A DECISION FRAMEWORK FOR CATTLE FEEDERS

by

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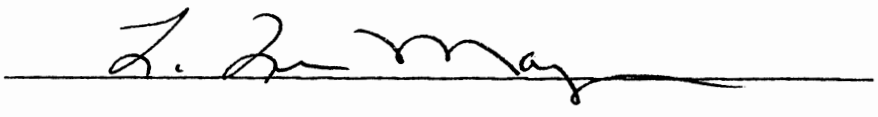
Scope and Method of Study: The purpose of this study was to develop a framework useful to cattle feeders in the buying and marketing process for a specific future feeding period by reducing the uncertainty associated with future live cattle spot prices. The live cattle futures contract was examined to see if it provided the cattle feeder with a means of accomplishing certain managerial objectives. Many authors conclude that utilizing the live cattle futures contract as a hedging mechanism does offer a means of obtaining managerial goals. Bayesian Analysis provided the method of reducing price risk by obtaining additional information. This method was then employed to evaluate five alternative strategies that were available to the cattle feeder.

Findings and Conclusions: The analysis reveals that Bayesian Analysis can reduce price risk involved in the cattle feeder's decision process of buying and marketing cattle by gathering additional information from experts in the cattle feeding industry. It was concluded that no specific strategy would produce the best results every time.

ADVISER'S APPROVAL 

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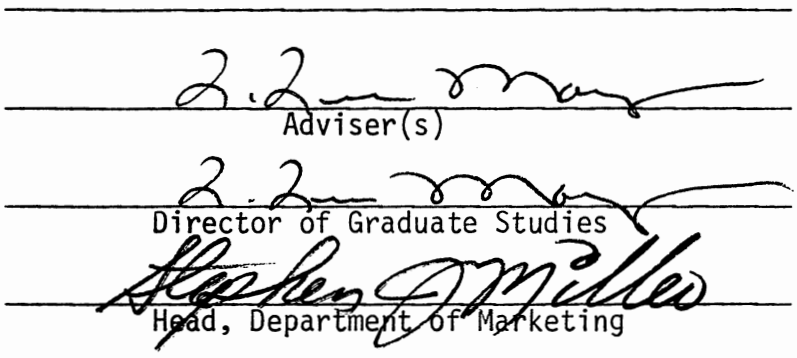

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CHAPTER I

INTRODUCTION

During the past decade the cattle feeding industry has been characterized by unstable prices and a high degree of uncertainty. Cattle feeders can no longer feed their animals with little price risk as they have in the past. Several "outside forces" are responsible for this instability in the fed cattle industry and for the cattle industry as a whole. Although the rapid ups and downs of the economy are probably the underlying cause for this instability, perhaps the most significant outside factor is the rise in the cost of production which has reduced the cattle feeder's profit.

Volatile beef prices and spiraling production costs in the past decade have created a need for the cattle producer to cautiously purchase replacement cattle and market the finished animal in an efficient manner. In the past this was an easier task due to less price fluctuation in the cattle market. The price of 600 pound feeder steers would be a good example of this price volatility. Within a year the price of this animal has ranged from $312 to $566 per head. This range of $114 spanned only a twelve month period; and within a five year period producers of not only feeders but of all beef cattle incurred losses never before experienced in the history of the cattle industry. During this period profits were cut severely and many beef

producers were forced out of the cattle business but the biggest losses were due to the reduction of inventory value. From January 1, 1974 to January 1, 1975, the farm value of cattle dropped by almost a billion dollars (51.5 percent) even though there was an increase (7.9 percent) in cattle numbers (1).

It is evident that the cattle industry in the last decade has been a "feast or famine" proposition. The cattle producers who have carried the risk at the right time have made considerable profits, however, those who were caught by a sharp unexpected change in price, with no protection from adverse effects, were crippled financially.

With a highly leveraged operation, it is easy to conceive situations where strong price reversals, along with spiraling production costs, could wipe-out a thinly financed cattle feeder. Producers who have learned to take advantage of marketing tools that the future market offers, can minimize this price risk by formulating certain hedging strategies to market their cattle. Hedging is consistently practiced by cattle producers to reduce risk associated with unfavorable price fluctuations or to achieve a specific management goal.

Statement of the Problem

The average Oklahoma cattle feeder will place a 600 to 700 pound feeder steer in the feedlot with the intention of marketing a 1,000 to 1,100 pound slaughter steer approximately three months later. A majority of the decisions that must be made concerning the livestock are clouded by the uncertainty of future slaughter cattle prices.

Buying feeder steers to place in the feedlot is the first decision that is based upon the cattle feeder's expectations of future fed

cattle prices. If feeding cattle is believed to be a profitable venture, then alternative hedging strategies made available by the futures market can aid the cattle feeder in reducing price risk, however, the selection of the appropriate strategy is essential in providing desirable results. The uncertainty associated with cattle prices makes this task very difficult.

Objectives

This study is an attempt to develop a framework useful to cattle feeders in the buying and marketing process for a specific future period by reducing the uncertainty associated with future live cattle spot prices. To accomplish this overall objective, the following goals will be pursued.

1. To examine the live cattle futures contract and the alternative heding strategies that it offers which can be developed to provide the cattle feeder with a means of accomplishing certain managerial objectives as minimizing price risk and improving profit potential.
2. To demonstrate how Bayesian Analysis can be employed to improve the cattle feeder's decision process of buying and marketing cattle under uncertain conditions.

Chapter II is a review of the literature on alternative hedging strategies that are available to the cattle feeder through the futures market. This chapter provides information concerning the different types of hedging tools and lays the foundation that is essential in understanding how these tools operate. Studies concerning the application of alternative hedging strategies and Bayesian Analysis are also

discussed. Chapter III further investigates Bayesian Analysis and discusses the procedures used in this study. Chapter IV is the analysis and results of a simulated future feeding period which utilizes the Bayesian approach to aid the decision maker in the buying and marketing process. Chapter V provides the summary and conclusions of the study.

CHAPTER II

LITERATURE REVIEW

In order to review the literature relevant to this study, five categories must be examined: (1) historical background of the live cattle futures contract, (2) basic hedging fundamentals, (3) alternative hedging strategies, (4) literature evaluating alternative hedging strategies, and (5) studies employing Bayesian Analysis. A large portion of this chapter will concentrate on the live cattle futures market, which provides the foundation for hedging cattle.

Historical Background of the Live Cattle Futres Contract

Futures markets for live cattle began in 1964 on the Chicago Mercantile Exchange. Cattle feeders looked to the futures market as a means of protecting their operations from the ever increasing risks associated with price fluctuations in the market. Speculators viewed the highly volatile prices as exceptional opportunities to make profits from wise futures trades. The live cattle futures market enabled the speculator to assume the risks that cattle feeders were trying to avoid (10).

Since its inception in 1964, many skeptics have questioned the live cattle future contract's ability to provide the potential hedging mechanism that cattle feeders were seeking.

Skadberg and Futrell (27) argue that live cattle and the cattle market have several characteristics that appear to be basically different from those of commodities traditionally traded with success in futures markets. The authors cite: (1) the non-storable nature of livestock, and (2) the lack of any stable seasonal price pattern as reasons for not offering significant hedging or pricing potential. However, Purcell (24) points out that the negative attitudes toward trade in the futures market rest primarily with a segment of producers.

Many authors (9, 7, 21, 26) discuss the role of live cattle futures contracts in a risk management framework. However, Working (32) argues that hedging is not necessarily done for the sake of risk reduction.

Ikerd (13) suggests two basic reasons why cattle producers may hedge their cattle: (1) to receive a higher price and (2) to reduce price risk. The author notes that the producer with the objective of receiving a higher price for his cattle will not hedge unless the futures market price exceeds his cash market expectations. The cattle feeder with the objective of reducing price risk has a much greater chance of achieving his goal by using the futures market.

Purcell (24) argues that most price analysts, marketing economists and cattle producers feel the live cattle futures market can be an effective tool in the hands of the well-informed decision maker. The author suggests there is economic justification for trade in the futures market since it: (1) provides a hedging mechanism which gives the cattle feeder the opportunity to reduce exposure to the risk of price fluctuation and (2) is a factor in the price discovery process.

After a rather modest beginning in the early 1960's, the live cattle futures trading grew rapidly during the early 1970's. The highly variable prices of the 70's greatly increased trading interest of cattle feeders and professional speculators alike (13).

Basic Hedging Fundamentals

To the cattle feeder, hedging fed cattle is the act of selling a live cattle contract while at the same time placing on feed cattle that will be ready for market near the maturity month for the futures contract. Later, when the producer is ready to sell his cattle, he typically will buy futures contracts to offset his previous sale, thus nullifying the futures delivery commitment. He then sells his cattle at his local market (14). It is possible, though usually neither practical or necessary, to deliver the cattle to fulfill the futures contract rather than to buy contracts to offset the previous sale.

A basic understanding of the live cattle futures trade is essential to the cattle feeder in developing effective hedging strategies which will act as risk management tools. Literature related to important basic characteristics of the live cattle futures market and the process of hedging will now be discussed.

The Futures Contracts

A futures contract is a legal obligation to deliver or accept delivery of a specified product. The live beef cattle contract involves 40,000 pounds of choice live beef. When futures contracts are bought and sold it is an obligation, not the transfer of a physical commodity, which is being bought and sold. Since commitments are the

things traded, it is possible to "sell" a contract before buying one (15).

The standardization of the contract encourages the needed volume to insure highly competitive markets and also makes it possible to fulfill an obligation by making an offsetting transaction.

Basis

Cox (4) refers to the "basis" relationship of futures to their cash market as one of the most important fundamentals of the heding process. Basis is defined by Purcell (24) as the difference between the futures price and the cash price at any particular point in time. When applied to livestock futures the basis refers primarily to time and quality differentials plus the transportation costs between the cash and futures markets during the life of the contract (15).

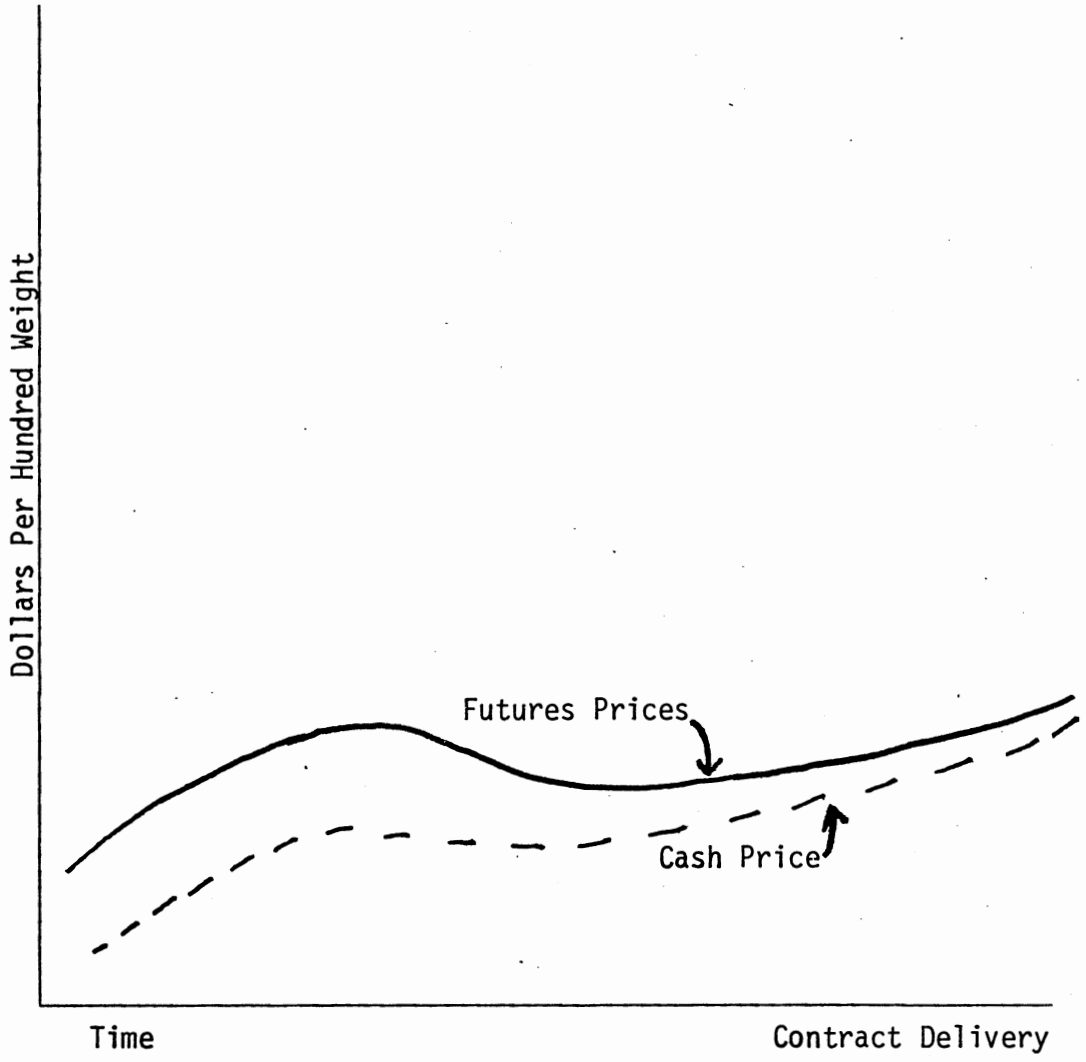
The basis is used to adjust the futures price to represent the quality, location and time applicable to the sale of the hedger's cattle to the local market. Ikerd (9) refers to this adjustment as localizing the futures price and this process determines what price the futures market is offering for cattle. Therefore, to effectively utilize the futures market to hedge fed cattle, the basis must be accurately calculated. Historic price relationships between local cash price and the futures price or actual costs to deliver the cattle to the delivery point designated in the futures contract are two methods of determining the basis for local market (15). If the actual basis varies from the calculated basis then the net effect of the hedge will deviate above or below the expected results.

The hedging process works because as the maturity date of the contract approaches, the cash and the futures price will tend to converge as shown in Figure 2-1. There are basic economic forces which tend to force convergence of the cash and futures markets. The threat of delivery under the futures contract provides one of these forces. Delivery of the cattle under the futures contract would take them out of the cash market where they would have normally been sold. This would decrease the supply of cattle in the local cash market which would provide impetus toward a higher cash price than would otherwise prevail. Since the feeder is delivering the cattle in the futures market, he will not offset this position by buying a futures contract. This will decrease the demand for the futures contract, causing the price to fall (24). These economic forces work to insure the two markets will move toward convergence.

Another set of forces is generated if the futures price would happen to settle above or below the cash price by more than the cost of delivery at maturity. If the futures price was lower than the cash price at maturity, then the trader would buy a futures contract, accept delivery, and sell the cattle in the higher cash market for a profit. If the futures price was higher than the cash price, it would be profitable to buy the cattle in the cash market and deliver them through the futures market. The profit potential from such actions would tend to push the two markets closer together (12).

Hedging Mechanics

The previous discussion which focused on basis and the forces pressuring it to decrease toward zero provides the foundation for the



Source: Gary Mennem and Wayne Purcell, "Hedging of Fed Beef Cattle," OSU Extension Facts No. 420.

Note: The basis should reflect carrying costs at any point in time.

Figure 2-1. Illustration of Cash Price and Futures Price Converging as Futures Contract Reaches Maturity

hedging mechanism.

Ikerd (10) notes that once the hedge has been placed, it is the basis rather than actual price levels which determines the realized hedge price. If the producer is able to get a cash price higher relative to his futures price (a more favorable basis) at the time he offsets the hedge, he will receive a higher net result from the hedge regardless of whether prices are higher or lower than expected. On the other hand, if the basis is greater than expected, then the net result of the hedge will be lower than expected.

Purcell (24) views the lock-in margin as another key component of a hedge. The lock-in margin is the difference between the break-even price and the price at which futures are sold minus any adjustments for the costs of delivery and hedging. This margin is actually the amount which can be guaranteed by hedging. The break-even price would include such costs as the price paid for the feeder steer, the costs of feed, interest, and other expenses incurred during the period the producer holds the cattle, and is the price required to break-even on the cattle.

The concepts discussed above play an important role in the hedge that will be demonstrated in the following example.

The cattle feeder in this example purchases 36 choice feeder steers and places them on feed November 1 and expects them to be ready to market on April 1. At that time each steer will weigh approximately 1,100 pounds bringing the total weight of the 36 steers to approximately 40,000 pounds which is equivalent to one live cattle futures contract. The producer estimates the break-even price on his steers to be $70 per cwt. On November 1 he decides to hedge his cattle with an April

futures contract which was then selling for $74. He estimates his hedging costs to be $.25 per cwt and the estimated basis is $1.50 per cwt. By subtracting the hedging costs and basis from the April futures price, he obtains a localized, realized futures price of $72.25 per cwt ($74-$1.75). The hedge will be completed at the end of the feeding period at which time the feeder will buy back an April contract at the quoted price on April 1 and sell his slaughter cattle on the cash market. By hedging his cattle he can "lock-in" a profit of $2.25 if the estimated basis is correct as shown in Figure 2-2. The first hedge (1) illustrates the protection the futures market offers in a downward market and the second hedge and (2) shows the forgone profits during a rising market. Alternative hedging strategies to help avoid this will be discussed later.

The hedging example in Figure 2-2 illustrates that regardless of price movements the feeder will receive the same price for his hedged cattle if his basis estimate is correct. Purcell (24) points out that there is a possibility of the two markets not converging by more than delivery costs at maturity and this is referred to as "basis risk."

Conceptually, the hedger trades the large risk associated with the unpredictability of the cash market price for the much smaller risk associated with a more predictable basis (10).

Alternative Hedging Strategies

In the hedging example which was illustrated in Figure 2-2 it is evident that opportunity costs are associated with hedging during an "up" market. Purcell (22) notes that the feeder can become disenchanted with the performance of a hedge if cash price does in fact rise since it takes away the windfall gain from a rising cash market just as it protects against a falling cash market.

Date	Cash Market	Futures Market	Basis
Nov. 1	Break-even at $70 cwt	Sell April Futures Contract for $74	Expected $1.50
(1) April 1	Sell 40,000 lbs. of fed beef at $68 cwt.	Buy 40,000 lbs. of live beef for $69.50	Realized $1.50
	Cash Loss $2	Futures Profit $4.50	
	Hedging Results:	Cash Price	$68.00
		Less Hedging Costs	(.25)
		Plus Futures Profit	4.50
		Realized Price	$72.25
		Less Break-even	(70.00)
		Lock-in Margin	$ 2.25
(2) April 1	Sell 40,000 lbs. of fed beef at $74	Buy 40,000 lbs. of live beef for $75.50	Realized $1.50
	Cash Profit $4	Futures Loss $1.50	
	Hedging Results:	Cash Price	$74.00
		Less Hedging Costs	(.25)
		Plus Futures Loss	(1.50)
		Realized Price	$72.25
		Less Break-even	70.00
		Lock-in Margin	$ 2.25

Figure 2-2. The Effects of Hedging in an Upward and Downward Trending Market

Basically, hedging programs are utilized to offer protection against unfavorable cash price fluctuations. However, each cattle feeder needs to consider how much protection is needed. He should determine his managerial and financial capacity to handle risk.

Purcell (24) concludes that the choice of a particular hedging strategy will depend upon:

1. The financial position of the individual,
2. The ability to manage risk,
3. The personal orientation of the manager toward accepting risk.

Several authors (1, 8, 22, 26) examine alternative hedging strategies. All of these various strategies can be classified into two basic categories: (1) the hedge and hold approach, which is referred to by some authors as forward pricing and (2) selective hedging which is also referred to as multiple hedging or a place and lift strategy (9, 24). The basic features of these two types of hedging will now be discussed.

The Hedge and Hold Approach

This hedging strategy is a rather simple procedure in which the cattle feeder will make only one hedging decision on each group of cattle that he hedges (9). This method of hedging would involve selling a futures contract at an acceptable price and holding the futures position until the cattle are sold in a cash market. This approach is especially appealing to the cattle feeder whose financial position or personal orientation cannot tolerate much risk of unfavorable price movements (24).

Selective Hedging

The main objective of this hedging strategy is to offer protection against the risk of downward prices and still allow all or a substantial part of the benefits of a rising cash market (25).

Selective hedging means that a given group of cattle are hedged more than once during the period they are on feed. The hedge may be placed and lifted many times from the time the initial hedge is placed until the time of delivery (9). If a producer lifts a hedge, he should realize that this returns him to a speculative cash position in that his cattle are no longer priced. If the original objective was solely to reduce price risk, then it is not in the producers best interest to lift his hedge since the cattle feeder's risk position is basically the same as it was when the initial hedge was placed. The only difference is associated with the increasing certainty of cash market prices as the delivery date approaches. However, the producer with the objective of receiving a higher price might expect he could possibly do so by lifting a hedge under the proper conditions and redhedging at a later date (11).

Purcell (23) indicates that producers using selective hedging strategies usually will attempt to place hedges when he has a reason to believe that the market will be declining and lifts the hedge in an expected rising market. How effective this approach will be depends on the criteria used in placing and lifting hedges.

Technical analysis of market trends might be considered practically essential for the cattle feeder who utilizes selected hedging. The basic use of technical analysis is to assist the hedger to avoid placing

hedges unless there is some indication of a downward trend in the market (13). Technical tools such as moving averages, point and figure analysis, and bar charts are used to help predict reversals in the market so the cattle feeder using a selective hedging strategy will know when to place and lift a hedge. The manager employing the controlled placement strategy will also utilize technical tools. Many authors (6, 13, 21, 28) discuss in detail the various technical tools and their benefit to producers employing selective hedging strategies.

Literature Evaluating Alternative Hedging Strategies

Several studies have evaluated the effects of alternative hedging strategies. Hague (8) tested several hedging strategies which were applied to a simulated cattle feeding operation in the Southern Plains feeding area. The results were generated in terms of net returns per head. This study indicated that hedging strategies can be developed which, if applied selectively based on the market situation, can decrease the risk confronting the cattle feeder without costly decreases in the mean level of net returns.

Riffe (26) evaluated various hedging strategies which were designed to reduce the severity of cash deficits and to minimize periods of technical insolvency in cattle feeding operations. The strategies were found to improve financial positions of cattle feeders by reducing the severity of deficits and by effecting a redistribution so that fewer deficit periods are observed consecutively.

In a study dealing with feeder cattle, Brown (1) uses price prediction models and technical tools to test alternative hedging strategies. The simulated results of the various strategies suggested that any of the hedging programs produced better results than not hedging. The author points out that the financial situation of the cattle feeder is important in selecting a hedging strategy.

Studies Employing Bayesian Analysis

Bayesian Analysis is a decision theory methodology that is useful in aiding a decision maker under uncertain conditions. A more detailed explanation follows in Chapter III.

The Bayesian Approach has been utilized in the Agricultural sector to aid managers in the decision process. Bullock and Logan (2) employed Bayesian Analysis to develop a framework to aid the cattle feeder in the decision of whether he should market a particular lot of cattle at their current weight or to continue feeding them. The statistical decision theory utilized in the study combined information about the historical pattern of month-to-month price changes with information provided by a price forecasting equation to develop feed or sell decision criteria.

In another study Eidman, Dean and Carter (5) applied Bayesian decision theory to management decisions under uncertainty. The decision theory provided the framework for which turkey producers could select between contract and independent production. The optimal action was first determined where only prior probabilities of the states of nature were available. This result was compared to results after the

posterior analysis was conducted. The value of the additional informational information obtained in the posterior analysis was found to be substantial.

CHAPTER III

METHOD AND PROCEDURE

The marketing strategies previously discussed are helpful in protecting the cattle feeder from price fluctuations but selecting the right strategy is difficult due to the uncertainty associated with the cattle market. Bayesian Analysis provides a framework that could be valuable to a decision maker who must deal with the uncertain and volatile cattle market.

The Bayesian Approach

Bayesian Analysis is useful in situations where the decision maker has several alternative courses of action, but is also faced with an uncertain future set of possible events. These characteristics make the Bayesian approach a prime candidate to aid the cattle feeder who can utilize various marketing tools to market his cattle in a highly uncertain future market.

The Bayesian approach to the decision problem provides a logical framework for working with alternative courses of action. Subjective or Bayesian probabilities for the future possible events or states of nature are used. These probabilities are based on the knowledge, experience, and judgement of the decision maker. In order to arrive at the best decision that is possible the decision maker may often want to obtain additional current information about the probabilities of

occurrence associated with the alternative states of nature (29). Bayesian Analysis provides a method of bringing in the new information to revise the initial probabilities (3).

Bayesian Analysis has come into prominence in decision making due to the lack of reliable objective information. Additionally, the subjectively oriented decision maker feels that it is very important for him to interject personal preferences or feelings into the decision making process (29). Thus, the Bayesian approach to decision making allows the knowledge, judgement, and experience of the decision maker to be used. It takes what the decision maker knows, as expressed in the prior probabilities, and adjusts it to facilitate the additional current information. In order to clarify this decision model, a step by step example follows.

The Bayesian Framework

Step 1: Define alternative courses of action (strategies) and alternative states of nature (possible events).

The first step of the Bayesian approach for a given problem situation should include all the possible alternatives the decision maker has and then narrow these strategies to a reasonable number. For this example, let's assume a farmer is faced with the decision of whether or not to plant a particular crop, thus his strategies would simply be:

S_1: Plant Crop S_2: Do Not Plant

The states of nature or future possible events must now be considered. The states of nature are not under the control of the

decision maker and there is generally a great deal of uncertainty associated with their occurrence. The future price expectations for the farmer's crop at harvest will be the states of nature in this example. Based on the farmer's knowledge and past experience, together with his consideration of the impact of economic forces relating to his crop, he lists the following expected future prices per bushel, thus giving the alternative states of nature.

$$N_1 = \$4.50 \qquad N_2 = \$5.00 \qquad N_3 = \$5.50$$

Step 2: Assign the prior probabilities to the states of nature.

In this step the farmer will assign probabilities to the states of nature based on his knowledge and experience. He will also utilize market outlook material to assign these prior probabilities which must add to 1.

$$P(N_1) = .2 \qquad P(N_2) = .5 \qquad P(N_3) = .3$$

Step 3: Construct a payoff table.

This step in the analysis involves the specification of the outcomes resulting from selecting a certain strategy and then having a particular state of nature occur. This interaction is usually referred to as the payoff for the strategy - state of nature combination. These estimates are presented in the form of a payoff table as shown in Figure 3-1. The body of the table shows the payoffs of the various S_iN_j alternatives. The table value for combination S_1N_3 is calculated as follows:

Table Value = Expected Price per bushel - Break-even Price per bushel.

Strategies	States of Nature		
	N_1 \$4.50 (.2)	N_2 \$5.00 (.5)	N_3 \$5.50 (.3)
S_1: Plant	-\$.10	\$.40	\$.90
S_2: Do Not Plant	0	0	0

Figure 3-1. Payoff Table for Decision to Plant Crop

Table Value = \$5.50 - \$4.60

= \$ .90

By taking expected values of the two strategies the expected payoff per bushel can be calculated in the following manner:

$$E(S_i) = \sum_{i=1}^{n} (S_i/N_j)\, P(N_j)$$

$$E(S_1) = (-\$.10)\ (.2) + (\$.40)\ (.5) + (\$.90)\ (.3)$$

$$= (-.02) + (.2) + (.27)$$

$$= \$.45$$

Therefore, the prior analysis would indicate a \$.45 per bushel expected payoff if the farmer planted a crop as S_1 indicates.

Step 4: Select a strategy or delay the decision and conduct a posterior analysis.

If the farmer is not satisfied with the information that the prior analysis is based upon, he will move into what is called the posterior analysis of the Bayesian approach. In this step of the analysis it will be necessary to gather additional current information which can be obtained from a survey or interview with experts in the area. However, before gathering this information the farmer will determine the possible results the information will provide and the reliability of this information. He will then assign probabilities according to his judged reliability of the expert's predictions. The possible results that the farmer will gather from the interview of ten experts will relate to the states of nature as follows:

Z_1 = Less than 3 of the 10 experts expect a poor crop yield, thus indicating an abundant supply and low prices at harvest suggesting N_1 will be the state of nature.

Z_2 = From 4 to 6 of the experts expect a poor crop yield, thus indicating a below average supply and an above average price at harvest suggesting N_2 will be the state of nature.

Z_3 = More than 6 of the experts expect a poor crop yeild, thus indicating a rather low supply and fairly high prices at harvest suggesting N_3 will be the state of nature.

Before conducting the interviews, the decision maker must rate the past performance of the expert's expectations to assign a reliability factor to their predictions. The farmer in this example assigns a 75 percent reliability factor which indicates that he believes the experts are correct 75 percent of the time. He then assigns this reliability factor in terms of probabilities as follows:

$$P(Z_1/N_1) = .75$$

$$P(Z_2/N_2) = .75$$

$$P(Z_3/N_3) = .75$$

The expression $P(Z_1/N_1) = .75$ is a conditional probability and is read "the probability of observing a Z_1 result, given that N_1 is the true state of nature, is .75."

Now the farmer must assign a probability to make up for the "error component" which represents the 25 percent that the experts are not correct. For example, what is the probability of observing Z_2 given N_3 is the true state of nature? Logic and rationale must be exercised when assigning these probabilities. The farmer will assign these conditional probabilities in the following manner:

$P(Z_1/N_1) = .75$ $\quad$ $P(Z_2/N_1) = .125$ $\quad$ $P(Z_3/N_1) = .10$

$P(Z_1/N_2) = .15$ $\quad$ $P(Z_2/N_2) = .75$ $\quad$ $P(Z_3/N_2) = .15$

$P(Z_1/N_3) = .10 \qquad P(Z_2/N_3) = .125 \qquad P(Z_3/N_3) = .75$

The farmer logically assigned the remaining probabilities. It appears perfectly logical that ($P(Z_1/N_2)$ should be greater than $P(Z_1/N_3)$ since Z_1 indicates an abundant supply thus lower prices. The reverse is true for Z_3 as a result. If Z_2 was the result, however, it would seem logical that equal probabilities should be given for N_1 and N_3 to occur.

It is now possible to calculate the posterior probabilities involving the results from the prior and posterior analysis. Through these calculations, which are based on Bayesian statistics, the farmer will end up with the desired probability that Bayesian Analysis provides. This is the probability of a state of nature occurring given a result and is expressed as $P(N_i/Z_j)$. In order to arrive at this result, the probabilities of each Z_i result must be calculated.

$$P(Z_i) = \sum_{i=1}^{n} P(N_i)\, P(Z_j/N_i)$$

$$P(Z_1) = \sum_{i=1}^{3} P(N_i)\, P(Z_1/N_i)$$

$$= (.2)\ (.75) + (.5)\ (.15) + (.3)\ (.1)$$

$$= .15 + .075 + .03$$

$$= .25$$

$$P(Z_2) = \sum_{i=1}^{3} P(N_i)\, P(Z_2/N_i)$$

$$= (.2)\ (.125) + (.5)\ (.75) + (.3)\ (.125)$$

$$= .025 + .375 + .0375$$

$$= .43$$

$$P(Z_3) = \sum_{i=1}^{3} P(N_i)\, P(Z_3/N_i)$$

$$= (.2)\ (.1) + (.5)\ (.15) + (.3)\ (.75)$$

$$= .02 + .075 + .225$$

$$= .32$$

After making these calculations, assume the farmer surveys the experts' opinions and observes Z_2 as the result. He will now calculate the posterior probabilities, given the Z_2 result in the following manner.

$$P(N_1/Z_2) = \frac{P(N_1)\, P(Z_2/N_1)}{\sum_{i=1}^{3} P(N_i)\, P(Z_2/N_i)}$$

$$= \frac{(.2)\ (.125)}{.43}$$

$$= .05$$

$$P(N_2/Z_2) = \frac{P(N_2)\, P(Z_2/N_2)}{\sum_{i=1}^{3} P(N_i)\, P(Z_2/N_i)}$$

$$= \frac{(.5)\ (.75)}{.43}$$

$$= .87$$

$$P(N_3/Z_2) = \frac{P(N_3)\, P(Z_2/N_3)}{\sum_{i=1}^{3} P(N_i)\, P(Z_2/N_i)}$$

$$= \frac{(.3)\ (.125)}{.43}$$

$$= .08$$

From these calculations, the posterior probabilities are:

$P(N_1) = .05$ $\quad P(N_2) = .87$ $\quad P(N_3) = .08$

A revised payoff table can now be constructed with the new posterior probabilities as shown in Figure 3-2. The prior probabilities are not ignored in the new probabilities since they, along with the probabilities relating the states of nature with survey outcomes, make up the numerator in the calculation formula for the posterior probabilities. In essence, the prior probabilities are weighted by the new evidence.

Evaluating the payoff table in Figure 3-2 produces these results:

$$E(S_1) = (-\$.10)\ (.05) + (\$.40)\ (.87) + (\$.90)\ (.08)$$

$$= (-\$.005) + (\$.348) + (\$.072)$$

$$= \$.415$$

$$E(S_1) = \$0$$

Thus, the posterior analysis indicates an expected profit of $.415 per bushel if the farmer decided to plant his crop.

Bayesian Analysis, as shown in this example, provides a method of improving the decision process for managers under uncertain conditions, by using additional information.

Procedure

To establish a framework that would be useful to cattle feeders in the buying and marketing process, a 140 day feeding period will be simulated. Five strategies will represent the alternative courses of action the cattle feeder has to select from as they are described below.

Strategy I

This strategy will be referred to as the no hedge strategy. In this situation the cattle feeder will simply purchase feeder steers for

Strategies	States of Nature		
	N_1	N_2	N_3
	\$4.50 (.05)	\$5.00 (.87)	\$5.50 (.08)
S_1: Plant Crop	-\$.10	\$.40	\$.90
S_2: Do Not Plant Crop	0	0	0

Figure 3-2. Revised Payoff Table

the purpose of selling them as slaughter cattle.

Strategy II

The second strategy is the hedge and hold approach. The day the feeder steers are purchased a hedge will be placed and held until the cattle are sold in the cash market.

Strategy III

This strategy will employ managerial discretion as to when the hedge will be placed. The hedge is placed when the point and figure chart signals a downward trend in the live cattle futures price for the appropriate month and is held until the cash position is liquidated.

Strategy IV

The place and lift or selective hedging strategy will also utilize the point and figure chart to place and life hedges according to reversing market trends. It is possible to hedge one group of cattle several times with this approach.

The states of nature in the simulation will be the possible prices for January live cattle prices, which will be 140 days in the future as the feeding period starts August 14. Assumptions will be made regarding production costs and similar factors.

Strategy V

This strategy is available to the cattle feeder who believes that a desirable profit cannot be obtained by feeding cattle. Here, he will simply not purchase the steers.

Collection of Data

Information concerning expected live cattle prices for January will be essential to assign values to the alternative states of nature and to the prior probabilities. Such information will be obtained from market outlook publications, January quotes for live cattle under "Futures Prices" in the Wall Street Journal and from the judgement and experience of the decision maker. The additional information used in the posterior analysis of the Bayesian approach will be obtained through personal and telephone interviews with ten experts in the cattle feeding industry.

CHAPTER IV

ANALYSIS AND RESULTS

Demonstrating the usefulness of Bayesian Analysis in improving the cattle feeder's decision process of buying and marketing cattle under uncertain conditions is the primary purpose of this chapter. In order to accomplish this objective a simulated marketing situation will be employed.

The Situation

For the purpose of this analysis, the assumptions and data utilized must be defined. The information used was current for August 15, 1980.

First, it is assumed the decision maker or cattle feeder in this case is faced with the uncertainty of future prices. He possesses a sound knowledge of hedging and is an experienced cattle feeder. Before an appropriate marketing strategy is to be selected, the decision must be made as to whether or not the feeder steers will be purchased to place on feed. This decision will be made only after the simulation has been completed and selected marketing strategies evaluated.

To perform the analysis, it is assumed that 109 feeder steers weighing 700 pounds per head can be purchased at the Oklahoma City Stockyards. The cattle would be purchased through an order buyer at a

price of 74¢ per pound. These steers will then be placed in a feedlot in Sublette, Kansas on August 15, 1980, the same day of the purchase. The cattle will remain on feed 140 days and will gain 3 pounds per day at a cost of 57¢ per pound. Thus, the steers would be marketed as slaughter cattle on January 2, each weighing approximately 1,100 pounds. Assuming no death loss, the total weight of the steers would be approximately 120,000 pounds, which is equivalent to three live cattle futures contracts.

The delivery costs from Oklahoma City to the feedlot will be $1.00 per cwt. and the capital needed to finance the operation would be borrowed at 14 percent interest. The commission fee to buy the cattle will be 35¢ per cwt. In this case it is assumed there will be no costs for selling the slaughter cattle.

Break-Even Price

Given the preceding data, a break-even price can be calculated for these steers. This price will play a big role in evaluating the various strategies available to the cattle producer.

Break-even price per head = Cost to Purchase + Cost of Gain + Delivery Cost + Commission Fee + Interest Expense.

Break-even price per head = (Purchase Price x Purchase Weight) + Cost per lb. of Gain x (Slaughter Weight - Purchase Weight) + Cost per cwt. Delivered (700/100) + Commission Fee per cwt. (700/100) + Interest Expense.

Break-even price per head = ($.74 per lb.) (700) + $.57 (1100 lbs. - 700 lbs.) + $1 (7) + $.35 (7) + ($.74) (700) + $.57 (1100 - 700) + $1 (7) + $.35 (7) x .14 x 140/360.

= $518 + $228 + $7 + $2.45 + $41.13

= $796.58

The break-even price per cwt. can now be calculated.

$$\text{Break-even price per cwt.} = \frac{\$796.58}{(1100/100)}$$

$$= \frac{\$796.58}{11}$$

$$= \$72.42$$

This would indicate that these steers would have to be sold as fed cattle at $72.42 per cwt. (72.42 cents per lb.) to recover the total costs involved to feed the cattle.

The Decision Model

Bayesian Analysis will be utilized as the decision model for the purpose of providing more certain price expectations for live cattle on January 2. This information will be helpful for the cattle feeder who must decide if feeding cattle for the period between August 15 and January 2 is profitable and if so, which marketing strategy would give the most desirable results. The four step Bayesian approach outlined in Chapter III will provide the method of analysis for the buying decision and the selected marketing strategies.

Analysis

Step 1: Define alternative courses of action and alternative states of nature.

Alternative Courses of Action

Five alternative courses of action or strategies will be at the cattle feeder's disposal. One of the strategies consists of complete

exposure to price risk in the cash market throughout the feeding period with no futres market involvement. Three of the five strategies are marketing strategies that utilize the futures market for the purpose of hedging as described in earlier chapters. The last strategy is a simple "do not produce" strategy which is always available to the cattle feeder if desired profits are not expected. These alternative strategies are shown below:

S_1: No Hedge

S_2: Hedge and Hold

S_3: Controlled Placement of the Hedge

S_4: Place and Lift (Selective Hedging)

S_5: Do Not Produce

Strategy I (S_1)

The first strategy is the no hedge approach which is completely exposed to price risk. However, this strategy produces desirable results in a rising cash market.

Strategy II (S_2)

This strategy's objective is to provide complete price risk protection. All of the cattle are hedged the day the cattle are placed on feed and then the hedge is removed at the end of the feeding period when the cattle are sold, by purchasing the same number of futures contracts that were originally sold. The hedge and hold approach provides the financially weak producer with the assurance of "locking in" his profits the day the steers are placed on feed. The

S_2 strategy is most desirable in a falling market. The returns lost in the down trending cash market are made up by buying the futures contracts for much less than they were sold. On the other hand, any "windfall profits" that would occur from a rising cash market would be foregone with this strategy.

Strategy III (S_3)

This strategy is a simple variation of S_2. Technical tools (point and figure charting) are employed with the purpose of taking advantage of a rising market by placing the hedge at a higher futures price than could have been received as quoted on the first day of the feeding period. The hedge is then held until the cattle are sold. This strategy will keep the cattle unhedged if the prices are trending upward at the first of the feeding period and a hedge will be placed when the point and figure chart indicates a reversal signal which is explained below. If prices are in a downward trend when the cattle are purchased, then the strategy will correspond to S_2.

The point and figure chart will require a 3-box reversal number with 20¢ box sizes as illustrated in Figure 4-1. Point and figure charts are constructed to show the direction of price change. Rising price fluctuations are represented by x's and downward trends are represented by o's. Reversing trends are signaled by price changes equal to some specified number of "boxes." In this situation, a 3-box reversal is required. Whenever a reversing trend is signaled, the next group of x's or o's is plotted one column to the right. In Figure 4-1 a buy signal occurs at $71.60 per cwt. and a sell signal is generated at $72.00 per cwt. at a later point in time.

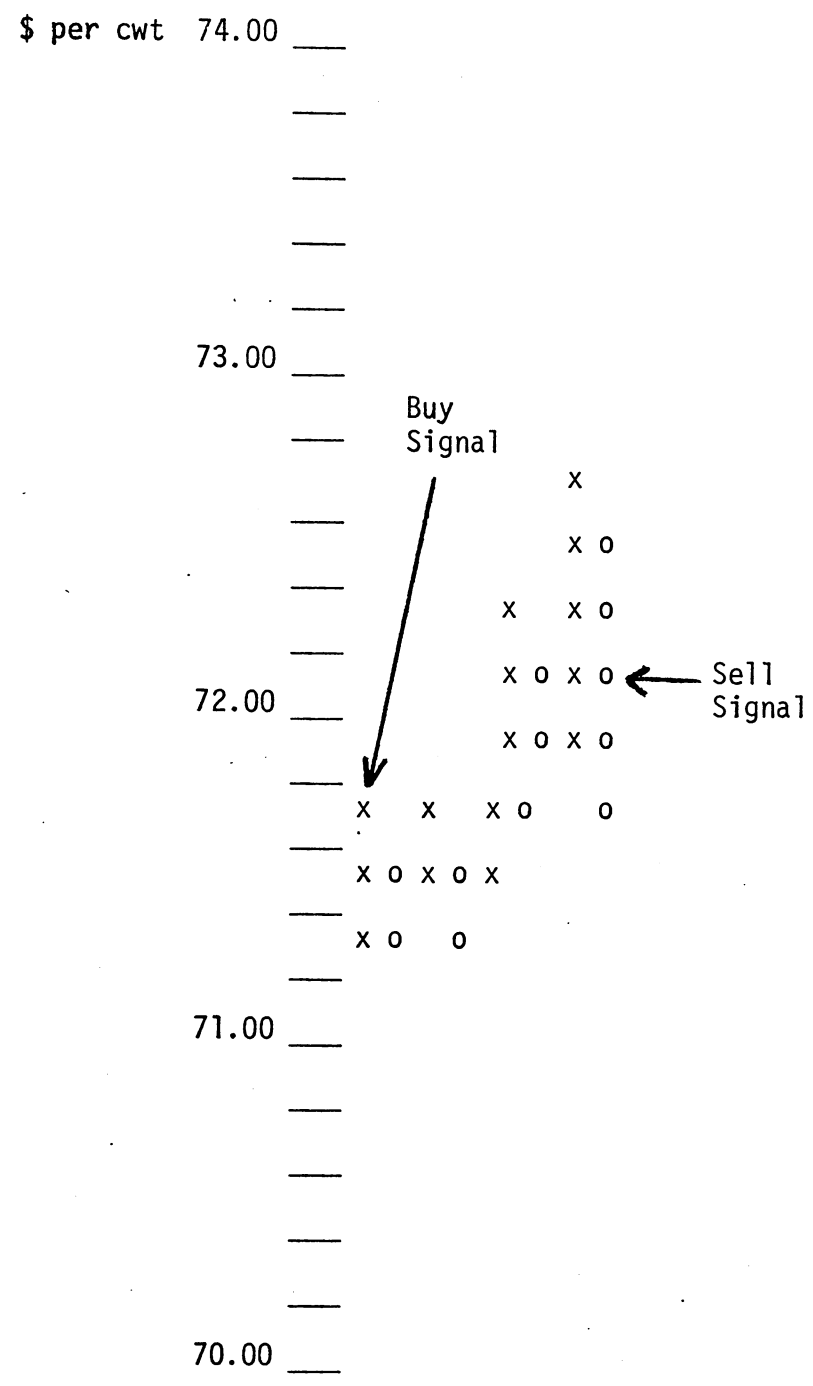


Figure 4-1. Illustration of Buy and Sell Signals Generated by a Point and Figure Chart

Strategy IV (S_4)

The fourth strategy is the place and lift approach. The objective of this strategy is to place the hedge in significant down markets and lift the hedge during significant rising markets.

The point and figure chart signals will indicate the proper time to place and lift hedges with this strategy and will use the same reversal requirement as indicated for S_3.

Strategy V (S_5)

This strategy is available if the cattle feeder believes that a profit cannot be obtained by purchasing the feeder steers and placing them on feed. If this is the case, then the producer will simply not produce.

Alternative States of Nature

Now that the strategies have been identified, the alternative states of nature or future possible outcomes for the price of January live cattle must be defined.

The decision maker in this situation carefully considered several factors before assigning the expected prices. Factors affecting the supply and demand of fed cattle which will impact upon January prices were analyzed.

The number of cattle on feed were researched. Several publications such as USDA reports and various market analysis and outlook material provide this information.

Demand factors such as beef consumption, the price of pork and

poultry and the economy as a whole were also considered in assigning the expected prices.

Market outlook material was relied upon to get an idea of what the expected range of prices for fat cattle would be in January. The futures quote for January live cattle was also considered, along with the other factors mentioned to assign the expected prices. The cattle feeder also utilized his experience and knowledge to subjectively assign the following price ranges which will represent the alternative states of nature.

State of Nature	Expected Price Range	Average
N_1	\$66-69	\$67.50
N_2	\$70-73	\$71.50
N_3	\$74-77	\$75.50
N_4	\$78-81	\$79.50
N_5	\$82-85	\$83.50

The first state of nature, N_1, reflects the most pessimistic views on the price of live cattle and the last state of nature, N_5, reflects the most optimistic views for the price of fed beef in January. Based on the cattle feeder's analysis and experience, he feels confident that the January live cattle price will fall within this \$19 price range.

Step 2: Prior Analysis. Assign the prior probabilities to the alternative states of nature.

Prior Probabilities

The information that was employed in assigning the alternative

states of nature were again called upon to assign the prior probabilities. It is very important to point out that this step of the Bayesian Approach in the assumed situation is very subjective. The cattle feeder has analyzed the information that will influence the price of January live cattle. It is evident from this information that the price range that is forecasted most often is the \$70-\$73 price range. The January futures quote is \$70.95 which also falls within this range. The decision maker also has a "gut feeling" that fed cattle prices in January will be in this price range. Given this information, a 35 percent probability is subjectively assigned to the \$70-\$73 price range.

The decision maker must now subjectively assign prior probabilities to the remaining four states of nature. N_1 and N_3 are assigned the same probability by the cattle feeder since he feels that both price ranges have about the same chance of occurring if N_2 is not the true state of nature. It is also believed that both of these possible price ranges have just over one-half the chance that N_2 has of being the true state of nature. Keeping this in mind the decision maker subjectively assigns a 20 percent prior probability to N_1 and N_3.

The fourth state of Nature, N_4, will be given a lower probability of occurring since the cattle feeder feels that this price range is a little high due to the United States economy and the supply of beef. However, he also feels that changes in the economy could possibly produce higher prices. Since N_3 was given a 20 percent chance of occurring, N_4 is given a slightly lower probability of 15 percent.

The cattle feeder feels that N_5 will probably not occur, but he lists this as a possibility due to his past experiences in the

cattle feeding industry. This last price range will be given a prior probability of 10 percent and this will give the prior probabilities a sum total of 100 percent or 1.0. The prior probabilities are now shown as follows:

$P(N_1) = .20$

$P(N_2) = .35$

$P(N_3) = .20$

$P(N_4) = .15$

$P(N_5) = .10$

It is this step of Bayesian Analysis that is appealing to all types of decision makers, not only in the cattle industry, because it enables them to utilize their own feelings, which are based on their past experiences, knowledge and judgement.

Step 3: Construct a payoff table and calculate the expected payoffs.

In order to accomplish this step of the analysis all S_iN_j combinations must be calculated for the payoff table.

Calculations for All Strategies

Strategy I (S_1)

To compute the S_iN_j combinations, the following equation will be used.

S_i Value (Profit or Loss per cwt.) = N_j Average price per cwt.

- Break-even price per cwt.

This equation indicates that the values assigned to the strategies or possible outcomes in the ultimate payoff table will represent the

profit or loss per cwt. that results from any $S_i N_j$ combinations.

The computations for Strategy I are shown below in the following table.

TABLE 4-1

S_1 VALUES (PROFIT OR LOSS PER CWT.)

	States of Nature				
	N_1	N_2	N_3	N_4	N_5
N_j Average price	$67.50	$71.50	$75.50	$79.50	$83.50
Break-even price	72.42	72.42	72.42	72.42	72.42
S_1 Value	- 4.92	- .92	3.08	7.08	11.08

Table 4-1 indicates that "windfall profits" are realized in a rising cash market. However, in order to have the opportunity to receive these profits, the cattle feeder must be willing to accept the losses that would occur if a lower price is received for his cattle in January as shown for N_1 and N_2.

At this point in the analysis, the cattle feeder is concerned about feeding cattle for this specific time period since a loss of $.92 per cwt will be realized for the no hedge strategy if the state of nature with the highest prior probability (N_2) is the outcome, however the remaining strategies will be analyzed in order to see

their possible outcomes.

Strategy II (S_2)

In order to calculate the payoff values for the hedge and hold strategy, the net returns from this hedging activity will be added to the net returns from the no hedge strategy, which represents the profit or loss in the cash market. Strategy I will also provide the base to calculate S_3 and S_4.

Since the alternative states of nature are cash prices, a 75¢ per cwt. expected basis will be used in calculating returns to the futures market price; and hedging costs will be 25¢ per cwt. The futures price quote for January, 1981 live cattle was $70.95 per cwt. as listed in the Wall Street Journal on August 15, 1980. The following equation will be employed to compute the hedging profit or loss per cwt.

$70.95 January Futures Price per cwt.
- (State of Nature Price per cwt. + $.75 basis)
- ($.25 Hedging Cost per cwt.)

Dollar Profit (Loss) per cwt. in Futures Market

Payoff values for S_2 can now be calculated with the use of this equation as shown in Table 4-2.

For each state of nature a $2.47 loss occurs since the net result was "locked-in" with the hedge and hold strategy. This loss can be attributed to the relatively high break-even price on the feeder steers.

TABLE 4-2

S_2 VALUES (PROFIT OR LOSS PER CWT.)

	States of Nature				
	N_1	N_2	N_3	N_4	N_5
N_j Average price	$67.50	$71.50	$75.50	$79.50	$83.50
Break-even price	72.42	72.42	72.42	72.42	72.42
Profit or Loss in Cash Market	-4.92	- .92	3.08	7.08	11.08
Profit or Loss in Futures Market	2.45	-1.55	-5.55	-9.55	-13.55
S_2 Value	-2.47	-2.47	-2.47	-2.47	-2.47

Strategy III (S_3)

Some assumptions are needed at this point of the analysis concerning the market behavior of January prices for live cattle since managerial discretion is utilized in placing the hedge for the third strategy. These assumptions will also be used in calculating the S_4 values. Let's assume the data would work as described.

N_1: $67.50

For state of nature N_1 to occur, the January live cattle futures price must drop from the August 15th quote of $70.95 to $67.50 by the second day of January. Since this is a drop of $3.45, it is not likely that any rising market trends would occur during the feeding period for this state of nature. Many market analysts predict that October will

be the weak month for fed cattle prices as pork supplies increase seasonally this time of the year and hog prices fall. Due to these expectations, a $2.00 setback will occur at this time. The fat cattle market will then level off at the $68.95 area, until December when the second setback will occur, which will bring the January live cattle price toward the expected level of $67.50 for this state of nature. The correction in December would be a result of the number of cattle coming off feed due to the 25 percent increase in placements during July.

N_2: $71.50

For the second state of nature to occur, it is evident that different price movements would take place since the January price for fat cattle must rise $.55 from the futures quote on August 15. The January contract will rise to the $72.00 level in September until experiencing a $1.60 correction in October which will bring the price of January fed cattle to $70.40 per cwt. The major difference in this state of nature from N_1 will take place during the month of November when the January contract will experience a $1.60 gain back to $72.00. The market will then weaken in December down to $71.00 before converging toward the cash price of $71.50 on the second day of January.

N_3: $75.50

N_3 will require an overall gain of $4.55 per cwt to realize $75.50 live cattle in January. To achieve this price level in January, the futures contract will rise from the $71.00 level in mid-August by $2.00 in September to $73.00 before experiencing a $1.00 setback in October to $72.00. The futures price will then rise up to $75.00 in November,

suffer a $1.50 correction to $73.50 in December before rising around the $75.50 area on January 2.

N_4: $79.50

The last two states of nature do not leave much opportunity for any significant corrections in the January futures price. For N_4 to occur, the January futures price for live cattle will rise $4.00 during the first 90 days of the feeding period before a $1.00 setback is experienced in October which brings the price to $73.95 per cwt. The contract price will then gradually rise for the remaining period bringing the January contract toward the cash price of $79.50 the second day in 1981.

N_5: $83.50

For this state of nature, the January futures price will reach $77.00 by the end of September before correcting to $75.00 the first of October. A strong bull market will then raise the price over the last two months as the price of January live cattle will close near the cash price of $83.50 on January 2.

It is now possible to calculate the values for S_3 given the subjective price movements for each state of nature. Strategy IV will also utilize the same assumptions in calculating the expected payoffs. As mentioned earlier, the point and figure chart will be used to signal a reversing market trend using a 20¢ box size and a 3-box reversal requirement. Therefore this tool will give a reversal signal 60¢ after the new trend actually occurs.

For strategy III, the hedge will be placed 60¢ after the first

reversal downward so a higher January futures price may be achieved. The return to the futures market using this strategy is calculated with the following equation.

Reversal Price - $.60
- (State of Nature Price + $.75 basis)
- ($.25 Hedging Cost)
Profit or Loss to Futures Market

With this particular strategy, the expected payoff for state of nature N_1 will correspond to the value for the second strategy since a falling market is occurring when the cattle are purchased. In this case, as in S_2, the hedge will be placed the day that the cattle are purchased and held until the cash position is liquidated.

Figure 4-2 provides the point and figure chart for state of nature N_2 showing the reversal price and the price where the hedge is placed.

The return to the futures market for N_2 is calculated using the previous equation in the following manner.

$72.00 - $.60
- ($71.50 + $.75)
- ($.25)
- $1.10 Loss to Futures Market

Similar calculations are made for the other possible states of nature.

The payoff values for S_3 are computed in Table 4-3. It is evident that the overall results from S_3 are better than S_2 since a higher January futures price could be obtained, however, it was shown that this strategy produced the same results in the case of a falling market as shown in N_1.

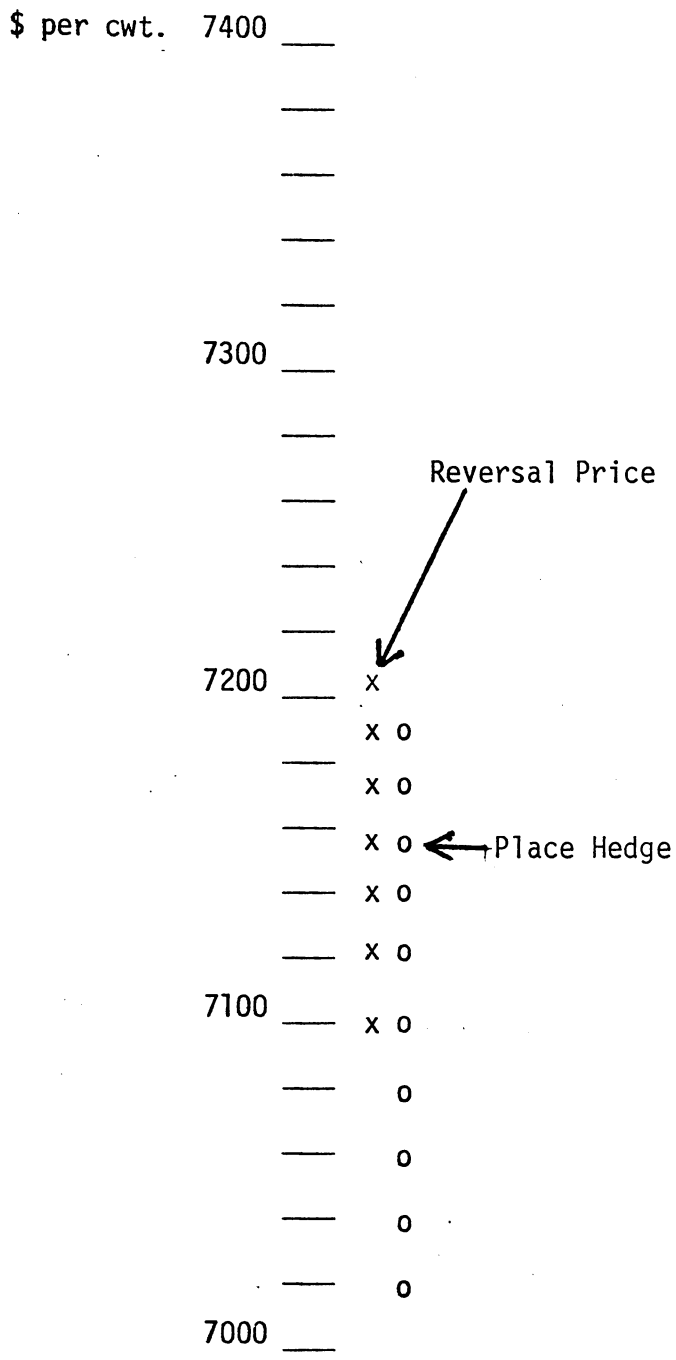


Figure 4-2. Point and Figure Chart for N_2 Illustrating Reversal Price and Hedging Price

TABLE 4-3

S_3 VALUES (PROFIT OR LOSS PER CWT.)

	States of Nature				
	N_1	N_2	N_3	N_4	N_5
N_j Average Price	$67.50	$71.50	$75.50	$79.50	$83.50
Break-even Price	72.42	72.42	72.42	72.42	72.42
Profit or Loss in Cash Market	-4.92	- .92	3.08	7.08	11.08
Profit or Loss in Futures Market	2.45	-1.10	-4.10	-6.15	-8.10
S_3 Value	-2.47	-2.02	-1.02	.93	2.98

Strategy IV (S_4)

The place and lift strategy is the most complex since the hedge is placed more than once in certain situations. Again N_1 will correspond to the S_2 value since the market is falling at the time of the purchase and no reversal signal is indicated during the feeding period. For state of nature N_2 and N_3, the hedge will be placed twice as the point and figure chart signals. To calculate the returns to the futures market in this case the following equations will be used.

First Placement

First Top Reversal Price - $.60

- (First Bottom Price + $.60)

- ($.25 Hedging Cost)

Profit or Loss from First Placement

Second Placement

Second Top Reversal - $.60
- (State of Nature Price + $.75 basis)
- ($.25 Hedging Cost)
Profit or Loss from Second Placement

Total Profit or Loss

Profit or Loss from First Placement
+ Profit or Loss from Second Placement
Profit or Loss from Futures Market

The point and figure chart for N_2 is shown in Figure 4-3 which illustrates the prices at which the first and second hedge is placed and lifted.

To return to the futures market for N_2 is calculated using the previous equations.

First Placement	Second Placement
$72.00 - $.60	$72.00 - $.60
- ($70.40 + $.60)	- ($71.50 + $.75)
- ($ .25)	- ($ .25)
$ .15 Profit	$ 1.10 Loss

$ .15 First Placement Result
- 1.10 Second Placement Result
- $ .95 Loss from Futures Market for N_2

N_3 is calculated in the same manner as shown below.

First Placement	Second Placement
$73.00 - $.60	$75.00 - $.60
-($72.00 + $.60)	-($73.50 + $.75)
-($ .25)	-($ .25)
$ .45 Loss	$ .10 Loss

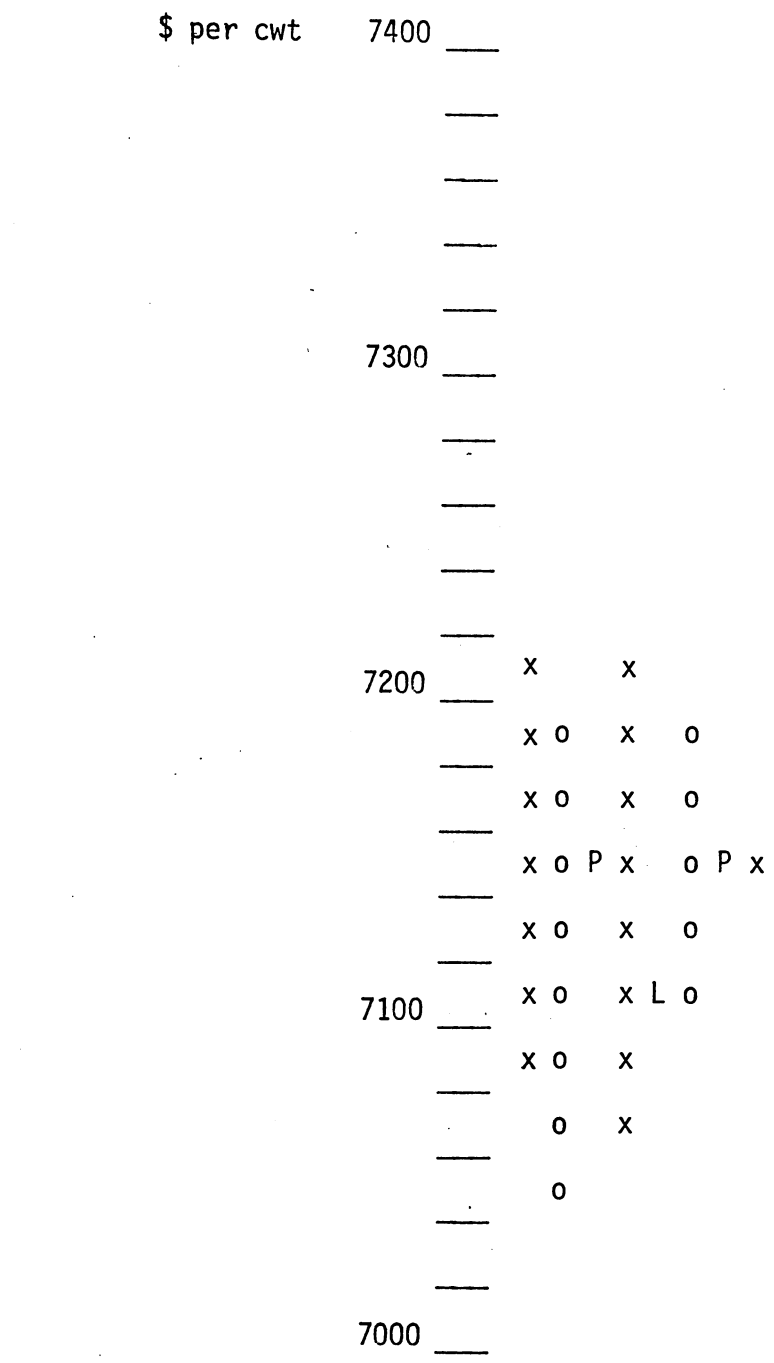


Figure 4-3. Point and Figure Chart for N_2

Note: P - Price hedge is placed

L - Price hedge is lifted

- $ .45 First Placement Result

- $ .10 Second Placement Result

$ .55 Loss from Futures Market for N_3

The results from the futures market for N_4 and N_5 are calculated differently since the hedge is placed and lifted only once. The equation used to calculate these returns is the following.

Top Reversal Price - $.60

- (Bottom Reversal Price + $.60)

- ($.25 Hedging Cost)

Profit or Loss from Futures Market

N_4 and N_5 are calculated as shown below.

N_4: $74.95 - $.60

-($73.95 + $.60)

-($ .25)

- $ .45 Loss from Futures Market

N_5: $77.00 - $.60

-($75.00 + $.60)

-($ .25)

$ .55 Profit from Futures Market

All values for S_4 can now be calculated as shown in Table 4-4. The results of the place and lift strategy clearly illustrate that a profit is not guaranteed. If relatively small fluctuations occur, as in this period, then this strategy does not produce the best results.

TABLE 4-4

	States of Nature				
	N_1	N_2	N_3	N_4	N_5
N_j Average Price	$67.50	$71.50	$75.50	$79.50	$83.50
Break-even Price	72.42	72.42	72.42	72.42	72.42
Profit or Loss in Cash Market	-4.92	- .92	3.08	7.08	11.08
Profit or Loss in Futures Market	2.45	- .95	- .55	- .45	.55
S_4 Value	-2.47	-1.87	2.53	6.63	11.63

Strategy V (S_5)

This strategy will simply provide expected payoffs of zero, since the cattle feeder does not produce.

The Payoff Table

After the payoffs for each possible state of nature have been calculated for all five strategies it is possible to construct a pay-off table as shown in Table 4-5.

The expected payoffs for the prior probability analysis may now be calculated.

$$E(S_i) = \sum_{i=1}^{n} (S_i/N_j)\, P(N_j)$$

$$E(S_1) = (-4.92)\ (.2) + (-.92)\ (.35) + (3.08)\ (.2) + (7.08)\ (.15) + (11.08)\ (.10)$$

TABLE 4-5

PAYOFF TABLE FOR PRIOR ANALYSIS

(PROFIT OR LOSS PER CWT.)

	States of Nature With Prior Probabilities					
Strategies	N_1 \$67.50 (.2)	N_2 \$71.50 (.35)	N_3 \$75.50 (.2)	N_4 \$79.50 (.15)	N_5 \$83.50 (.10)	Expected Payoff
S_1	-4.92	- .92	3.08	7.08	11.08	1.49
S_2	-2.47	-2.47	-2.47	-2.47	-2.47	-2.47
S_3	-2.47	-2.02	-1.02	.93	2.98	- .96
S_4	-2.47	-1.87	2.53	6.63	11.63	1.52
S_5	0	0	0	0	0	0

$= (-.98) + (-.32) + (.62) + (1.06) + (1.11)$

$= \$1.49$ per cwt.

$E(S_2) = (-2.47)\ (.2) + (-2.47)\ (.35) + (-2.47)\ (.2) + (-2.47)\ (.15) + (-2.47)\ (.10)$

$= (-.49) + (-.87) + (-.49) + (-.37) + (-.25)$

$= -\$2.47$ per cwt.

$E(S_3) = (-2.47)\ (.2) + (-2.02)\ (.35) + (-1.02)\ (.2) + (.93)\ (.15) + (2.98)\ (.10)$

$= (-.49) + (-.71) + (-.20) + (.14) + (.30)$

$= -\$.96$ per cwt.

$E(S_4) = (-2.47)\ (.2) + (-1.87)\ (.35) + (2.53)\ (.2) + (6.63)\ (.15) + (11.63)\ (.10)$

$= (-.49) + (-.65) + (.51) + (.99) + (1.16)$

$= \$1.52$ per cwt.

$E(S_5) = 0$

The results of the prior analysis indicate that the particular feeding period in this situation is not very favorable for the cattle feeder since only two of the five strategies give a positive expected payoff. S_4 gives the best results with an expected payoff of \$1.52.

Step 4: Select a strategy or delay the decision and conduct a posterior analysis.

The decision to select a strategy will be delayed in order to conduct a posterior analysis to obtain more information concerning the price of live cattle in January.

To conduct a posterior analysis, the cattle feeder accumulated the additional information from specialists in the cattle feeding industry through telephone and personal interviews by asking them to project the price of live cattle for the first of January. Before the interviews were conducted, the decision maker decided on the following possible results and related them to the previously selected states of nature as used in the prior analysis.

Z_1 = The average price expectation of the ten experts interviewed falls within the \$66-\$69 price range, suggesting N_1 will be the state of nature.

Z_2 = The average price expectation of the ten experts interviewed falls within the \$70-\$73 price range, suggesting N_2 will be the state of nature.

Z_3 = The average price expectation of the ten experts interviewed falls within the \$74-\$77 price interval, suggesting N_3 will be the state of nature.

Z_4 = The average price expectation of the ten experts interviewed falls within the \$78-\$81 price range, suggesting N_4 will be the state of nature.

Z_5 = The average price expectation of the ten experts interviewed falls within the \$82-\$85 price interval, suggesting N_5 will be the state of nature.

The reliability of the experts must also be considered before the interview takes place. Again, this is a subjective procedure that the cattle feeder must perform in the analysis. He recalls the past accuracy of these experts and also the confidence he places in their

expertise in this area. After careful consideration the producer subjectively assigns a 70 percent reliability factor. With this information the probability associated with the results given the states of nature are shown below.

$$P(Z_1/N_1) = .7$$
$$P(Z_2/N_2) = .7$$
$$P(Z_3/N_3) = .7$$
$$P(Z_4/N_4) = .7$$
$$P(Z_5/N_5) = .7$$

Logic and rationale are used to assign the "error component" which will deal with the 30 percent when the experts are not correct. The conditional probabilities for observing Z_i given N_j are assigned in the following manner:

Z_1 Result	Z_2 Result	Z_3 Result
$P(Z_1/N_1) = .70$	$P(Z_2/N_1) = .10$	$P(Z_3/N_1) = .05$
$P(Z_1/N_2) = .15$	$P(Z_2/N_2) = .70$	$P(Z_3/N_2) = .10$
$P(Z_1/N_3) = .10$	$P(Z_2/N_3) = .10$	$P(Z_3/N_3) = .70$
$P(Z_1/N_4) = .03$	$P(Z_2/N_4) = .06$	$P(Z_3/N_4) = .10$
$P(Z_1/N_5) = .02$	$P(Z_2/N_5) = .04$	$P(Z_3/N_5) = .05$

Z_4 Result	Z_5 Result
$P(Z_4/N_1) = .04$	$P(Z_5/N_1) = .02$
$P(Z_4/N_2) = .06$	$P(Z_5/N_2) = .03$
$P(Z_4/N_3) = .10$	$P(Z_5/N_3) = .10$
$P(Z_4/N_4) = .70$	$P(Z_5/N_4) = .15$
$P(Z_4/N_5) = .10$	$P(Z_5/N_5) = .70$

The remaining probabilities were assigned in a logical manner. For example, $P(Z_1/N_2)$ should be greater than $P(Z_1/N_3)$ since Z_1 indicates an expected price range of \$66-\$69, which is much closer to the N_2 price range of \$70-\$73 than the \$74-\$77 price interval of N_3. The probabilities for the remaining four Z_i results were assigned with the same logic in mind.

Interview Results

The results of the 10 interviews that were actually conducted (see Appendix) indicate that the average price expectation of the experts for live cattle for the first of January is \$72.60 per cwt. The high price expectation was \$80 per cwt. and the low expectation was \$68 per cwt. Seven of the ten experts expected prices would fall within the \$70-\$75 range. Therefore Z_2 best fits the interview results.

Posterior Probabilities

The posterior probabilities can now be calculated with Z_2 best fitting the results of the interviews.

$$P(N_1/Z_2) = \frac{P(N_1)\ P(Z_2/N_1)}{\sum_{i=1}^{3} P(Z_2/N_j)\ P(N_j)}$$

$$= \frac{(.2)\ (.1)}{(.1)\ (.2) + (.7)\ (.35) + (.1)\ (.2) + (.06)\ (.15) + (.04)\ (.10)}$$

$$= \frac{.02}{.298}$$

$$= .067$$

$$P(N_2/Z_2) = \frac{P(N_2)\ P(Z_2/N_2)}{\sum_{i=1}^{3} P(Z_2/N_j)\ P(N_j)}$$

$$= \frac{(.35)\ (.7)}{.298}$$

$$= .822$$

$$P(N_3/Z_2) = \frac{P(N_3)\ P(Z_2/N_3)}{\sum_{i=1}^{3} P(Z_2/N_j)\ P(N_j)}$$

$$= \frac{(.2)\ (.1)}{.298}$$

$$= .067$$

$$P(N_4/Z_2) = \frac{P(N_4)\ P(Z_2/N_4)}{\sum_{i=1}^{3} P(Z_2/N_j)\ P(N_j)}$$

$$= \frac{(.15)\ (.06)}{.298}$$

$$= .03$$

$$P(N_5/Z_2) = \frac{P(N_5)\ P(Z_2/N_5)}{\sum_{i=1}^{3} P(Z_2/N_j)\ P(N_j)}$$

$$= \frac{(.10)\ (.04)}{.298}$$

$$= .014$$

The posterior probabilities can now be employed to construct a revised payoff table, as shown in Table 4-6, which reflects in the expected payoff column the decision maker's knowledge that is adjusted by the experts expectations.

TABLE 4-6

PAYOFF TABLE FOR POSTERIOR ANALYSIS
(PROFIT OR LOSS PER CWT.)

	States of Nature With Posterior Probabilities					
Strategies	N_1 \$67.50 (.067)	N_2 \$71.50 (.822)	N_3 \$75.50 (.067)	N_4 \$79.50 (.03)	N_5 \$83.50 (.014)	Expected Payoff
S_1	-4.92	- .92	3.08	7.08	11.08	- .52
S_2	-2.47	-2.47	-2.47	-2.47	-2.47	-2.47
S_3	-2.47	-2.02	-1.02	.93	2.98	-1.82
S_4	-2.47	-1.87	2.53	6.63	11.63	-1.18
S_5	0	0	0	0	0	0

The expected payoffs taken from the revised payoff table are calculated as follows:

$$E(S_i) = \sum_{i-1}^{n} (S_i/N_j)\, p(N_j)$$

$$E(S_1) = (-4.92)\ (.067) + (-.92)\ (.822) + (3.08)\ (.067) + (7.08)\ (.03) + (11.08)\ (.014)$$

$$= (-.33) + (-.76) + (.21) + (.21) + (.15)$$

$$= -\$.52$$

$$E(S_2) = (-2.47)\ (.067) + (-2.47)\ (.822) + (-2.47)\ (.067) + (-2.47)\ (.03) + (-2.47)\ (.014)$$

$$= (-.16) + (-2.04) + (-.16) + (-.07) + (-.04)$$

$= -\$2.47$

$E(S_3) = (-2.47)\ (.067) + (-2.02)\ (.822) + (-1.02)\ (.067) + (.93)\ (.03) + (2.98)\ (.014)$

$= (-.16) + (-1.66) + (-.07) + (.03) + (.04)$

$= -\$1.82$

$E(S_4) = (-2.47)\ (.067) + (-1.87)\ (.822) + (2.53)\ (.067) + (6.63)\ (.03) + (11.63)\ (.014)$

$= (-.16) + (-1.54) + (.16) + (.20) + (.16)$

$= -\$1.18$

$E(S_5) = 0$

The expected payoffs from the posterior analysis indicate that none of the five strategies produce a positive return. The high price of the feeder steers along with the expensive production costs contribute to the expected losses for S_1 through S_4. With the new knowledge and resulting probabilities, the positive expected payoffs for S_1 and S_4 from the prior analysis are now negative.

Results

In order to measure the dispersion of the expected payoffs, the standard deviation for each of the expected payoffs is calculated for both the posterior and the prior analysis.

Standard Deviations of Payoffs for Posterior Analysis

$\sigma S_i = [\Sigma\ P\ (\text{Possible Payoff} - \text{Expected Payoff})^2]^{\frac{1}{2}}$

$\sigma S_1 = [.067\ (-4.92 + .52)^2 + .822\ (-.92 + .52)^2 + .067\ (3.08 + .52)^2 + .03\ (7.08 + .52)^2 + .014\ (11.08 + .52)^2]^{\frac{1}{2}}$

$$= [(1.30) + (.13) + (.87) + (1.73) + (1.88)]^{\frac{1}{2}}$$
$$= 2.43$$

$$\sigma S_2 = [.067\ (-2.47 + 2.47)^2 + .822\ (-2.47 + 2.47)^2 + .067\ (-2.47 + 2.47)^2 + .03\ (-2.47 + 2.47)^2 + .014\ (-2.47 + 2.47)^2]^{\frac{1}{2}}$$
$$= [(0) + (0) + (0) + (0) + (0)]^{\frac{1}{2}}$$
$$= 0$$

$$\sigma S_3 = [.067\ (-2.47 + 1.82)^2 + .822\ (-2.02 + 1.82)^2 + .067\ (-1.02 + 1.82)^2 + .03\ (.93 + 1.82)^2 + .014\ (2.98 + 1.82)^2]^{\frac{1}{2}}$$
$$= [(.03) + (.03) + (.04) + (.23) + (.32)]^{\frac{1}{2}}$$
$$= .81$$

$$\sigma S_4 = [.067\ (-2.47) + (1.18)^2 + .822\ (-1.87 + 1.18)^2 + .067\ (2.53 + 1.18)^2 + .03\ (6.63 + 1.18)^2 + .014\ (11.63 + 1.18)^2]^{\frac{1}{2}}$$
$$= [(.11) + (.39) + (.92) + (1.83) + (2.30)]^{\frac{1}{2}}$$
$$= 2.35$$

$$\sigma S_5 = [.067\ (0 - 0)^2 + 8.22\ (0 - 0)^2 + .067\ (0 - 0)^2 + .03\ (0 - 0)^2 + .014\ (0 - 0)^2]^{\frac{1}{2}}$$
$$= 0$$

Standard Deviations of Payoffs

for Prior Analysis

$$\sigma S_i = [\Sigma\, P\,(\text{Possible Payoffs} - \text{Expected Payoffs})^2]^{\frac{1}{2}}$$

$$\sigma S_1 = [.2\ (-4.92 - 1.49)^2 + .35\ (-.92 - 1.49)^2 + .2\ (3.08 - 1.49)^2 + .15\ (7.08 - 1.49)^2 + .1\ (11.08 - 1.49)^2]^{\frac{1}{2}}$$
$$= [(8.22) + (2.03) + (.51) + (4.69) + (9.20)]^{\frac{1}{2}}$$
$$= 4.96$$

$$\sigma S_2 = [.2\ (-2.47 + 2.47)^2 + .35\ (-2.47 + 2.47)^2 + .2\ (-2.47 + 2.47)^2 + .15\ (-2.47 + 2.47)^2 + .1\ (-2.47 + 2.47)^2]^{\frac{1}{2}}$$
$$= [(0) + (0) + (0) + (0) + (0)]^{\frac{1}{2}}$$
$$= 0$$

$$\sigma S_3 = [.2\ (-2.47 + .96)^2 + .35\ (-2.02 + .96)^2 + .2\ (-1.02 + .96)^2 + .15\ (.93 + .96)^2 + .1\ (2.98 + .96)^2]^{\frac{1}{2}}$$
$$= [(.46) + (.39) + (.0007) + (.54) + (1.55)]^{\frac{1}{2}}$$
$$= 1.71$$

$$\sigma S_4 = [.2\ (-2.47 - 1.52)^2 + .35\ (-1.87 - 1.52)^2 + .2\ (2.53 - 1.52)^2 + .15\ (6.63 - 1.52)^2 + .1\ (11.63 - 1.52)^2]^{\frac{1}{2}}$$
$$= [(3.18) + (4.02) + (.20) + (3.92) + (10.22)]^{\frac{1}{2}}$$
$$= 4.64$$

$$\sigma S_5 = [.2\ (0 - 0)^2 + .35\ (0 - 0)^2 + .2\ (0 - 0)^2 + .15\ (0 - 0)^2 + .1\ (0 - 0)^2]^{\frac{1}{2}}$$
$$= 0$$

It is evident that the standard deviation of the expected payoffs, which is a measure of price risk, is much smaller for the posterior analysis for all strategies excluding S_2 and S_5 as shown in Figure 4-4.

Figure 4-4 shows that the possible distributions of expected payoffs after the posterior analysis was conducted has less variability than the distribution of expected payoffs from the prior analysis. This indicates that less price risk is involved when the cattle feeder makes his decision after the posterior analysis is conducted since he has obtained additional information concerning the price of live cattle in January.

This simulated marketing situation has shown that Bayesian Analysis can be a useful tool by aiding the cattle feeder in the decision

process of buying and marketing cattle. The Bayesian Approach allowed consideration of alternative strategies and their possible outcomes. The experienced cattle feeder's knowledge and judgement was not ignored as he assigned prior probabilities to the possible outcomes in the prior analysis. Price risk was reduced in the posterior analysis by adjusting the prior probabilities with the additional information which was obtained from experts in the cattle feeding industry.

	Prior Analysis		Posterior Analysis	
Strategies	Expected Payoff	σS_i	Expected Payoff	σS_i
S_1	1.49	4.96	- .52	2.43
S_2	-2.47	0.0	-2.47	0.0
S_3	- .96	1.71	-1.82	.81
S_4	1.52	4.64	-1.18	2.35
S_5	0.0	0.0	0.0	0.0

Figure 4-4. Expected Payoffs and Standard Deviations of Expected Payoffs for Prior and Posterior Analyses (Profit or Loss per cwt.)

The results of the specific feeding period utilized in the analysis gives an idea of how cattle feeders can suffer considerable losses if no measures are taken to reduce price risk. The high production costs

involved with feeding cattle, as reflected in this situation, make it necessary to receive a fairly high price for the fed cattle in order to make a profit. In situations such as this it can definitely be worth the time to conduct an analysis, as conducted in this study, in order to decrease the risk of making a wrong decision.

CHAPTER V

SUMMARY AND CONCLUSIONS

Cattle feeders have experienced "feast or famine" situations in the last decade due to the volatile price movements of inputs and outputs. Many of the production and marketing decisions that must be made by cattle feeders are clouded by uncertainty regarding future slaughter cattle prices. The primary objective of this study was to develop a framework useful to cattle feeders in the buying and marketing process for a specific future period by reducing the uncertainty associated with future live cattle spot prices. This objective was accomplished by first examining alternative hedging strategies and then demonstrating how Bayesian Analysis could assist in the process of selecting an appropriate strategy for a particular feeding period. Bayesian Analysis aids the cattle feeder's decision process under uncertain conditions through the collection and utilization of additional information.

Summary of Findings

Since three of the five alternative strategies employed in the study were a variation of hedging strategies, the live cattle futures contract was examined to see if an adequate hedging mechanism was available to the cattle feeder. The actual hedging process was then

analyzed along with the factors that make it work.

Bayesian Analysis was introduced as a decision model that could be used to aid in problem situations involving uncertainty. This form of statistical decision theory provided a method of evaluating the alternative strategies that were available to the cattle feeder. This approach provided a framework in which the decision maker's subjective evaluations were combined with the expectations of experts in the decision process of whether or not to feed cattle and then applying the appropriate strategy.

In order to demonstrate how Bayesian Analysis could assist the cattle feeder, a simulated feeding period was analyzed which utilized current information. The following five strategies were evaluated through the Bayesian Approach:

1. No hedge. This strategy simply placed feeder steers on feed and then sold them as slaughter cattle.
2. Hedge and hold. This strategy utilized the futures market as a hedge was placed when the cattle were purchased and held until they were sold in the cash market.
3. Controlled placement of the hedge. The hedge was placed the first time the point and figure chart signaled a downward trend in January live cattle prices. If prices were in a downward trend when the cattle were purchased, then the strategy corresponded to the hedge and hold strategy.
4. Place and lift. The hedge was placed and lifted according to signals from the point and figure chart.
5. Do not produce. In this strategy the feeder steers were simply not purchased due to undesirable expected outcomes.

The returns for each strategy were provided by the four step Bayesian Approach. The expected payoffs and standard deviations of expected payoffs for the prior and posterior analyses are shown in Table 5-1.

TABLE 5-1

EXPECTED PAYOFFS AND STANDARD DEVIATIONS OF EXPECTED PAYOFFS FOR PRIOR AND POSTERIOR ANALYSES

(PROFIT OR LOSS PER CWT.)

Strategies	Prior Analysis		Posterior Analysis	
	Expected Payoff	σS_i	Expected Payoff	σS_i
S_1	1.49	4.96	- .52	2.43
S_2	-2.47	0.0	-2.47	0.0
S_3	- .96	1.71	-1.82	.81
S_4	1.52	4.64	-1.18	2.35
S_5	0.0	0.0	0.0	0.0

The results of the prior analysis indicate that only S_1 and S_4 produce positive expected payoffs, with S_4 (controlled placement of the hedge) producing the best results with an expected payoff of $1.52 per cwt.

After the prior analysis was conducted, the cattle feeder made the decision to delay the selection of a strategy in order to collect

additional information by conducting a posterior analysis.

As shown in Table 5-1, the expected payoffs produced by the four feeding strategies after the posterior analysis was conducted produced negative payoffs. These results reflected the price information obtained and the high costs of production involved with feeding cattle for the specific time period analyzed. The additional price information in this specific case revealed that the S_1 and S_4 strategies may not be profitable, as first thought. It is important to keep in mind that a different time period and different assumptions could produce different results. Therefore, any one strategy will not be the best every time.

To determine if the additional price information obtained in the posterior analysis of the Bayesian Approach provided the cattle feeder with less variability in the expected payoffs, a standard deviation was calculated for each strategy in the prior and posterior analyses. As shown in Table 5-1, the additional information in the posterior analysis did reduce price risk involved in the decision process as reflected by the respectively lower standard deviations for the posterior payoff estimates, excluding S_2 and S_5.

Conclusions

This study demonstrated the usefulness of the Bayesian decision model in situations involving uncertainty as indicated by the standard deviations of expected payoffs for the prior and posterior analyses. Although Bayesian Analysis is general in scope, it was utilized for specific application to cattle feeders in the Oklahoma area.

It is essential to emphasize that this study presented a method of selecting an appropriate strategy for a specific feeding period. There is no implication that any one strategy would produce the best results for all situations.

The strategy that produces the highest expected payoff will not be the best strategy for all cattle feeders. If the producer is a risk averter he might choose the strategy that gives a more certain price such as the hedge and hold approach would provide. On the other hand if the producer's goal is to maximize profits then he may select a strategy that would possibly provide a higher payoff. The decision as to which strategy to use must be made by the individual producer after carefully considering:

1. The financial position of the individual.
2. The managerial capacity or ability to manage risk.
3. The personal orientation of the manager toward accepting risk.
4. The goals and objectives of the individual.

For the feeding period simulated in this study, the cattle feeder would most likely not feed cattle, due to the negative expected payoffs for each production strategy. If a decision framework such as this would have been utilized in the past, then possibly some cattle feeders may not have suffered the losses they incurred while feeding cattle.

Recommendations for Further Research

During the course of this study some areas for future research were found.

The effects of a fully hedged program needs to be analyzed. In this case the feed grains and even feeder cattle could be hedged to

help the producer reduce price risk. It is expected that the benefits from such a program would prove substantial to the cattle feeder.

Finally, a large cattle feeder could possibly take advantage of an optimal long-run level of price risk exposure by employing some combination of hedging strategies. A portfolio approach might be used to determine such an optimal mix of strategies.

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APPENDIX

INDIVIDUALS PROVIDING EXPERT JUDGEMENT

Dr. John Franzmann, Professor of Agricultural Economics, Oklahoma State University, Stillwater, Oklahoma.

Mr. Tom Gillam, General Manager, National Feeder Service, Oklahoma City, Oklahoma.

Mr. John Hughes, President, Oklahoma Cattlemen's Association, Bartlesville, Oklahoma.

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Dr. James Trapp, Professor of Agricultural Economics, Oklahoma State University, Stillwater, Oklahoma.

Mr. Lewis Trentman, Owner-General Manager, Sublette Feeders Inc., Sublette, Kansas.

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