placed and lifted as dictated by the appropriate moving average combination until such time the fattened cattle are sold and the futures contracts liquidated.

This process simulates a feedlot operation whereby an operator continuously feeds one lot of cattle after another. Corn and feeder cattle requirements are multiple hedged one feeding period in advance until offsetting cash positions are taken and the cattle are placed on feed and corn requirements secured. The cattle on feed are subject to multiple short hedging until the cash position is sold on the cash market as slaughter weight cattle. The feedlot operator is continuously "covering" himself from adverse input price changes and declining output prices by multiple hedging these commodities based upon optimized moving average combinations.

Calculations of Costs and Margins

In this chapter the simulation will calculate the margin between the actualized costs of feeder cattle and corn to the value of the finished product, fat cattle. It is assumed that the feedlot is continuously feeding cattle, therefore all other costs such as utilities, wages, repairs, etc., associated with cattle feeding are assumed constant and fixed for each lot of cattle under any simulated marketing strategy. The following five equations are used in the simulation to calculate costs and margins between the feeder cattle plus corn costs, and the gross value of the fat cattle.

Feeder cattle costs are calculated in the following manner:

$$NFC_t = PFC_t \pm FCHP_{t-k,t} + IM_{fc}$$

where:

NFC_t = the net feeder cattle cost at time t;

t = date that feeder cattle are purchased in the cash market and corresponding hedges liquidated;

k = length of feeding period (140 days);

PFC_t = average weekly cost of 600-700 pound feeder steers at Oklahoma City for date t times number of head purchased;

$FCHP_{t-k,t}$ = profit from futures market transactions on long hedges dictates by the selected moving average combination (a $50 per round trade commission charge is included);

IM_{fc} = interest accrued on initial margin requirements ($1,200 per contract times annual average prime interest rate plus one percent).

NFC_t is a cost, therefore if $FCHP_{t-k,t}$ is a positive figure this will decrease the net cost of feeder cattle, and it $FCHP_{t-k,t}$ is negative, the results are higher feeder cattle costs. The cash only position will simply be the value of the cost for PFC_t, with $FCHP_{t-k,t}$ and IM_{fc} equal to zero. PFC_t and $FCHP_{t-k,t}$ must involve approximately the same number of feeder cattle or the position will be over hedged or under hedged. For this simulation a feeder cattle contract of 42,000 pounds is equal to 64 head of 650 pound feeder steers.

Corn requirement costs for feed are calculated as follows:

$$NCC_t = \frac{7.75(LCwt - FCwt) \times PCC_t}{56} \pm CCHP_{t-k,t} + IM_{cc}$$

where:

NCC_t = net corn cost at time t;

t = date corn requirements are purchased in the cash market and corresponding futures market positions liquidated;

k = length of feeding period (140 days);

LCwt = slaughter weight of fat cattle in pounds (1,050 pounds);

FCwt = placement weight of feeders in pounds (650 pounds);

PCC_t = monthly average Oklahoma farm price for corn at date t times number of feeders to be fed;

$CCHP_{t-k,t}$ = profit from futures market transactions on long hedges dictated by the selected moving average combinations (a $50 per round trade commission charge is included);

IM_{cc} = interest accrued on initial margin requirements ($1,000 per contract times annual average prime interest rate plus one percent).

NCC_t is a cost, therefore if $CCH_{t-k,t}$ is positive it will reduce the corn cost; if $CCHP_{t-k,t}$ is negative net corn costs will be increased. One futures market contract of corn is equal to 5,000 bushels, therefore the amount of corn fed and the futures contract size must be of approximately the same amount. In this simulation 55 bushels of corn is fed to each steer during the 140 day feeding period. At this ratio 91 head of cattle will consume 5,000 bushels (one contract) of corn. The cash position will be the value of $\frac{7.75(LCwt - FCwt) \times PCC_t}{56}$, with $CCHP_{t-k,t}$ and IM_{cc} equal to zero.

Returns are generated by the sale of the fattened cattle and is calculated in the following manner:

$$NLC_{t+k} = PLC_{t+k} \pm LCHP_{t,t+k} + IM_{lc}$$

where:

NLC_{t+k} = net value of the fat cattle at slaughter time;

t = date at which time feeders are placed on feed;

k = length of feeding period (140 days);

PLC_{t+k} = weekly average price for slaughter steers at Guymon, Oklahoma at date t+k times number of feeders placed on feed at t less one percent death loss;

$LCHP_{t,t+k}$ = profit from futures market transactions on short hedges dictated by the selected moving average combination (a $50 per round trade commission charge is included);

IM_{lc} = interest accrued on initial margin requirements ($1,200 per contract times annual prime interest rate plus one percent).

NLC_{t+k} is a return, therefore if $LCHP_{t,t+k}$ is positive the net value of the fat cattle is increased, if $LCHP_{t,t+k}$ is negative the net value is decreased. Again the number of cattle on feed and eventually sold must be equated with the number of fat cattle associated with the futures contract. There are 38 head of cattle weighing 1,050 pounds in a 40,000 pound live cattle futures contract. The cash position value is simply the value of PLC_{t+k}, with $LCHP_{t,t+k}$ and IM_{lc} being zero.

The margin between actualized costs of feeder cattle and corn and revenues from the sale of fat cattle is computed in the following equation:

$$MAR = NLC_{t+k} - (NFC_t + NCC_t)$$

The margin will be simulated for the "no hedge", traditional cash position and will serve as the basis of comparison for the other multiple hedging marketing alternatives. This chapter will not only analyze the margin for the different strategies but will also calculate and analyze the standard deviation and coefficient of variation. These calculations will provide insight into the effectiveness and the variability of the different strategies over the five year simulation period.

Hedging Strategies

The traditional "no hedge" cash position strategy will serve as the control to which other alternatives will be compared. Various degrees and combinations of multiple hedging strategies based upon selected moving average combinations involving feeder cattle, corn, and live cattle will be simulated over the test period. The standard deviation, coefficient of variation, and the margin between the input costs of feeder cattle plus corn, and the returns from fat cattle sales will be analyzed.

It should be understood that the performance of these simulations covering the past historical test period do not imply identical future performances. Rather, the results of these hedging strategies should be utilized in the context of furthering the manager's marketing knowledge and be employed as a valuable input for future decision-making processes.

Strategy I

This is a strategy of complete exposure to price risk and corresponds to the unhedged production and marketing activities of the feeding operation. This strategy is used to measure the relative effects of the other strategies and to illustrate the effects of complete exposure to price risk.

In this strategy feeder cattle and feed requirements (corn) are purchased the initial day of the feeding period (t). The cattle are then fed 140 days (k) to a weight of 1,050 pounds and then sold. This difference between input costs and the value of slaughter animals are shown in Figure 8. This difference will be referred to as the production margin for the remainder of the chapter. The points on the graph represent the production margin for each of the 56 lots of 190 head of cattle marketed from May, 1975 through December, 1979. As Figure 8 indicates, complete exposure to price risk results in both large profits and losses for the cattle feeder.

The production margins derived from the simulation vary from a negative $85.23 per head to a positive $225.54 per head. Nine of the 56 lots marketed resulted in feeder cattle and corn costs being greater than the gross value of the fat cattle. Remembering that all other costs associated with the transformation of feeder cattle to slaughter weight animals are assumed constant and that this margin is just the difference between the input costs of corn and feeder cattle, and the values of the fat cattle, it is understandable why cattle feeders would welcome marketing strategies that reduce price variability (risk). The standard deviation about the mean for Strategy I is $14,563 with the coefficient of variation equal to 1.10. The mean production margin is $13,182.

Figure 8 shows that production margins during 1975 are all greater than the mean of the complete test period. This is contrasted with 1976

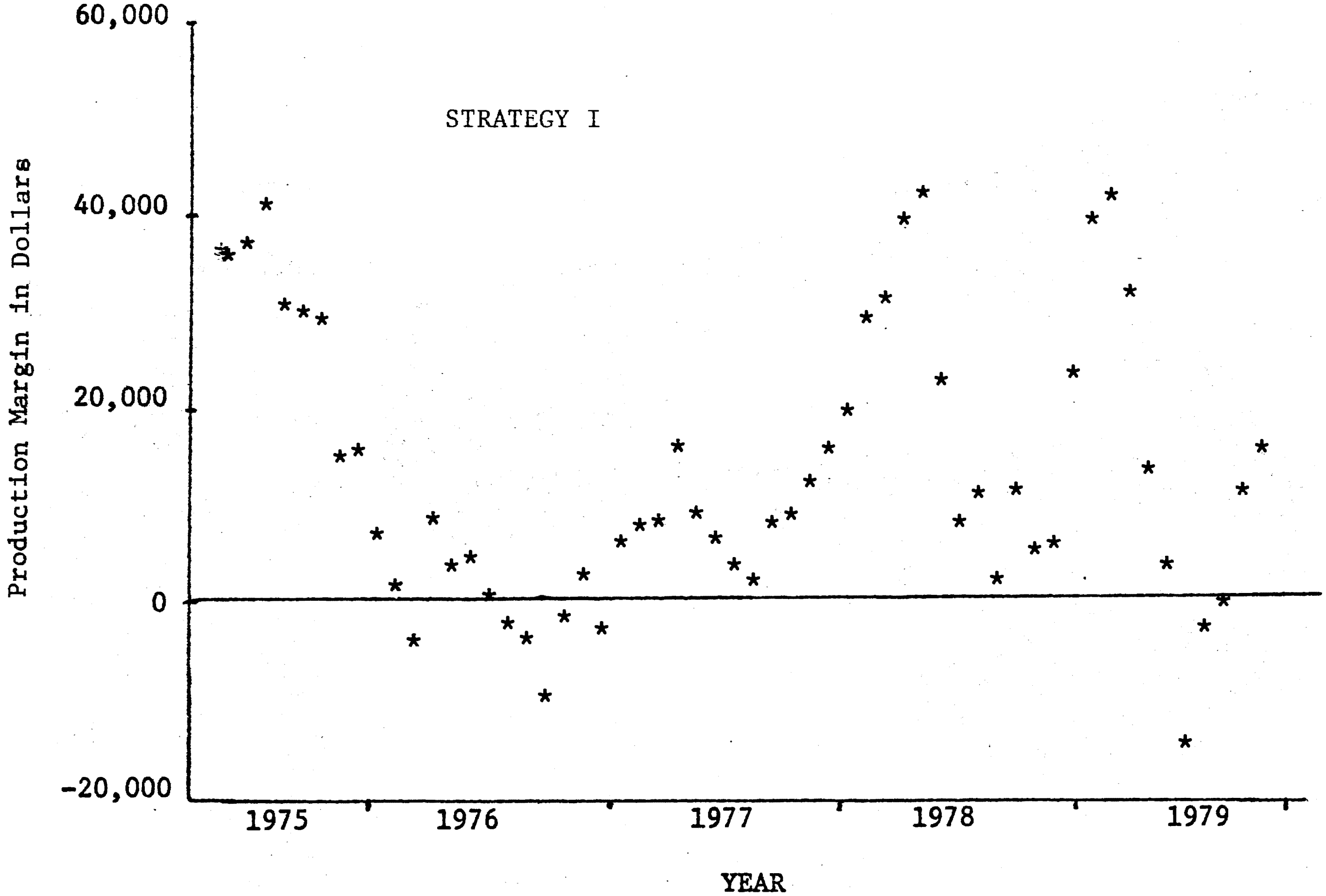


Figure 8. Simulated Production Margin for Each Lot of Cattle Marketed Under Strategy With No Hedging, May, 1975-1979

and 1977 where only one lot of cattle produced a margin above the mean. These two years proved to be the least profitable for cattle feeders. 1979 illustrates the price risk associated with feeding cattle, as the second most profitable lot and the least profitable lot both occurred in 1979, only four months apart.

Strategy II

This strategy consists of multiple hedging one of these components of price risk under study. The three alternatives under Strategy II are: (a) unhedged cash positions in corn and feeder cattle, with live cattle multiple hedged; (b) unhedged cash positions in corn and live cattle multiple hedged; and (c) live cattle and feeder cattle unhedged with the corn requirements being multiple hedged.

The first alternative (IIa) involves open cash positions of the inputs, corn and feeder cattle. At the beginning of each feeding period corn and feeder cattle are purchased in the cash market. Once the feeder cattle are purchased, the operator becomes exposed to possible adverse price movements in the value of his future output, fat cattle. This simulation makes use of the moving average combination 1-3-5w with a minimum penetration requirement of \$.09 to signal when sell hedges should be placed and lifted on the live cattle futures market during the period t to t+k.

The mean gross value of the 56 lots of 190 head of cattle, unhedged, is \$97,256. The mean gross value derived by the simulation employing a 1-3-5w (.09) moving average combination to direct sell hedges is \$98,041, or an increase of \$4.13 per head of cattle marketed. The standard deviation and coefficient of variation of the unhedged value of the slaughter animals are $22,669 and .23 respectively. Multiple hedging, employing the 1-3-5w (.09) moving average combination, reduced the standard deviation and coefficient of variation to $20,874 and .21.

Figure 9 shows the production margins for each lot of cattle marketed during the test period using the 1-3-5w (.09) moving average combination to multiple hedge fat cattle. The number of negative production margins, as compared to Strategy I, is reduced from nine to four lots. The largest single production margin for one lot of cattle is increased to $237.95 per head with the single largest loss being cut to a negative $58.39 per head marketed. The mean production margin for this alternative is $13,967 per lot compared to $13,182 for Strategy I.

The low to negative production margins experienced during 1976 due to depressed live cattle prices are greatly improved by the multiple short hedging of the fat cattle on the futures market. The mean production margin for 1976 was only $.12 per head marketed for Strategy I. This same margin is increased to $38.73 per head marketed by the use of the 1-3-5w (.09) moving average combination to short hedge the fat cattle on the futures market. The standard deviation and coefficient of variation for the production margin are reduced to $12,283 and .88 respectively by this alternative.

The second alternative of Strategy II involves unhedged positions in corn and live cattle with feeder cattle requirements being long hedged, as directed by the 3-4-6 (.07) moving average combination derived in Chapter III, during the period t-k to t for each lot. Corn requirements are purchased at the average monthly cash price for time t. Fat cattle are sold at the average weekly price at time t+k. Feeder

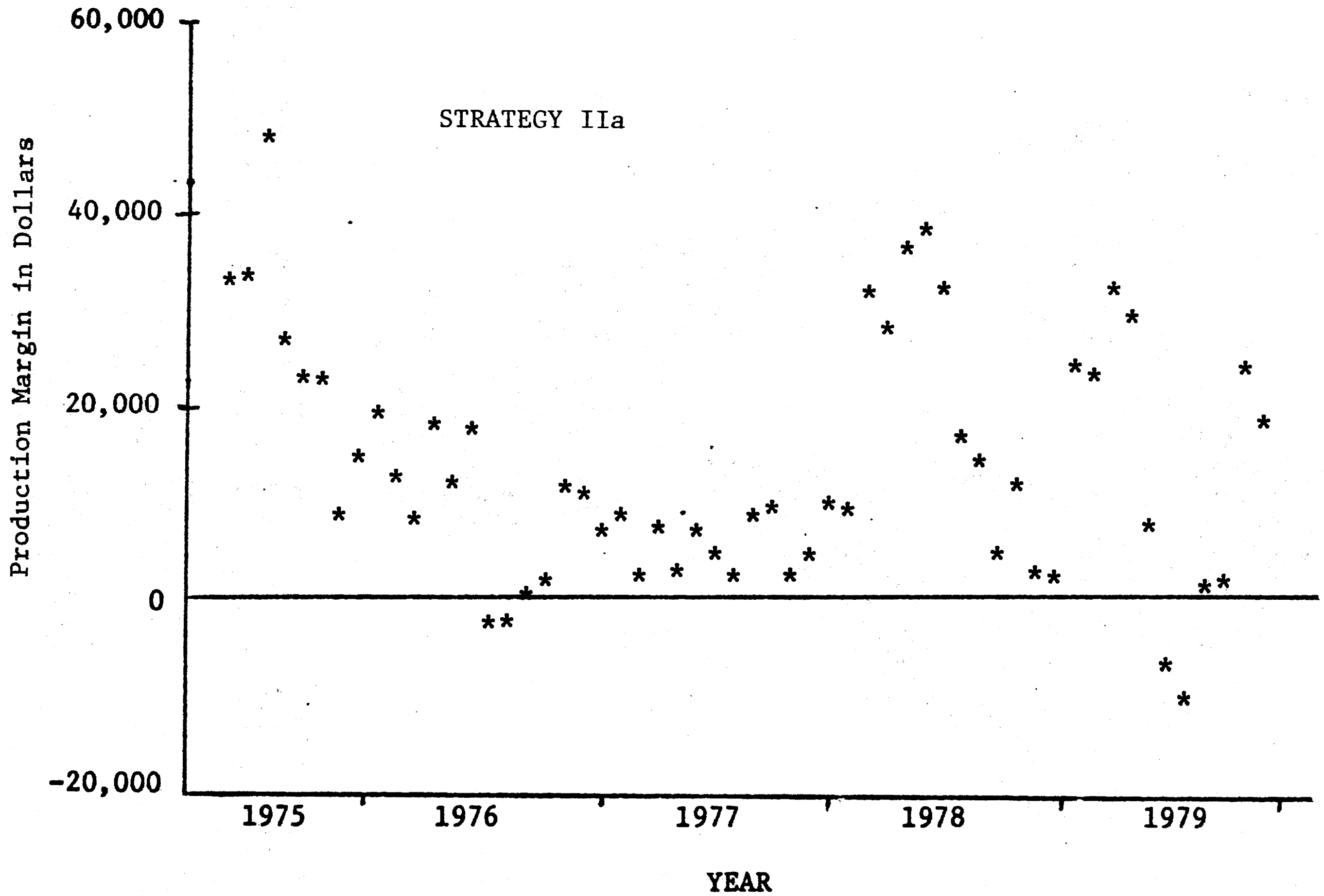


Figure 9. Simulated Production Margin for Each Lot of Cattle Marketed Under Strategy With Live Cattle Multiple Hedged, May, 1975-1979

cattle are purchased at the weekly average price at Oklahoma City for time t with any open futures contracts liquidated at time t.

Alternative (IIb), decreased the average cost of 192 head of feeders from \$59,798 to \$54,457, for a savings of \$27.82 per head of feeder cattle purchased. The standard deviation and coefficient of variation associated with the cash costs of 192 head of feeder cattle have a value of \$21,999 and .37 respectively. These same figures for 192 head of feed cattle are reduced to \$18,293 and .34 when the hedging profits or losses generated by the 3-4-6 (.07) moving average combination are included.

Figure 10 shows the production margins under alternative (IIb) with feeder cattle requirements being multiple hedged. This reduced the number of negative margins to only two lots. This alternative produced a maximum production margin of \$269.98 per head and a minimum margin of a negative \$22.32 per head. The standard deviation and coefficient of variation of the production margin associated with this alternative are \$13,556 and .73 respectively.

The third alternative (IIc) consists of open cash positions in feeder cattle and live cattle with corn requirements long hedged using the optimized moving average combination of 7w-15-26 with a \$.009 minimum penetration requirement for the time period of t-k to t for each lot of animals. Feeder cattle are purchased at the weekly average price for time t and the fat cattle are sold at the end of the feeding period. Corn requirements are hedged during period t-k to t, at which time corn requirements are purchased at the average monthly Oklahoma price and any outstanding futures contracts are liquidated.

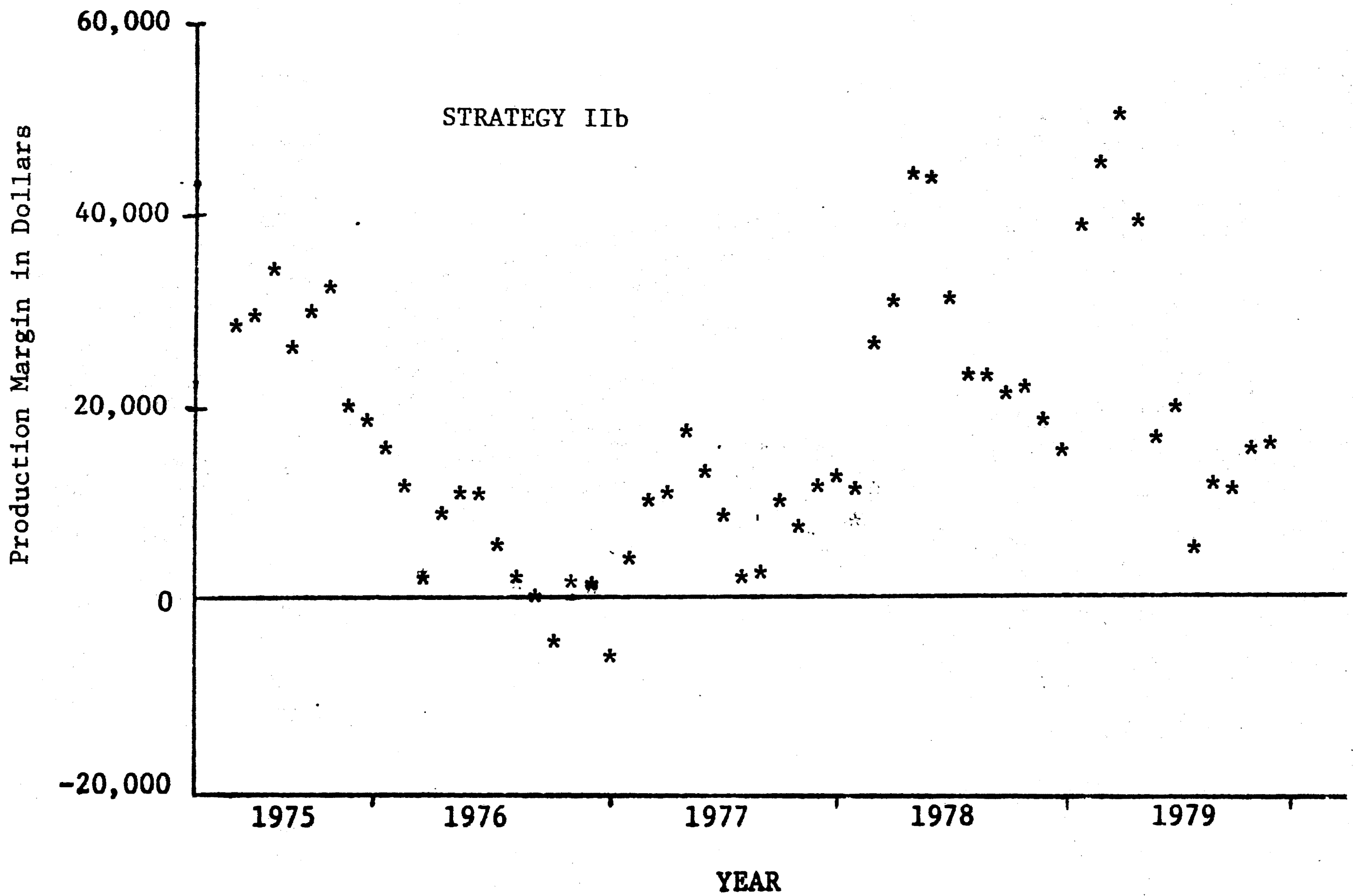


Figure 10. Simulated Production Margin for Each Lot of Cattle Marketed Under Strategy With Feeder Cattle Multiple Hedged, May, 1975-1979

This marketing method resulted in lowering the mean corn costs for each lot of cattle by \$377 or 3.77¢ per bushel of corn purchased. The standard deviation and coefficient of variation for the value of the cash corn requirements for each lot of cattle is \$3,420 and .14 respectively. Multiple hedging, using the 7w-15-26 (.009) moving average combination reduced these figures to \$3,221 and .13.

Figure 11 represents the production margins for each lot of cattle marketed during the test period using the 7w-15-26 (.009) moving average combination to long hedge corn requirements. The number of negative margins is reduced by one as compared to Strategy I. This alternative obtained a slight increase in the most profitable lot and a slight decrease in the largest loss of the production margins compared to Strategy I. The standard deviation and coefficient of variation association with this alternative are \$14,710 and 1.08. This coefficient of variation is only slightly less than the 1.10 value for the unhedged position.

Strategy III

This strategy consists of multiple hedging different combinations of two of the three components of price risk being analyzed in this study. The three possible alternatives are: (a) an exposed cash position in live cattle with two inputs hedged; (b) an open cash position in feeder cattle with corn and live cattle hedged; and (c) an unhedged position in cash corn with the feeder cattle and live cattle positions being multiple hedged.

The production margins are calculated by the same process in this simulation as explained for Strategy II. In order to reduce unneeded

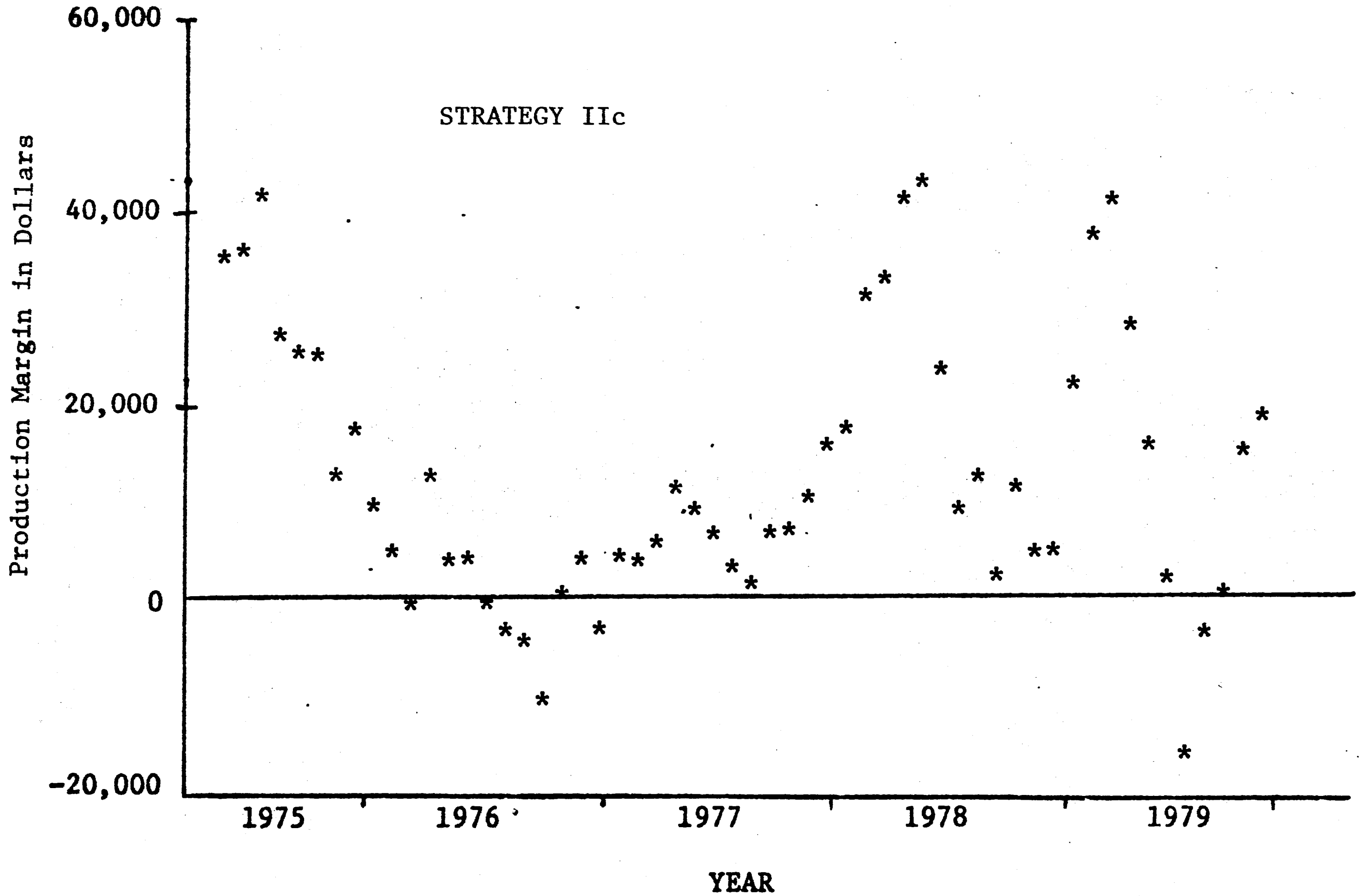


Figure 11. Simulated Production Margin for Each Lot of Cattle Marketed Under Strategy With Corn Multiple Hedged, May, 1975-1979

repetition because of the similarity in the procedure between Strategy II and Strategy III, results are summarized in Table XV and Figures 12, 13, and 14. The important results will be discussed from these tables and figures, keeping in mind the general procedure of the production and marketing simulation is of the same format as described in Strategy II.

TABLE XV

RESULTS FROM SIMULATION OF CATTLE MARKETINGS WITH COMBINATIONS OF TWO HEDGED POSITIONS AND ONE OPEN CASH POSITION, 1975-1979

Alternative Positions	Mean Production Margin	Standard Deviation	Coefficient of Variation
Cash Live Cattle Hedged Corn and Feeder Cattle	18,900	13,600	.72
Cash Feeder Cattle Hedged Corn and Live Cattle	14,751	12,799	.87
Cash Corn Hedged Feeder and Live Cattle	19,313	11,640	.60
All Cash	13,182	14,563	1.10

Given the results in Strategy II, it is of no surprise that the alternative of multiple hedging feeder cattle and live cattle generated the largest mean production margin of the three alternatives (Table XV). The mean production margin for this alternative (IIIc) is $19,313. This is an increase of over $32 per head marketed when compared to Strategy I.

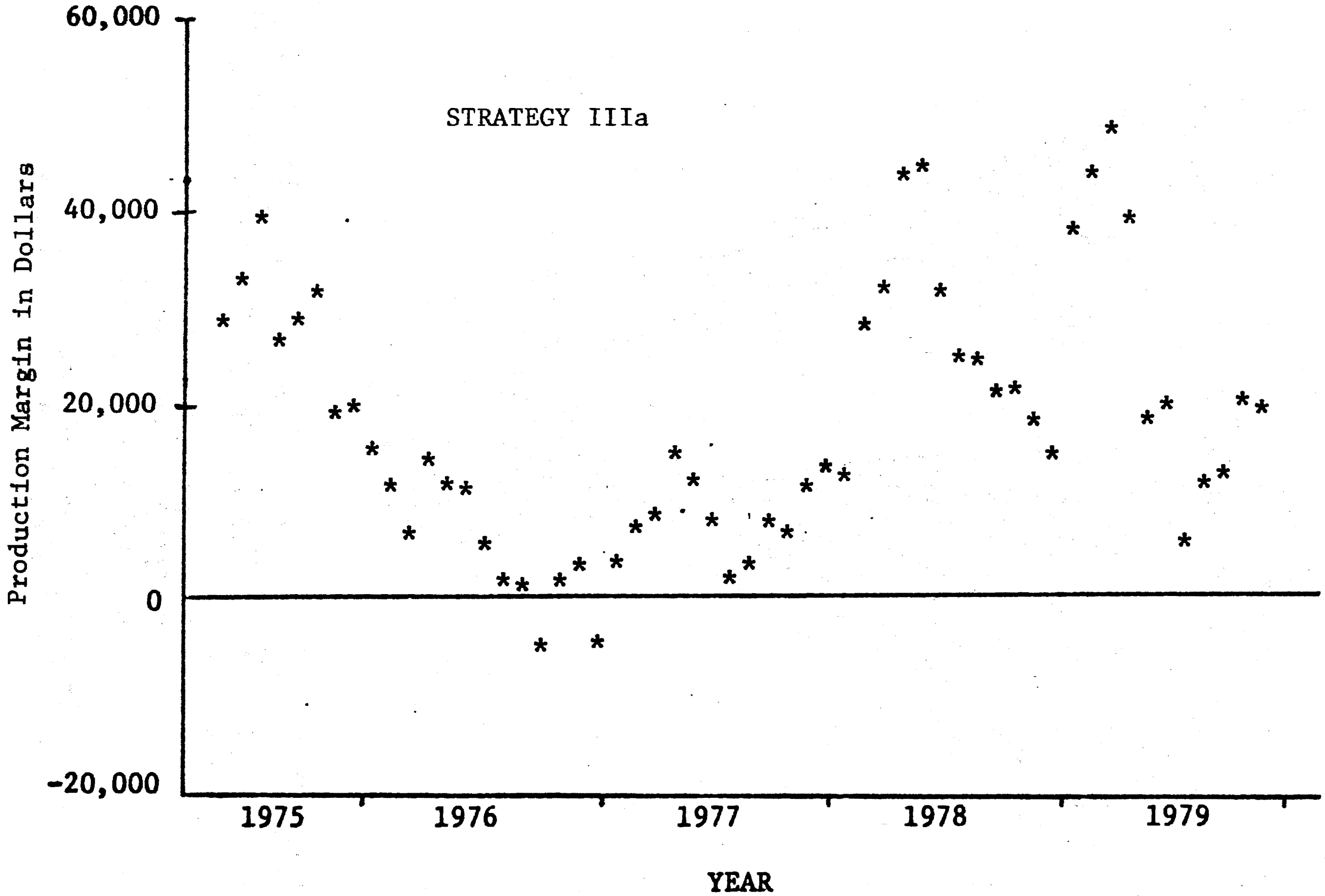


Figure 12. Simulated Production Margin for Each Lot of Cattle Marketed Under Strategy With Feeder Cattle and Corn Multiple Hedged, May, 1975-1979

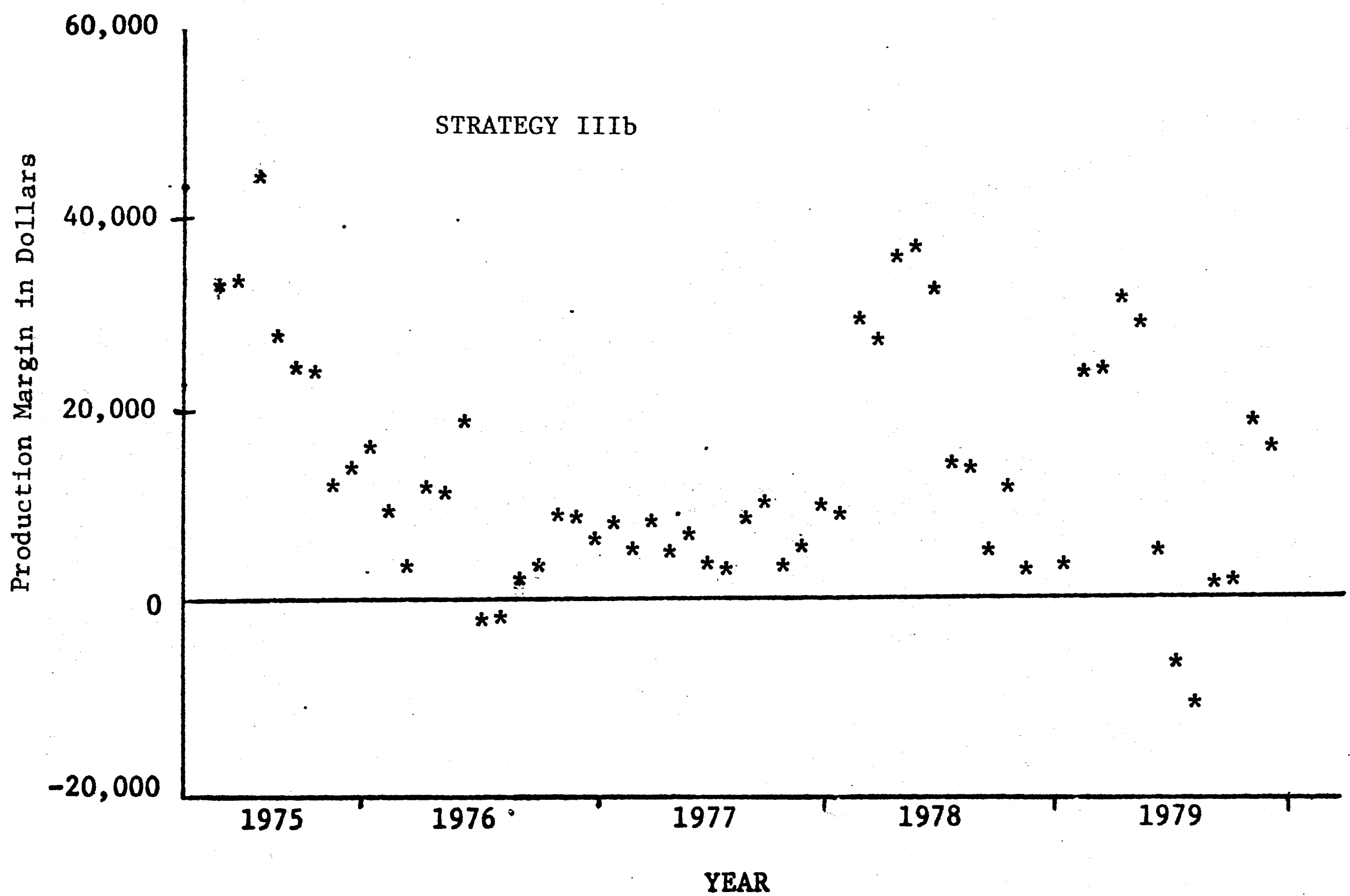


Figure 13. Simulated Production Margin for Each Lot of Cattle Marketed Under Strategy With Corn and Live Cattle Multiple Hedged, May, 1975-1979

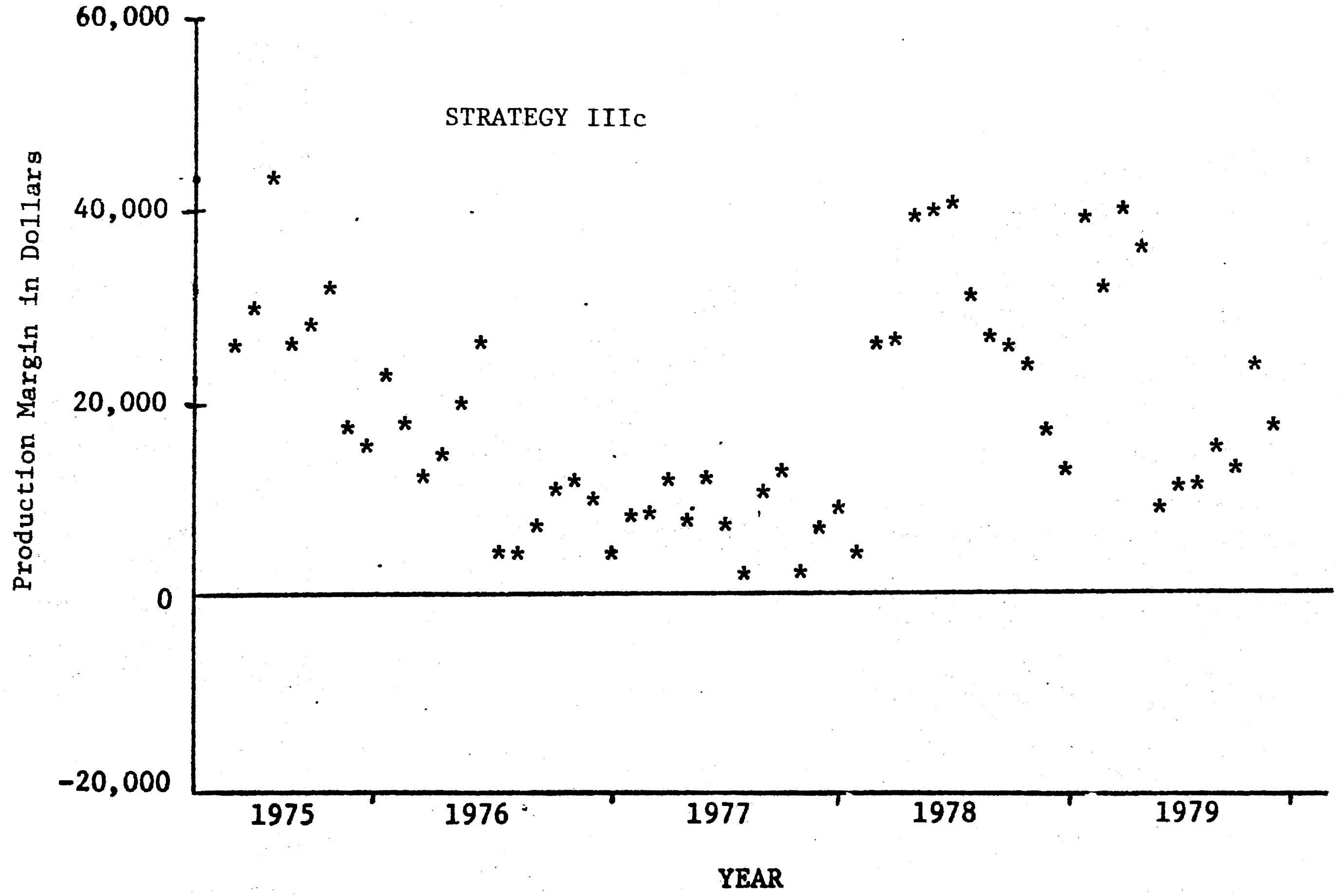


Figure 14. Simulated Production Margin for Each Lot of Cattle Marketed Under Strategy With Feeder and Live Cattle Multiple Hedged, May, 1975-1979

This alternative also resulted in a substantial reduction in the standard deviation and coefficient of variation of the production margins with values of \$11,640 and .60 respectively.

Figure 12 represents production margins for the different lots of cattle marketed during the test period for alternative (IIIa), an unhedged position in live cattle and multiple hedged positions in corn and feeder cattle. Figure 13 represents alternative (IIIb), with feeder cattle being unhedged and corn and live cattle being multiple hedged. Figure 14 shows production margins derived from the simulation of alternative (IIIc), with corn being unhedged and feeder cattle and live cattle subject to multiple hedging.

Multiple short hedging of live cattle using the 1-3-5w (.09) moving average combination combined with multiple long hedging of feeder cattle employing the 3-4-6 (.07) moving average combination and then purchasing corn requirements on the cash market resulted in no negative production margins for the entire test period. The single largest margin is less than those derived in Strategy II, but the lowest margin is much greater than those values recorded under the Strategy II alternatives. The smallest margin generated by this marketing alternative is \$1,997 of \$10.51 per head marketed.

Strategy IV

Strategy IV encompasses the three major sources of price variability that a cattle feeder faces under a complete multiple hedging scheme. This complete hedge of corn, feeder cattle, and fat cattle has the potential of alleviating the greatest amount of price risk that cattle feeders are exposed to. Under this strategy feeder cattle and corn requirements are subject to multiple long hedging during the period t-k through t, at which time any outstanding futures contracts are liquidated and replaced by cash positions. The cattle placed on feed are then subject to multiple short hedging during the feeding period k (t through t+k). At the end of the feeding period the fat cattle are sold on the cash market and any futures contracts are liquidated.

This strategy increased the mean production margin to $19,681 per lot from $13,182, or $34.20 per head of cattle marketed. The value of the standard deviation and coefficient of variation associated with Strategy IV are $12,128 and .62 respectively. Figure 15 represents the production margin for each lot of cattle sold during the test period. The largest profit for one lot of cattle is $239.39 per head, with the smallest profit being $9.23 per head marketed.

Further Comparison of the Hedging Strategies

Table XVI lists the profits generated from the buying and selling of futures contracts as a result of the multiple hedging strategies using the moving average combinations of 3-4-6 (.07) for feeder cattle, 7w-15-26 (.009) for corn, and 1-3-5w (.09) for live cattle during the specified period for each of the 56 lots of cattle marketed. These transaction profits are calculated and recorded in the month for which that lot of cattle is marketed. Profits are the result of the buying and selling of one contract, with a $50 per round trade commission fee assessed.

The last row of Table XVI gives the yearly summation of profits generated that particular year for the three commodities. Live cattle short hedges generated net losses in all but one year, 1976. However,

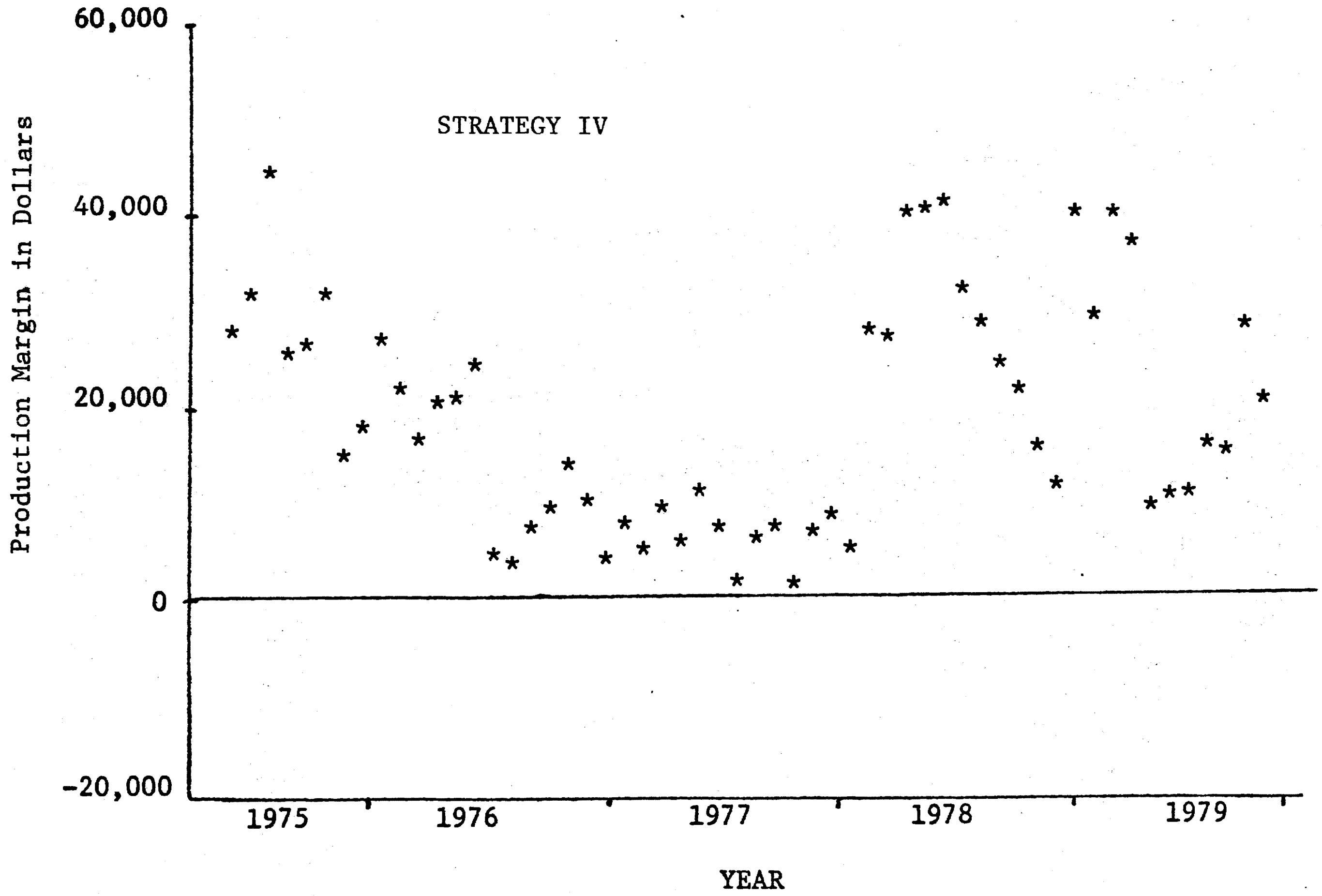


Figure 15. Simulated Production Margin for Each Lot of Cattle Marketed Under Strategy With all Three Commodities Multiple Hedged, May, 1975-1979

TABLE XVI

PROFITS IN DOLLARS FROM HEDGING TRANSACTIONS OF THE FEEDER CATTLE, CORN, AND LIVE CATTLE FUTURES MARKETS DURING THE TEST PERIOD, 1975-1979*

Month Cattle Marketed	1975			1976			1977			1978			1979		
	Feeder Cattle Long Hedge	Corn Long Hedge	Live Cattle Short Hedge	Feeder Cattle Long Hedge	Corn Long Hedge	Live Cattle Short Hedge	Feeder Cattle Long Hedge	Corn Long Hedge	Live Cattle Short Hedge	Feeder Cattle Long Hedge	Corn Long Hedge	Live Cattle Short Hedge	Feeder Cattle Long Hedge	Corn Long Hedge	Live Cattle Short Hedge
January				2068	1987	2278	-725	200	1910	-486	0	-1048	3533	-475	-534
February				2832	1750	1918	-218	-525	770	-1846	0	-1800	5524	-300	268
March				2832	2325	2108	1100	-1650	-480	-1056	787	0	2391	-650	-2832
April				837	2637	990	1110	-1025	160	-48	725	-982	3067	-75	-1854
May	-1909[a]	955	-478	3020	37	1776	947	-1387	-1942	1093	662	-902	2711	-75	-240
June	-662	955	-398	2459	-437	2930	1257	-575	-282	841	662	-902	1081	762	-1762
July	-662	1225	920	2354	-187	-458	732	12	-172	2857	400	1922	6180	-162	-1940
August	-486	0	-212	2072	-337	290	-283	-37	-122	5318	625	1432	7568	125	1082
September	1131	-162	-648	1834	-337	1382	922	-37	1480	4239	613	560	5575	225	784
October	2558	-162	-418	2366	-337	3102	795	-700	592	6578	-25	628	4260	812	342
November	2118	-1249	-684	734	1014	2390	-242	-500	-1048	3798	-37	98	1577	2588	1682
December	892	1000	-490	0	737	1530	493	-225	-1170	4738	150	-404	422	1263	162
TOTAL	2980	1662	-2408	23408	8852	20236	5888	-6449	-304	26026	4562	-1398	43889	4038	-4842

*Hedging transactions are based upon the buy and sell signals generated by the 3-4-6 (.07), 7w-15-26 (.009) and the 1-3-5w (.09) moving average combinations for feeder cattle, corn, and live cattle, respectively.

[a]Net profits from hedging transactions are reported in dollars per futures contract, including a $50 per round trade commission fee but excluding any interest charge on margin requirements.

these losses are relatively small in each of the other years. Long hedging of corn generated profits in four of the five years. This is encouraging in light of the fact that corn was in a sustained down trend for three of the five years covered in this simulation. Feeder cattle long hedges generated large profits due to the strong bull market that occurred during much of the simulation period. For example, the long hedges reduced the average cost of a 650 pound feeder steer by $57.15 for the cattle marketed in 1979. The largest reduction in average cost for one contract of 64 feeders calculated in the simulation is $118.25 per head.

Table XVII shows a yearly distribution of production margins (per head basis) for Strategy I and Strategy IV. The unhedged strategy produced both the largest and smallest single yearly per head production margin ($149.46 and $0.12) while the fully multiple hedged strategy produced a much less variable yearly production margin. Table XVII also indicates that a complete multiple hedging program decreases profits slightly in very profitable years (1975), but increases profit during periods of very low returns (1976), as compared to the unhedged cash position. These results illustrate that the objectives of this research project were fulfilled. That is, multiple hedging, in this simulation, increased profits and reduced price variability.

A summary of the relevant statistics for each marketing strategy is shown in Table XVIII. The mean production margin per lot of cattle marketed along with the corresponding standard deviation and coefficient of variation is given for each strategy. The per head production margin is also given in Table XVIII.

TABLE XVII

DISTRIBUTION BY YEARS OF THE PRODUCTION MARGIN IN DOLLARS PER HEAD MARKETED, 1975-1979

	1975*	1976	1977	1978	1979	Yearly Average
Strategy I	149.46	0.12	39.75	108.83	75.14	74.66
Strategy IV	147.51	81.54	39.23	141.64	122.64	106.51

*Involves eight lots of cattle being marketed with all other years consisting of 12 lots being marketed.

TABLE XVIII

SUMMARY OF STATISTICS FOR SIMULATED CATTLE FEEDING PRODUCTION MARGINS BY STRATEGIES, 1975-1979*

Marketing Strategy	Mean Production Margin per Lot	Production Margin per Head	Standard Deviation of Production Margin	Coefficient of Variation of Production Margin
Strategy I	13,182	69.38	14,563	1.10
Strategy IIa	13,967	73.51	12,238	.88
Strategy IIb	13,523	97.49	13,556	.73
Strategy IIc	13,559	71.36	14,710	1.08
Strategy IIIa	18,900	99.47	13,644	.72
Strategy IIIb	14,344	75.49	12,820	.89
Strategy IIIc	19,313	101.65	11,640	.60
Strategy IV	19,681	103.58	12,128	.62

*The analysis from 1975 to 1979 includes 56 lots of 190 head of cattle marketed.

One of the major objectives of this study was to attempt to develop a marketing strategy for cattle feeders that would provide price stabilization and increased profit as compared to the traditional cash market method. The results shown in Table XVIII indicate this objective was accomplished.

The fully integrated program of multiple hedging feeder cattle, corn, and slaughter cattle (Strategy IV), as calculated in this simulation, resulted in increased profits and decreased variability. Compared to Strategy I, Strategy IV increased the production margin from $69.38 per head to $103.58, a 49 percent increase. A breakdown of the three commodities indicates that multiple short hedging of live cattle increased the value of the slaughter cattle by $4.13 per head, multiple long hedging of feeder cattle decreased the cost of feeder cattle by $28.11 per head marketed, and multiple long hedging of corn decreased feed costs by $1.98 per head marketed. Using the coefficient of variation as an indicator of variability (price risk), Strategy IV reduced the price variability of the margin between feeder cattle plus corn costs, and the returns of the slaughter cattle by 44 percent.

A close examination of Table XVIII reveals that multiple long hedging of corn requirements increased profits and decreased price variability by a relatively small amount. This table also shows that Strategy IIIc actually has a slightly smaller coefficient of variation figure than Strategy IV. On the surface this may seem as if multiple long hedging of feedgrain requirements have little impact on the profitability and price risk associated with a feeding operation. However, there are several factors that contributed to these results derived by this simulation.

As previously mentioned, corn futures market prices were in a major bear market from late 1974 until late 1977. Thus, multiple long hedging of corn would not be expected to generate much profit during this period of time. A factor affecting the price variability of the production margin associated with corn was that cash corn prices for Oklahoma were available in average monthly price form. This averaging process contributes to the reduced price variability in the cash corn market.

The concept of risk management and the findings of this study can provide one last interesting thought; that is the concept of equating the coefficients of variation (price risk) by altering the number of cattle on feed for the different marketing strategies. Using the results from this simulation the following scenario can be theorized.

A feedlot operator, for example, markets 1,000 head per year through his feedlot. This manager does not utilize any techniques of price risk reducing mechanisms such as forward contracting, hedging, or any other such marketing tools. His operation and he, himself, are able to handle the price risk associated with feeder cattle and corn purchases, and slaughter cattle sales through the cash markets at the given price for that day. Combining the results from this study and the simulation of Strategy I, this marketing practice should logically produce a price risk factor (coefficient of variation) of approximately 1.10. Using this same scenario it is also logical to assume that employing Strategy IV (multiple hedging of feeder cattle, corn, and live cattle) should reduce the price risk factor by approximately 40 percent.

The cattle feeder has two options available to equate this difference in price risk between the unhedged and the fully multiple hedged marketing alternatives. He can either decrease production under Strategy I or increase production using Strategy IV. The first alternative is illogical. Therefore, in this example, the operator could potentially increase production by 40 percent and realize the same amount of price risk that is associated with Strategy I. This analogy assumes that production risk is a constant proportion and does not increase at an increasing rate as production increases.

Summary

This chapter has presented the results of various marketing strategies based upon the feeding simulation used in this study. Strategy I, of complete exposure to price risk, is used to measure the relative effects of the other strategies and to illustrate the effects of complete exposure to price risk. Various other strategies are tested ranging from the unhedged position to an alternative of complete coverage by multiple hedging. Optimized moving average combinations are used to signal when hedges are placed and lifted. Profits as well as the standard deviation and coefficient of variation statistics are calculated. The complete multiple hedging strategy reduced price risk and increased profits by 44 percent and 49 percent respectively. A final concept of equating price risk (coefficient of variation) for the different strategies by increasing or decreasing production levels was examined.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Cattle feeders in the past five years have experienced volatile and sometimes very unfavorable price movements for both inputs and outputs. Whereas in 1970, it was virtually impossible to make a costly marketing mistake because of low price variability, the second half of the 1970's and most likely the 1980's are, and will continue to be, characterized by volatile price movements, thus demanding intelligent marketing decisions. Successful cattle feeders in the 1980's will be decision makers that are able to cope with and successfully manage these volatile adverse price fluctuations.

The theory, concepts, and brief applications of risk management in today's cattle feeding industry were presented. A theoretical model, developed by Ward and Fletcher, was discussed illustrating the hypothetical process by which the best combination of cash and futures positions for a firm could be derived. This was incorporated with examples and the important decision criteria that is involved in deciding how much risk an operation and its manager can handle. Risk was defined as either originating from production or marketing. The three risk management strategies discussed were: (1) production flexibility; (2) forward pricing; and (3) multiple hedging.

The marketing strategy employed by a cattle feeder should be based on his goals or objectives. This study has assumed a primary goal of profit maximization with the reduction of price risk as a secondary goal, but still a very important goal. It was hypothesized that technical price analysis of the feeder cattle, corn, and live cattle futures market would assist the cattle feeder in determining the optimum time to place and life hedges, and as a result this would increase profits and reduce price risk. Multiple hedging employing a technical tool known as moving averages was the device selected for obtaining the objective of a more favorable price and a reduction in price risk.

The parameters for moving averages were optimized by the use of a direct search technique known as the Box Complex Procedure. This procedure optimized the moving average parameters in order to maximize net profits from the trading of futures contracts based on the buy and sell signals generated by the moving average combinations. Problems arising from the search procedure were discussed, however the overall results from the Box Complex Procedure were excellent.

By employing the Box Complex Procedure, optimized moving average parameters were obtained for feeder cattle, corn, and live cattle using actual futures markets price data for selected 1975 through 1979 contracts. The direct search technique derived several moving average combinations for the commodities with approximately equal results. Even though one combination would generate the greatest amount of net profit for a commodity, the choice was not clear cut. In many cases, a slightly less than maximum net profit combination would have a higher percentage of profitable trades or a less variable yearly net profits structure. The moving average combinations selected for the marketing simulations in this research project were 3-4-6 (.07), 7w-15-26 (.009), and the 1-3-5w (.09) for feeder cattle, corn, and live cattle respectively.

The next step for this research project was to take the results from the moving average parameter research and test these optimized technical tools as a device to signal multiple hedging opportunities for feeder cattle, corn, and live cattle against the marketing strategy of complete exposure to price risk (no hedging). A realistic simulation was created such that it would correspond with a continuous feedlot operation in Northwest Oklahoma. Feeder cattle were placed on feed at such a rate so as to insure one lot of cattle (190 head) would be marketed every month. This resulted in 56 lots of cattle being fed and marketed during the simulation. It was assumed that the feedlot would feed and market cattle at the same rate under any marketing strategy, therefore all costs were assumed constant and fixed except for the costs of feeder cattle, corn and the hedging expenses. Therefore, the margin between actualized feeder cattle plus corn costs, and the net return from the sale of the slaughter cattle was calculated and analyzed in this study.

The following marketing strategies were simulated with the margin between feeder cattle, corn costs, and live cattle sales recorded and analyzed. The strategies tested were as follows:

I) No hedging. This strategy of complete exposure to price risk is used as a basis to evaluate the other marketing strategies.

IIa) Strategy of unhedged cash positions of corn and feeder cattle with multiple short hedging of fat cattle.

IIb) Unhedged positions in corn and live cattle with feeder cattle requirements being multiple long hedged.

IIc) Unhedged positions in feeder cattle and live cattle with corn requirements subject to multiple long hedging.

IIIa) Multiple hedging of feeder cattle and corn requirements with an unhedged cash position in live cattle.

IIIb) Multiple hedging of corn and live cattle and unhedged cash position in feeder cattle.

IIIc) Multiple hedging of feeder and live cattle with corn requirements unhedged.

IV) Multiple hedging of both inputs and the output. This is the strategy of maximum "coverage" from adverse price risk.

The simulation results for each strategy were compared by examining the production margin and its graphic interpretation over time, mean, standard deviation, and coefficient of variation. All of the strategies showed an increase in the mean production margin as compared to Strategy I. Multiple long hedging of feeder cattle resulted in the greatest amount of profit and the highest degree of price risk reduction, as measured by the coefficient of variation, for any one of the commodities. Multiple short hedging of live cattle increased the value of the fat cattle marketed even though live cattle were in an upward trending market during much of the time covered in this simulation. Multiple long hedging of corn resulted in reducing the cost of the feedgrain, in light of the fact corn futures were in a downtrending market three of the five years of this simulation. Strategy IV, of complete multiple hedge coverage, increased the production margin by 49 percent of $34.20 per head marketed over Strategy I. This strategy also reduced price risk, as measured by the coefficient of variation, by 44 percent.

The marketing year of 1976 is a very good case in point for the use of the multiple hedging technique based upon optimized moving average combinations. Five of the 12 lots marketed in 1976 under Strategy I resulted in negative values. The mean production margin was only $.12 per head for the entire year. However, by the use of Strategy IV this margin was increased to approximately $80 per head. All of these results clearly indicate that multiple hedging of feeder cattle, corn and live cattle using optimized moving average parameters to generate buy and sell signals can potentially increase profits and reduce risk for a continuous feedlot operation.

Suggestions for Further Research

Several areas of related research appear to be potentially promising. Employing the use of the Box Complex Procedure, alternative criteria could be used as the objective function that is to be maximized or minimized in order to derive optimized moving average parameters. The coefficients of variation (risk) could be minimized or the percent profitable trade figure could be maximized in order to satisfy manager's differing needs.

Alternative technical tools other than moving average combinations need to be programmed for computer use and then tested and optimized. This could lead to examining combinations of different technical tools and then test marketing strategies based upon multiple decision criteria. All of these ideas can be extended to include other agricultural commodities such as soybeans, wheat, hogs, etc.

Further reserach needs to be done in the area of price risk analysis. Large agriculture commodity producing units, as well as most producing units in general, will not be able to withstand the potential adverse price risk associated with the production or transformation of their product. For these firms a portfolio analysis approach might be used to determine an optimal cash and futures mix.

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