1974

The determination of basis patterns and the results of various hedging strategies for live cattle and live hogs

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by

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A Thesis Submitted to the
Graduate Faculty in Partial Fulfillment of
The Requirements for the Degree of
MASTER OF SCIENCE

Department: Economics
Major: Agricultural Economics

Signatures have been redacted for privacy

Iowa State University
Ames, Iowa

1974

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CHAPTER I: INTRODUCTION

For many years the livestock producer has faced a variable price structure. He seldom knows the price he will receive for his livestock when he puts them into the feedlot. Through hedging, the futures market offers him an opportunity to establish, within relatively narrow limits, the price he will receive for his livestock before he places them on feed or at any time during the feeding period. But, this opportunity creates a decision problem for the feeder: he must select a hedging strategy.

Objectives

The objectives of this study are: a) to develop a framework for defining and comparing hedging strategies, b) to test selected hypotheses concerning the level and variability of the cash-futures price difference (basis), c) to use the results of the basis analysis to formulate alternative hedging strategies that may be used by Iowa livestock feeders, and d) to use simulation analysis to compare the mean and variability of net returns from alternative hedging strategies.

Procedure

The following procedure will be used to achieve the above objectives. First, the components of a hedging strategy will be specified. Second, the cash-futures price difference (basis) will be analyzed by use of regression analysis. Third, five separate hedging strategies, applicable to typical midwestern feeding systems, will be developed. In two of these strategies results from the analysis of the basis will be used to formulate decision criteria. Fourth, computer simulation models will be used to generate results for the hedging strategies. Fifth, the hedging strategies will be compared by comparing the mean and variance of the net price from each strategy.

Outline

In Chapter II the component decision problems for a hedging strategy are specified and discussed. In Chapter III the discussion focuses on three previous studies involving livestock hedging. Two of these studies analyze various hedging strategies for cattle; the third study analyzes hedging strategies for hogs. A description of the feeding systems used, and the development of the hedging strategies are included in Chapter IV. Chapter V contains an analysis of the basis and the calculation of the target price while Chapter VI contains a description of the simulation model that was used to test the strategies. The results of the analysis of the hedging strategies are presented in Chapter VII.

The scope of this research is limited to only five hedging strategies and three feeding systems; these obviously represent only a sample of the possible hedging strategies and feeding systems. This study does not include an analysis of the proportion of a feeder's livestock he should hedge, or an analysis of risk versus expected return in fulfilling the hedger's objectives.

There are several major differences between this research and previous research concerning livestock hedging strategies. First, the hedging strategies that are developed here are more nearly appropriate for Corn Belt feeders. Second, daily price data are used. The use of daily data permits more accurate calculation of the hedging costs and the maximum margin that the feeder needs to maintain his hedge. The maximum margin is important because it indicates the feeder's capital requirements. The use of daily data also allows the testing of a mechanical strategy. Third, we will present more meaningful criteria for making decisions regarding the placing of a hedge.

CHAPTER II: THE HEDGING STRATEGY

Because the main task undertaken in this dissertation is to develop and compare hedging strategies, we need to define the term "hedging strategy". A hedging strategy is a set of rules for making decisions. It should include a rule or procedure for making each of these decisions:

a) whether or not to place a hedge,

b) which contract to use in placing the hedge,

c) when to place the hedge,

d) what proportion of the livestock to hedge,

e) how to lift the hedge,

f) when to lift the hedge, and

g) whether and when to replace the hedge.

Alternative hedging strategies employ alternative rules or procedures for making one or more of these decisions.

Whether or Not to Place a Hedge

Consider first, rules a livestock feeder may use to decide whether or not to place a hedge. Assume that the livestock feeder has already decided to place livestock on feed. In deciding whether or not to place a hedge most producers will probably want to consider the expected price and the variability of price both with and without a hedge. Thus a hedging strategy should incorporate procedures for estimating and comparing expected prices with and without a hedge.

it might also incorporate procedures for comparing price risk under the two alternatives. It should also contain information about the producer's risk preferences. Finally it should provide a rule for using this information to make a decision.

Target price

In order to compare the expected prices with and without a hedge we first need to estimate the price with a hedge. The estimated price with a hedge is termed the "target price".

Because there are two ways to lift a hedge, the target price is the higher of two price estimates; one for delivering on the contract and one for offsetting the contract and marketing locally. The estimated at-farm price the feeder receives if he delivers on the contract is equal to the futures contract selling price minus the hedging cost minus the cost of delivering on the futures contract:

$$\hat{P}_D = FP_S - \widehat{LMC} - \widehat{ADC} - \widehat{HC} \quad (2.1)$$

where:

$\hat{P}_D$ = estimated at-farm price with delivery.

FP_S = futures selling price.

$\widehat{LMC}$ = estimated cost of marketing from the farm to the local market.

$\widehat{ADC}$ = cost of marketing from the farm to the futures delivery point minus LMC.

$\widehat{HC}$ = estimated cost of hedging.

Notice that in this equation total marketing costs are the sum of two components: farm to local marketing costs, and local market to delivery point costs.

The estimated at-farm price if the feeder offsets is equal to the futures contract selling price minus the futures contract buying price plus the local cash price minus the local marketing costs minus the cost of hedging:

$$(2.2) \qquad \hat{P}_O = FP_S - \widehat{FP}_B + \widehat{CP}_L - \widehat{LMC} - \widehat{HC}$$

or:

$$(2.3) \qquad \hat{P}_O = FP_S - \hat{B} - \widehat{LMC} - \widehat{HC}$$

where:

$\hat{P}_O$ = estimated at-farm price with offsetting and marketing locally.

$\widehat{FP}_B$ = estimated futures buying price.

$\widehat{CP}_L$ = estimated local cash price

$\hat{B}$ = $FP_B - CP_L$ = estimated basis.

The estimated net at-farm price is the higher of $\hat{P}_O$ and $\hat{P}_D$. From equations 2.1 and 2.3 it is clear that $P_O \lesseqgtr P_D$ if $B \lesseqgtr ADC$. Thus we can define the target price as the futures contract selling price minus the smaller of $\hat{B}$ and $\widehat{ADC}$, minus LMC and $\widehat{HC}$.

From the definition of the target price presented above, one can see that five variables are needed to calculate the target price:

1) futures contract selling price,

2) $\hat{B}$,

3) ADC,

4) LMC, and

5) HC.

The futures contract selling price is the only variable that does not need to be estimated when the target price is calculated. The reason for this is that futures trading is conducted constantly, and in many cases trading occurs up to a year before the contract delivery time. All of the other variables must be estimated.

Table 1 illustrates the six steps in calculating the target price. We first assume that the cattle are to be marketed on August 15th. The second step is to decide on a futures contract. Since the cattle are to be marketed on August 15th, we use the August contract, which is trading at $32.45 on March 1st. The third step is to estimate the basis at the marketing date. The estimated basis ($\hat{B}$) is $ .55 for this example. The fourth step in calculating the target price is to estimate the additional delivery cost (ADC) which is $ .75 in this example. The fifth step in calculating the target price is to estimate the cost of hedging which includes commission charges and interest on the margin deposit. A hedging cost of $ .14 was calculated

Table 1. Example of the calculation of the target price

Target price on March 1st for August 15th marketing date		
August futures price on March 1st		\$32.45
Estimated basis ($\hat{B}$)	.55	- .55
Additional delivery costs (ADC)	.75	
Estimated hedging costs ($\widehat{HC}$)		- .14
Target price (P)		\$31.76

for the example in Table 1. The final step is to subtract the smaller of the estimated basis and the additional delivery cost, and the cost of hedging from the futures price. The resulting target price is \$31.76.

When deciding whether or not to hedge, the feeder needs to compare the target price with an estimated price. There are several ways to estimate the price without a hedge. For example the feeder might assume that the cash price at the beginning of the feeding period will equal the price at the end of the feeding period. A more sophisticated method for estimating the price is to use outlook information that perhaps has been developed using an econometric model.

Given an estimate of net returns with and without a hedge, a specific decision rule can be formulated. One rather simple decision rule would be to hedge if the target price is greater than the forecasted cash price and to not hedge if the target price is less than the forecasted cash price. More sophisticated rules may be developed by taking into account the variability of prices with and without hedging and the feeder's attitude toward risk.

Futures Option

The primary criterion for choosing a futures option is whether or not delivering on the contract is a relevant alternative for the feeder. If delivery is feasible then one decision rule is to use the futures contract maturing nearest to but not before the expected marketing date. The underlying reason for this is to give the feeder an opportunity to deliver on his contract, an opportunity that is not available when a later option is used. If delivery is entirely out of the question then other futures contracts could be used. One decision rule for choosing a futures option in this case would be to use the futures contract yielding the highest target price.

When to Place a Hedge

A third decision concerns when to place the hedge. This may be made in conjunction with the decision to place, or not place, a hedge. One decision rule may be to always hedge when the livestock are placed on feed. However a hedge does not necessarily have to be placed at the beginning of the feeding period; it may be placed anytime during the feeding period. A decision rule for placing a hedge during the feeding period might be to place a stop-sell order in a specified amount under the futures price when the cattle are placed on feed. Then if the futures price moves lower by this amount a hedge would be placed.

Proportion of Livestock to Hedge

Another decision concerns the proportion of the livestock to hedge. Rules for making this decision will not be formulated here, but they are discussed in Heifner (16) and Ward and Fletcher (31).

How to Lift a Hedge

Once the livestock are hedged the producer faces a decision as to how to lift the hedge. As we mentioned earlier there are essentially two ways to lift a hedge:

deliver on the contract, or execute an offsetting futures transaction. There are two factors to consider when choosing which method to use in lifting the hedge: net price received and the feasibility of the method. The decision rules for lifting a hedge at the end of the feeding period are:

a) if B is greater than ADC, then deliver on the contract (2.1),

b) if B is less than ADC, then lift the hedge by offsetting (2.3),

c) if B equals ADC, then both methods will return the same price.

These rules will give the feeder the highest net price at marketing time if he hedged. Table 2 illustrates these decision rules.

In part 2 of Table 2 we see the calculation of the net farm price. This calculation is the same as equation 2.1 except that we are now using actual figures rather than estimates. Using the procedure presented in Table 2 we obtain a net farm price of $31.21, if the hedge is lifted by offsetting. Part 3 of Table 2 shows the calculation of the net farm price if the hedge is lifted by delivering on the contract.

The calculation of the net price is the same as that presented in equation 2.1 or 2.3, again we are now using actual values for the variable rather than estimates. This calcu-

Table 2. Illustration of lifting a hedge

Part I		
Basis on August 15th		$ .85
ADC		.75
LMC		.25
Part II		
Net price if offset		
Local cattle price (CP_L)		$29.75
Futures transaction		
Sell - March 1st (FP_S)	$32.45	
Futures price on August 15th (FP_B)	30.60	
Gain or loss on futures	$ 1.85	1.85
Hedging costs (HC)		- .14
Net Price[a]		31.46
LMC		- .25
Net at-farm price		$31.21
Part III		
Net price if delivered		
Sell futures - March 1st		$32.45
ADC		- .75
Hedging costs		- .14
Net price[a]		31.56
LMC		- .25
Net at-farm price		$31.31

[a]The net price is equivalent to the target price presented in Table 1. If we want the net at-farm price then we must subtract LMC from the net price (eq. 2.1 and 2.3).

lation results in a price of \$31.31.

From the information presented in Table 2 we see that the higher net price would be obtained by delivering on the contract (\$31.31 versus \$31.21). If we look at our rules we see that they would have given the same results, i.e., deliver on the contract. These results would have been obtained because B was greater than ADC (\$ .85 > \$ .75), and according to rule (a) the higher net price results from delivering on the contract if B > ADC.

The above criteria can only be used when delivery is allowed and the livestock meet delivery requirements, otherwise offsetting is the only feasible alternative because the feeder cannot deliver on the contract.

When to Lift the Hedge

The decision as to when to lift the hedge has been rather actively debated. Some futures market specialists say that a hedge should only be lifted at the end of the feeding period as was discussed above. Others feel that in certain situations a hedge should be lifted before the end of the feeding period. Thus one decision rule might be to lift the hedge if the futures price rises a specified amount above the price at which the contract was sold.

When and Whether to Replace the Hedge

The last decisions to be discussed, when and whether to replace a hedge, are relevant only if the hedge is lifted before the end of the feeding period.

The decision as to whether or not to replace the hedge could be based on the decision rules mentioned in the section on whether or not to hedge. The decision maker also could use the decision rules previously mentioned when a decision to replace the hedge is needed.

We have shown that a hedging strategy consists of rules for making decisions. These decisions are:

a) whether or not to place a hedge,

b) which contract to use in placing the hedge,

c) when to place the hedge,

d) what proportion of the livestock to hedge,

e) how to lift the hedge,

f) when to lift the hedge, and

g) whether and when to replace the hedge.

CHAPTER III: LITERATURE REVIEW

Several studies have examined the profitability of hedging live cattle and live hogs. Among these are studies by Holland, Purcell, and Hague (18); Johnson (20); and Wood (35). These studies compared the mean and variability of net revenue for several alternative hedging strategies for both cattle and hog feeding enterprises.

The procedure employed in each study was to develop several alternative hedging strategies and then to test them using simulated feeding situations. The differences between the alternative hedging strategies concerned the rules for deciding whether or not to place a hedge.

The hedging strategies employed two kinds of decision rules: "naive" and "selective". A naive decision rule is one in which the feeder always takes the same action. An example would be: never hedge. A selective decision rule is one requiring the feeder to take a different action depending on the situation. An example would be: hedge if the target price is greater than the forecasted cash price, and do not hedge if the target price is less than the forecasted cash price.

In all three of the studies, two strategies involving naive rules for deciding whether to place the hedge were tested. One of these naive decision rules is: never hedge (routine nonhedging). The other is: always hedge (routine hedging). Routine hedging involves placing the hedge at the beginning of the feeding period and lifting the hedge when the livestock are marketed.

The researchers also developed various selective decision rules. These decision rules were based on such factors as the seasonality of prices, on the ability to lock in a profit at the beginning of the feeding period, and on whether the futures price was above the cash price at the time the hedge was placed.

Naive Strategies

The mean net return and the variance of the returns for each of the naive strategies are presented in Table 3. These results show that for cattle routine hedging reduces the variance of the feeder's net return, but it also results in a substantial reduction in average returns. Holland, Purcell, and Hague found that mean net returns increased from \$3.73 per head with a hedge to \$10.16 per head with no hedge. Accompanying this increase in mean net returns was an increase in the variance of the returns from \$135.64 per head with a hedge to \$454.71 per head without a hedge. Johnson found that with a hedge average profits were a negative \$ .56 per head compared to \$7.29 per head without

Table 3. Mean and variance of net returns from routine hedging and routine nonhedging for cattle and hogs: results of three separate studies[a]

	Study					
	Holland, Purcell, & Hague		Johnson		Wood	
Strategy	Mean net return $/head	Variance $/head	Average profits $/head	Variance $/head	Mean net return $/head	Variance $/head
Routine Hedge	$ 3.73	$135.64	$ -.56	$184.33	$16.09	$109.56
Routine Nonhedge	10.16	454.71	7.29	555.73	14.20	44.30

[a]Source: (18, 20, 35).

Table 4. Holland, Purcell, and Hague's selective hedging strategies for cattle (1965 - 1970): mean net returns and variance of returns[a]

Selective Strategy	Mean net return $/head	Variance $/head
1	$10.96	$407.97
2	4.45	324.68
3	10.32	301.95
4	9.17	322.23
5	11.63	438.85

[a]Source: (18).

a hedge. The variance of the profits increased along with the profits from $184.33 per head with a hedge to $555.73 per head without a hedge. However, Wood arrived at just the opposite results for hogs. That is, the mean net return with a hedge was $16.09 per head with a variance of $109.56 per head compared to a mean net return of $14.20 per head and a variance of $44.30 per head without a hedge.

Holland, Purcell, and Hague's Selective Strategies

Table 4 gives the mean net return and the variance of the returns from the five selective hedging strategies developed by Holland, Purcell, and Hague. The first strategy uses a decision rule based on the seasonal movement of cattle prices. The decision rule is to hedge the cattle only if they are to be marketed during the September - December period. The first line in Table 4 shows that by using this decision rule a feeder would achieve a mean net return of $10.96 per head with a variance of $407.97 per head.

The second strategy uses a decision rule wherein a hedge is placed if the "expected lock-in" is less than the mean net return from not hedging. The expected lock-in is the futures price minus the basis minus the cost of production, or the target price minus the cost of production. The mean net return from not hedging is the average return from past feeding operations where hedging was not used. The second line in Table 4 shows that this rule would have given the feeder a mean net return of $4.45 per head with a variance of $324.68 per head.

The third strategy, which gave a mean net return of $10.32 per head and a variance of $301.95 per head, is the reverse of the second; i.e., the cattle are hedged if the expected lock-in is greater than or equal to the mean net return without hedging. Holland, Purcell, and Hague justify this rule as follows:

> "a) if the expected lock-in return is greater than the average return, then attempt to guarantee that return by hedging, and b) if the expected lock-in return is lower than the average return, then gamble that product prices will increase and do not hedge" (18).

The fourth decision rule developed places a hedge if the expected net revenue is less than the mean net return without hedging and the expected lock-in is greater than zero. The expected net revenue is the projected value of the steer using a seasonal price index minus the cost of production using current grain prices. This strategy allows the feeder to hedge if his expected net return is unfavorable and there is hope of a favorable return from hedging. It also allows him to gamble and not hedge when fat cattle, feeder cattle, and grain prices indicate a favorable return. This decision rule yielded the results in line four of

Table 4: a mean net return of $9.17 per head and a variance of $322.23 per head.

The fifth strategy is a modification of the first strategy. Using this strategy all livestock marketed in the September - December period are hedged, but the option to hedge during the rest of the year is available. The decision rule is to place a hedge if there is a price decrease of more than $1.00 over any four week interval during the feeding period. Line five of Table 4 shows that this strategy yielded a mean net return of $11.63 per head and a variance of $438.85 per head. This was the highest mean return of any of Holland, Purcell, and Hague's hedging strategies.

In looking at the means and variances presented in Table 4, in general, we find that the higher the mean the higher the variance. Strategy three is an exception in that it yields the third highest mean, but it has the smallest variance of the five selective strategies. When the five selective strategies are compared to the naive strategies the selective strategies do fairly well. Three of the selective strategies yielded a higher mean net revenue and a smaller variance than the naive strategy of nonhedging. The mean net returns for the selective strategies were greater than the mean net return from routine hedging.

However none of the selective strategies could match the routine hedging strategy in the variance of returns.

Johnson's Selective Strategies

Johnson developed four selective hedging strategies. The mean and variance of the profits from his strategies are presented in Table 5. There appears to be no difference between Johnson's average net profit and Holland, Purcell, and Hague's mean net return.

Table 5. Johnson's selective hedging strategies for cattle (1964 - 1969): mean net profits and variance of profits[a]

Selective Strategy	Mean profit $/head	Variance $/head
Breakeven price	$ 7.14	$359.91
Futures - cash method	9.63	434.21
Contract - hedge method	8.40	116.27
Contract - reverse hedge method	16.66	440.77

[a]Source: (20).

Johnson's first selective strategy was based on the breakeven price. The decision rule was to place a hedge if the adjusted futures price, or target price, was more than the breakeven price of producing the cattle. The outcome of using this strategy is presented in line one of Table 5, where we find a mean profit of $7.14 per head and a variance of $359.91 per head.

The second strategy developed was called the futures - cash method. Using this decision rule the cattle are hedged only if the futures price for a contract maturing during the expected marketing period was greater than the cash price when the cattle were placed on feed. A mean profit of $9.63 per head and a variance of $434.21 per head were obtained by using this strategy.

Johnson's third strategy is identical to the second strategy except that if the cattle are not hedged using the second strategy they are sold on contract at the cash price prevailing at the time they are placed on feed. Line three of Table 5 shows that this strategy yielded a mean net return of $8.40 per head and an exceptionally small variance of $116.27 per head.

The fourth strategy that Johnson developed was called the contract - reverse hedge method. This strategy is the same as the third strategy except with this strategy if the feeder contracts the cattle he would then take a long position in the futures market. We can see in line four of Table 5 that even though this strategy had a very high mean profit per head of $16.66, the variance was also quite high at $440.77 per head.

In looking at Table 5 we find again that generally speaking the higher the mean return the higher the variance of that return. Johnson, however, appears to have an excellent strategy in his contract - hedge method. This method gives the third highest average profit of all his strategies, but the variance is the smallest of any of the strategies, including the routinely hedged strategy.

Wood's Selective Strategies

Wood developed five selective hedging strategies for hogs. The mean and variance of the net returns using these strategies are presented in Table 6. His first decision rule is the same as Holland, Purcell, and Hague's first selective strategy except that it is applied to hogs.

Table 6. Wood's selective hedging strategies for hogs (March 1966 - December 1970): mean net returns and variance of returns[a]

Selective Strategy	Mean net return $/head	Variance $/head
1	$14.57	$63.33
2	14.93	80.62
3	16.65	90.07
4	16.69	96.55
5	16.70	96.42

[a]Source: (35).

The first line in Table 6 shows the mean net returns of $14.57 per head and the variance of $63.33 per head which were obtained when this strategy was tested by Wood. Wood's second strategy, which gave a mean net return of $14.93 per head and a variance of $80.62 per head, is to place a hedge only if the seasonal price index in the planned month of sale is below the price index when the hogs are placed on feed.

The decision rule used in placing a hedge for Wood's third selective strategy consists of placing a hedge if the futures price for the option nearest the end of the feeding period is greater than the estimated seasonally adjusted cash price. The following procedure is used to calculate the estimated seasonally adjusted cash price: the seasonal index for the month in which the feeding period ends is divided by the seasonal index for the month in which the feeding period begins, this quantity is then multiplied by the cash price at the beginning of the feeding period. By using this strategy Wood obtained a mean net return of $16.65 per head and a variance of $90.07 per head.

The fourth strategy automatically hedges all animals whose feeding period ends in January while using strategy three for the rest of the year. The fifth hedging strategy differs from strategy four in that the hogs are automatically hedged if the feeding period ends in January or February. The fourth and fifth lines of Table 6 show that these two strategies gave almost identical results. The fourth strategy had a mean net return of $16.69 per head and a variance of $96.55 per head while the fifth strategy had a mean net return of $16.70 per head and a variance of $96.42 per head.

As with the two previous studies discussed, Wood found that the higher the mean net return the higher the variance of the return (Table 6), (35). Wood's selective strategies three, four and five, performed rather well when compared to the routine hedging strategy. These three strategies gave a higher mean net return and a lower variance than did routine hedging. None of the selective strategies could match the mean net return and variance from routine nonhedging.

Conclusions

In looking at the results from the twenty strategies presented we find that generally speaking the greater the mean net return the greater the variance in that return. This would indicate that at least with the strategies presented the feeder has to take a smaller return in order to reduce his risk. So, of the strategies presented, there is no one best strategy. Rather the feeder needs to evaluate his own risk taking ability and then pick a strategy that fits his circumstances.

The strategies that were used in these studies are deficient in five respects. First, using the mean net return from past years, as was done in Holland, Purcell, and Hague's second selective strategy (18), does not appear to be a very good indicator of expected returns without hedging. Rather, a forecast of expected returns for the particular feeding period would seem more appropriate. Second, according to economic theory, production should not proceed if at least the variable costs cannot be recovered. Thus the idea of starting production when an adequate return cannot be expected is economically unwise. However, this appears to be the case with Holland, Purcell, and Hague's third selective strategy where they gamble on higher prices if the expected lock-in return is lower than the past mean net returns.

Third, Johnson's second selective strategy appears to be based on the rather naive assumption that if the futures price is above the cash price at the beginning of the feeding period this relationship will remain throughout the feeding period. Fourth, in many of the strategies the futures price is not localized, or a target price is not used. This would tend to distort the futures price relative to the cash price and not give an accurate comparison to the cash and futures prices. The strategies suffering this weakness are Johnson's futures-cash method and contract reverse hedge method (20), and Wood's third selective strategy. Fifth, none of the hedging strategies allowed the feeder to lift his hedge by delivering on the contract, all hedges were lifted by offsetting.

This research will differ from past studies in several respects. First, the strategies presented above were tested using simulated feedlots. The cattle were placed on feed every week and fed for seventeen (17) or twenty (20) weeks. The hogs were placed monthly and marketed fourteen weeks later. This procedure, especially for cattle, appears to be quite satisfactory for large feedlots. But these feeding systems, and thus the results of the hedging strategies are not particularly applicable to the typical midwestern feeder. The midwestern feeder generally feeds only a few lots of cattle a year. These are the feeders that my feeding systems are designed for.

Second, we do not consider production costs, only the net price received. Production costs are not considered because we assume that the feeder has already made the decision to feed cattle. Thus he needs to decide on how to market these cattle to receive the highest net price. This is what our strategies will attempt to help him do.

Third, by using the target price instead of the futures price in our first and second selective strategies we will overcome the problem mentioned earlier with comparing the cash price and futures price. Fourth, all of our strategies give the feeder the option of lifting his hedge by delivering on the contract or offsetting and delivering locally, thus correcting one of the problems with the previous studies, i.e., no alternative methods of lifting the hedge.

CHAPTER IV: FEEDING SYSTEMS AND HEDGING STRATEGIES

The feeding systems presented here are designed to reflect the more common feeding systems used in the midwest. Three cattle feeding systems and three hog feeding systems will be discussed. In the latter part of this chapter the discussion will center around a description of the two naive and three selective hedging strategies that will be used in this study. The same naive and selective strategies will apply to both cattle and hogs.

Feeding Systems

Cattle feeding systems

Table 7 gives a brief outline of the cattle and hog feeding systems. Using the first cattle feeding system the cattle feeder would place 400 pound steer calves on feed November fifteenth. They are marketed on August fifteenth when they weigh approximately 1,100 pounds and grade choice. The second cattle feeding system will involve placing 600 pound yearling steers on feed on the first business day following January first. These cattle will be marketed at approximately 1,100 pounds on June fifteenth. Using the third cattle feeding system, 600 pound steers are

Table 7. Cattle and hog feeding systems

	Cattle Feeding Systems 1	2	3	Hog Feeding Systems 1	2	3
Date livestock placed on feed	Nov. 15	1st business day following January 1st	Apr. 15	July 1	Sept. 1	1st business day following Jan. 1st
Beginning weights (pounds)	400	600	600	40	40	40
Marketing date	Aug. 15	June 15	Dec. 15	Oct. 15	Dec. 15	Apr. 15
Marketing weight (pounds)	1,100	1,100	1,100	220	220	220

purchased on April fifteenth. They are grazed through the summer and then placed in the feedlot for finishing in the late summer. These steers will go to market on December fifteenth weighing approximately 1,100 pounds.

Hog feeding systems

All of the hog feeding systems place forty pound pigs on feed and market them as 220 pound hogs. The hog feeder using the first hog feeding system would place hogs on feed on July first and market them on October fifteenth. Using the second feeding system, hogs placed on feed September first are marketed on December fifteenth. If the feeder used the third hog feeding system, he would market hogs on April fifteenth. These hogs were placed on feed on the first business day following January first. The feeder may have farrowed or purchased the pigs.

Hedging Strategies

Five different hedging strategies will be tested with each feeding system. Of the five hedging strategies four differ only in the criteria used to decide whether or not to place a hedge. The other hedging strategy includes selective rules for making more decisions. In addition to deciding whether or not to place the hedge, the feeder will need to decide when to place the hedge, when to lift the hedge, and whether and when to replace the hedge. Table 8 compares the five hedging strategies to be discussed.

Naive strategies

Two naive strategies will be tested. The first naive strategy is routine nonhedging; the second is routine hedging.

Selective strategies

Three selective hedging strategies will be tested. These are labeled: 1) futures-forecasted cash price strategy, 2) Bayesian strategy, and 3) ten-day moving average strategy.

Futures-forecasted cash price strategy (FFCP) The futures-forecasted cash price strategy involves forecasting the cash price for the expected marketing period and then comparing the forecasted cash price with the target price. A hedge is placed if the target price is greater than the forecasted cash price. If the opposite is true then no hedge is placed. The forecasting model that was used is described in the Appendix.

Bayesian strategy Bayesian decision theory is used to obtain a rule for deciding whether or not to place a hedge. There are three advantages to using

Table 8. Comparison of the five hedging strategies

	Routine Nonhedging	Routine Hedging	Futures Forecasted Cash Price (FFCP)	Bayesian Strategy	Ten-day Moving Average
How hedge is placed	No hedge placed	Automatically at beginning of feeding period	If TP> FCP, then a hedge is placed	Given Z_i then use a_i which maximizes net price	If the selling price is touched then hedge
When hedge is placed	----	At beginning of feeding period	At beginning of feeding period	At beginning of feeding period	Anytime during feeding period if criteria are met
When hedge is lifted	----	At end of feeding period	At end of feeding period	At end of feeding period	Anytime during feeding period if criteria are met
How hedge is lifted	----	a) delivering b) offsetting whichever gives the highest net price	a) delivering b) offsetting whichever gives the highest net price	a) delivering b) offsetting whichever gives the highest net price	Same as Routine Hedging unless during feeding period; then offset

a Bayesian strategy. First, a Bayesian strategy contains all admissible strategies. An admissible strategy is a strategy that is not dominated by another strategy. All admissible strategies are contained in the possible sets of prior probabilities that correspond to the Bayesian strategies. Second, a Bayesian strategy can always be a pure strategy. This eliminates the problem of choosing from among an infinite number of randomized strategies, and thus focuses attention on a finite number of pure strategies. Third, a Bayesian strategy is relatively easy to obtain computationally (14).

The information needed to obtain a Bayesian decision strategy, for a no data problem, is: a) the actions open to the decision maker, b) the possible states of nature facing the decision maker, c) the payoff resulting from each combination of actions and states of nature, d) the prior or subjective probabilities for the states of nature, and e) the objectives of the decision maker. The subjective probabilities are provided by the decision maker and represent his opinion about the occurrence of a certain state of nature.

The general procedure for finding the Bayesian strategy for the no-data problem, given the above information, involves multiplying the prior probabilities times the payoff and summing over each action. The result is called the expected payoff using prior probabilities. The decision maker's objectives then determine which strategy is chosen; e.g., if his objective is to maximize his expected revenue a strategy which maximizes expected revenue will be chosen.

Because we are using Bayesian decision theory to decide whether or not to hedge, we will illustrate the above procedure with a simple hedging example. In our example the actions open to the feeder (decision maker) are to hedge (a_1), or to not hedge (a_2). The possible states of nature are: 1) the net price is higher with a hedge (θ_1), or 2) the net price is lower with a hedge (θ_2). The payoff resulting from each combination of actions and states of natures are shown in Table 9A. Also shown in Table 9A are the prior subjective probabilities. The feeder's objective is to maximize his expected net price.

Table 9B shows the calculation of the expected payoff using prior probabilities. Because the feeder's objective is to maximize expected price, the feeder would choose action a_2.

The above procedure illustrates the no-data problem. We will now discuss the data problem. The data problem uses the same information as the no-data problem plus another set of conditional probabilities. The conditional

Table 9. Example of the computation of a Bayesian strategy

A.

	Payoff Table $U(\theta_i, a)$		Prior probabilities
	a_1	a_2	$P(\theta_i)$
θ_1	36.00	32.00	.40
θ_2	31.50	37.00	.60

B.

	$U(\theta_i, a)$		$P(\theta_i)$	$(P(\theta_i)U(\theta_i, a))$	
	a_1	a_2		a_1	a_2
θ_1	36.00	32.00	.40	14.40	12.80
θ_2	31.50	37.00	.60	18.90	22.20
Expected payoff using prior probabilities				33.00	35.00

C.

	Conditional probabilities $P(Z \mid \theta_i)$	
	Z_1	Z_2
θ_1	.80	.20
θ_2	.35	.65

D.

Strategies	Action taken after (Z_i)	
	Z_1	Z_2
S_1	a_1	a_1
S_2	a_1	a_2
S_3	a_2	a_1
S_4	a_2	a_2

Table 9. Continued

E.

	$P(Z \mid \theta_i)$ Z_1	Z_2	$P(\theta_i)$	Joint probabilities	Z_1	Z_2
θ_1	.80	.20	.40	$P(\theta_1)P(Z \mid \theta_1)$	.32	.08
θ_2	.35	.65	.60	$P(\theta_2)P(Z \mid \theta_2)$	.21	.39
				$P(Z)$	.53	.47

Action probabilities

$P(\theta_i \mid Z)$

P_1 $\frac{.32}{.53} = .60$ $\frac{.08}{.47} = .17$

P_2 $\frac{.21}{.53} = .40$ $\frac{.39}{.47} = .83$

F. $G(P(\theta_i \mid Z), a)$

	Z_1	Z_2
a_1	34.60	31.48
a_2	34.00	36.05

Maximizing strategy	a_1	a_2
	34.60	36.05

Weighted average payoff corresponding to the Bayesian Strategy

$$(34.60).53 + (36.05).47 = 35.27$$

probabilities are the probabilities that particular outcomes of an experiment will occur given each state of nature. The experiment gives additional information about the probable states of nature.

The procedure for determining the optimal strategy is slightly more complex for the data problem than for the no-data problem. First the possible strategies should be determined. Now the subjective probabilities $(P(\theta_i))$ and the conditional probabilities $(P(Z \mid \theta_i))$ are multiplied to form the joint probabilities $(P(\theta_i)P(Z \mid \theta_i))$. The conditional action probabilities $(P(\theta_i \mid Z))$ are found by dividing the joint probabilities by the marginal probabilities $(P(Z))$. The next step is to calculate the expected payoff of each action given a particular experimental observation $(G(P(\theta_i \mid Z),A))$. To do this the expected payoff of (θ_i,a_i) is multiplied times the conditional action probabilities and then summed over the actions.

Referring to the example in Table 9, the experiment used is to compare the target price to the forecasted cash price. The possible outcomes of the experiments are Z_1, the target price is greater than the forecasted cash price and Z_2, the target price is less than the forecasted cash price. Table 9C gives the conditional probabilities, while Table 9D shows a list of the strategies. The calculation of the conditional action probabilities is shown in Table 9E, while $G(P(\theta_i \mid Z), A)$ is shown in Table 9F.

Following the assumption that the feeders goal is to maximize expected net price, the feeder would take action a_1 if the outcome of the experiment is Z_1, and he would take action a_2 if the outcome of the experiment is Z_2. Thus the Bayesian strategy is strategy S_2 (Table 9D).

The value of the experiment can be obtained by subtracting the expected payoff for the no-data problem from the weighted average payoff of the optimal Bayesian strategy for the data problem. For the example presented in Table 9, the value of the experiment was \$ .27, which means that by using the experiment the producer's net price was increased \$ .27 above his net price without the experiment.

The actions, states of nature, and experiments that will be used to form a strategy for deciding whether or not to place a hedge are identical to those presented in the above example. We also assume that the feeder is trying to maximize his expected net price.

Ten-day moving average strategy   The third selective strategy uses the ten-day moving average (10-DMA) mechanical trading rule presented in Keltner (22). The first thing that one needs to do to use this rule is to calculate the average of the high, low and closing prices of the futures option to be used. This average should be calculated for each day beginning at least ten days before the cattle are to be placed on feed and continuing to the end of the feeding period. The past ten days daily averages are then used to calculate a 10-day moving average price (10-AP).

From the daily price range a 10-day moving average of the price range is calculated (10-APR). To find the buying or selling price, to be used for the next day, 10-APR is added to 10-AP (buying price) or subtracted from 10-AP (selling price).

An example of the use of the ten-day moving average rule is shown in Table 10. The example illustrates the rule applied to soybeans. An example using grain was used because the rule has been shown to work for grain, while its ability to determine when to take a position has not been proven with livestock.

The 10-day moving average (10-AP) is shown in column 6 of Table 10, while the 10-day moving average of the price range (10-APR) is shown in column 8 of Table 10. Columns 9 and 10 of Table 10 show the buying price and selling price to be used for the next day.

On June twelth a buying price of 210 7/8 and a selling price of 209 1/8 were calculated. The next day, June fifteenth, the market went above 210 7/8, thus a

Table 10. Ten-day moving average rule applied to Chicago November soybeans from June 1 to October 30, 1959[a]

(1) 1959	(2) High	(3) Low	(4) Close	(5) Average of High Low and Close	(6) Past 10-day Average Price (10-AP)
	Chicago November Soybeans				
June					
1	211 7/8	210 7/8	211 3/8	211 3/8	
2	211 5/8	211 1/4	211 1/2	211 1/2	
3	211 3/4	210 7/8	211 1/4	211 1/4	
4	211 1/4	210 3/8	210 7/8	210 7/8	
5	210 5/8	208 7/8	208 7/8	209 1/2	
8	209 3/8	208 1/8	209 3/8	209 1/8	
9	209 1/2	208 5/8	209 1/2	209 1/4	
10	209 3/8	208 3/4	209	209 1/8	
11	209	208 1/4	208 3/8	208 1/2	
12	209 1/2	208 1/2	209 3/8	209 1/8	210
15	211	209 3/8	211	210 1/2	209 7/8
16	211 5/8	210 1/4	211 5/8	211 1/8	209 7/8
17	211 1/2	210 5/8	210 7/8	211	209 3/4
18	211 3/4	210 1/2	211	211 1/8	209 7/8
19	212 3/8	210 1/2	212 3/8	211 3/4	210
22	212 7/8	212	212 3/4	212 1/2	210 3/8
23	212 3/8	210 7/8	210 7/8	211 3/8	210 5/8
24	212 3/8	210 3/8	212 3/8	211 3/4	210 7/8
25	212 1/2	211 1/2	212	212	211 1/4
26	212 1/4	211 5/8	212	212	211 1/2
29	212 3/4	211 1/4	211 3/8	211 3/4	211 5/8
30	211 1/8	210 1/4	211	210 3/4	211 5/8

[a]Source: (22).

(7) Price Range for Day	(8) Past 10-day Average Price Range (10-APR)	(9) Buying Price	(10) Selling Price	(11) Bought	(12) Sold
		(Good for next day)			
1					
3/8					
7/8					
7/8					
1 5/8					
1 1/4					
7/8					
5/8					
3/4					
1	7/8	210 7/8	209 1/8		
1 5/8	1		208 7/8	210 7/8	
1 3/8	1 1/8		208 3/4		
7/8	1 1/8		208 5/8		
1 1/4	1 1/8		208 3/4		
1 7/8	1 1/8		208 7/8		
7/8	1 1/8		209 1/4		
1 1/2	1 1/8		209 1/2		
2	1 1/4		209 5/8		
1	1 3/8		209 7/8		
5/8	1 1/4		210 1/4		
1 1/2	1 1/4		210 3/8		
7/8	1 1/4	212 7/8			210 3/8

contract was purchased for 210 7/8. The contract will be sold when the market falls below the selling price. This occurs on June thirtieth when the market falls below the selling price of 210 3/8.

The above procedure will be followed throughout the length of the feeding period. However, since we will be using this strategy for hedging we will not be interested in taking a long position. Consequently we will be looking for a selling price until a position is taken, then we will watch for a buying price at which to lift the hedge. This strategy will be used to place and lift a hedge anytime during the feeding period. So we could have a hedge placed and lifted more than once during the feeding period. If a hedge is lifted before the end of the feeding period it can only be lifted by buying back the contract, no movement of cattle will occur. If a hedge is still on when the cattle are to be marketed then the feeder will be given the option of delivering on the contract or offsetting, as was outlined in Chapter II. The cash price prevailing on the day the cattle are marketed will be used if there is no hedge in affect at the end of the feeding period.

CHAPTER V: ANALYSIS OF THE BASIS AND DETERMINATION OF THE TARGET PRICE

Cash and Futures Price Data

The data used in this analysis are the daily Omaha cash price for cattle, the daily Chicago-Peoria cash hog price, and the Chicago Mercantile Exchange futures price for live cattle and live hogs. The live cattle futures price was adjusted for Omaha delivery from 1964 through 1970 by subtracting $ .75 from the futures price. This adjustment was necessary because Omaha was a nonpar delivery point during this time, and a $ .75 per hundredweight discount was taken on cattle delivered there. In 1971 Omaha became the par delivery point for cattle and thus no adjustment has been necessary since then. The live hog futures price was not adjusted for delivery because Chicago-Peoria was a par delivery point.

Analysis of the Basis

We have previously defined the basis as the futures price minus the cash price. To be more specific the basis that we will examine is the difference between the near month futures contract price and the cash market price. In equation form we have:

(5.1) $B_{ij} = FP_{ij} - CP_j$ $i = 1,6; \quad j = 1,365$

where:

B_{ij} = basis for the ith option on the jth day.

FP_{ij} = futures price of the ith option on the jth day.

CP_j = cash price on the jth day.

Using equation 5.1 and adjusting for Omaha delivery we obtain the daily basis shown in Figures 1-8. In these figures the vertical axis measures the basis in dollars per hundredweight, while the horizontal axis indicates trading days. Each vertical represents the last day of trading for the particular option. So, in each case the near month period is presented.

These figures reveal several general trends. First, there is a seasonal pattern with the August basis and October basis being the lows for the year, and the February basis and December basis being the highs for the year. Second, the October basis tends to increase and to approach zero as the final day of trading is approached. This would seem to indicate that there is arbitrage between the October futures and the cash markets.

Again looking at Figures 1-8 one can see that the basis fluctuates quite substantially; not only from year to year and option to option but within an option. Table 11 shows the mean and standard deviation of the basis for each option month. The results presented in this table clearly

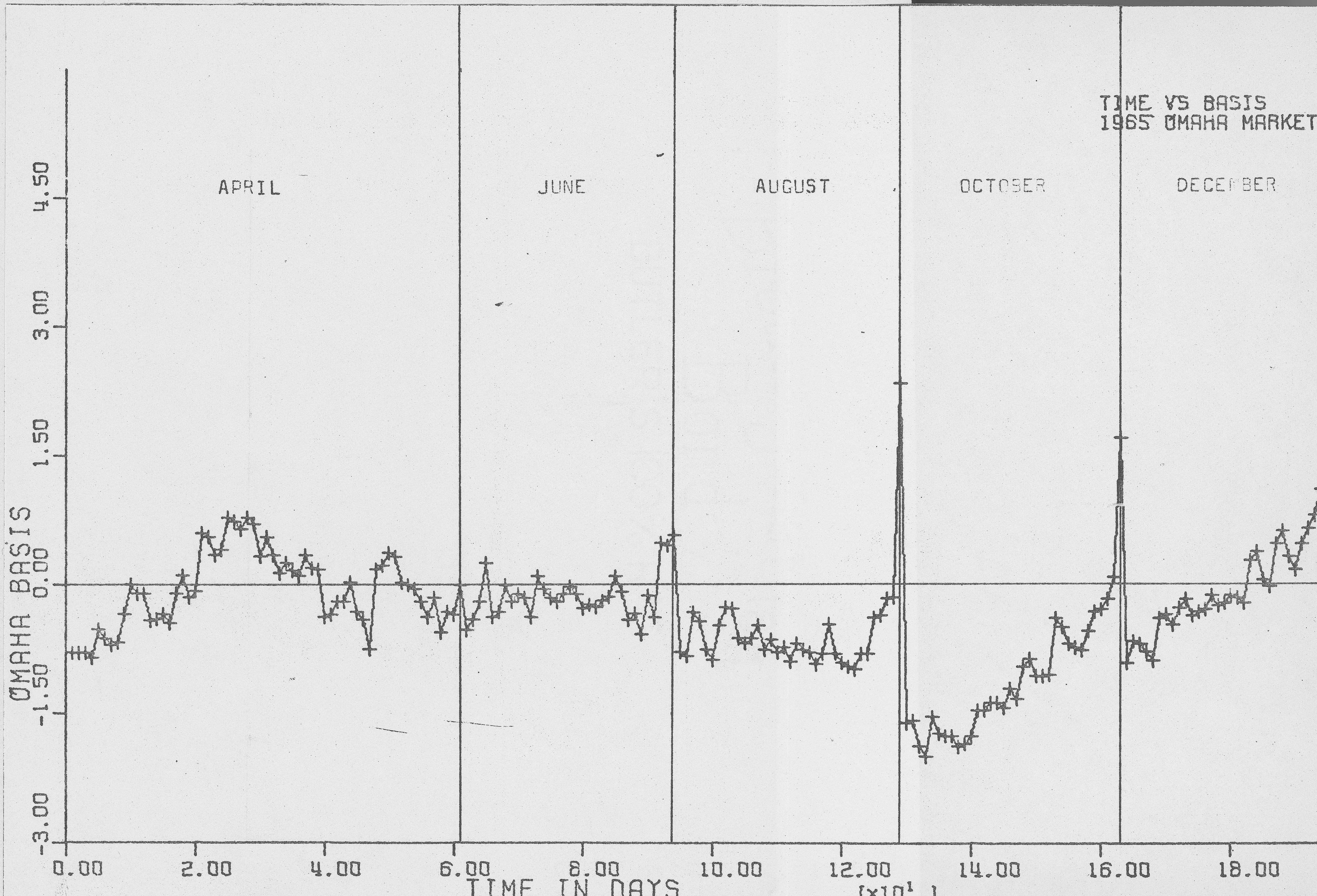

Figure 1. 1965 Omaha basis for cattle ($/cwt)

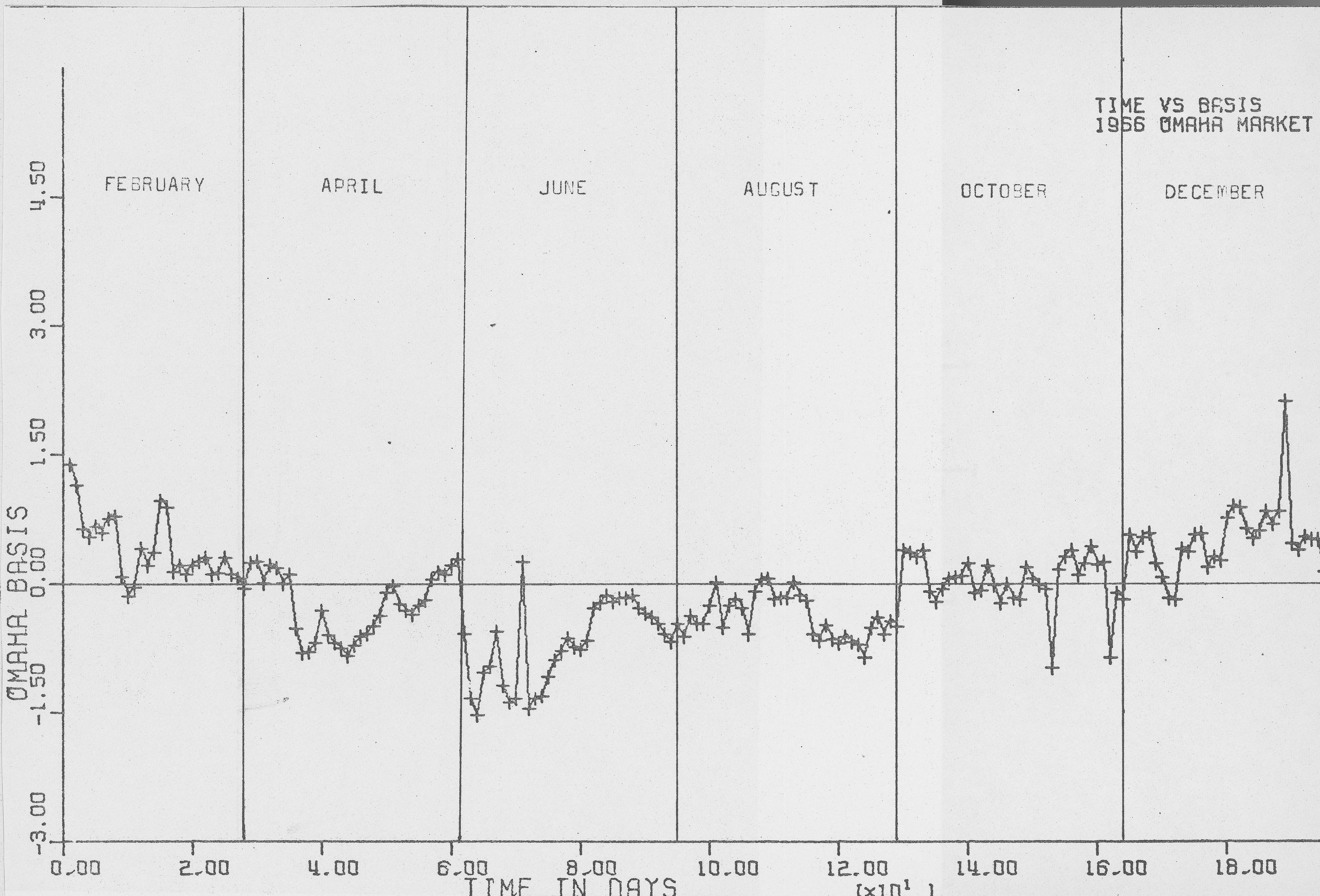

Figure 2. 1966 Omaha basis for cattle ($/cwt)

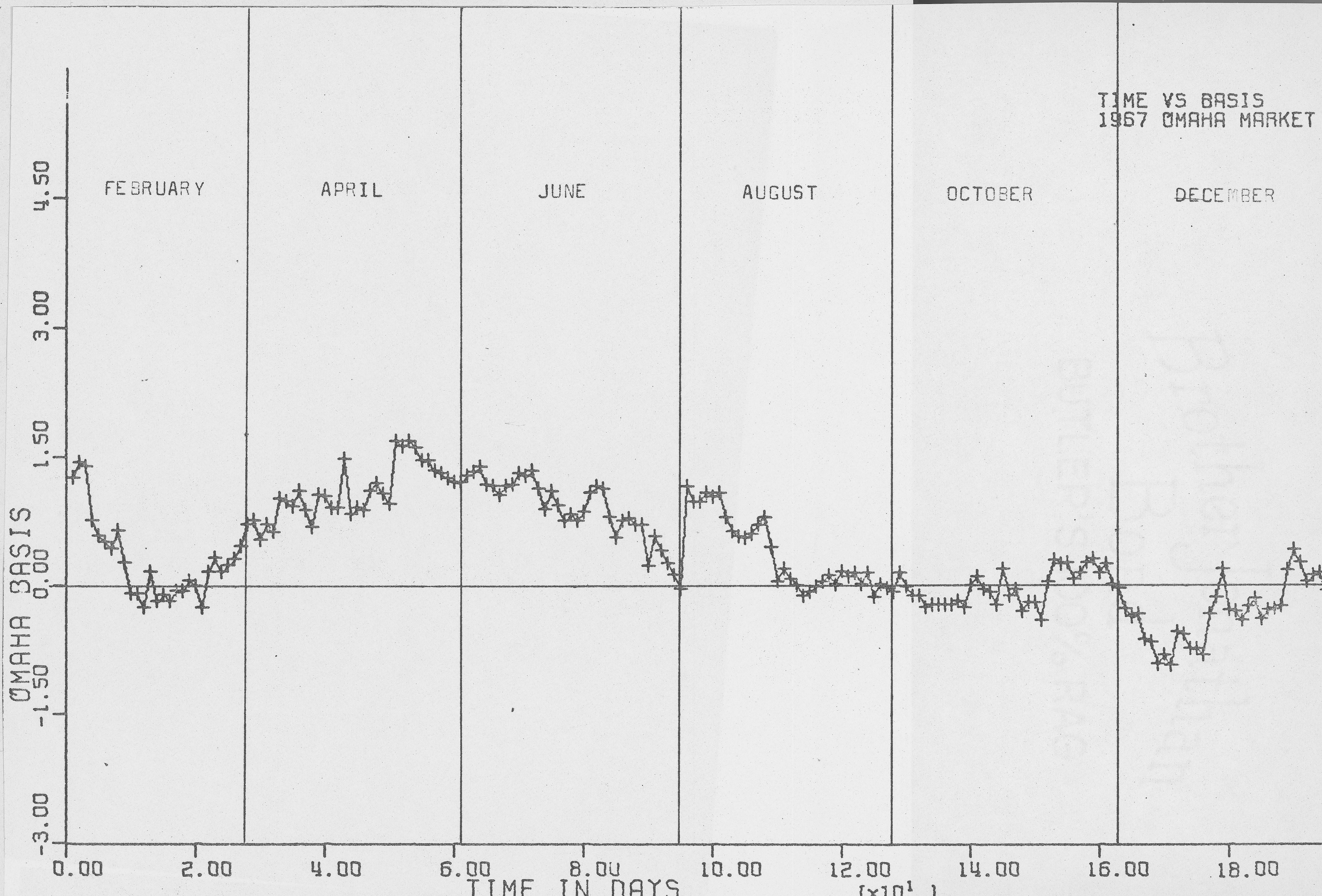

Figure 3. 1967 Omaha basis for cattle ($/cwt)

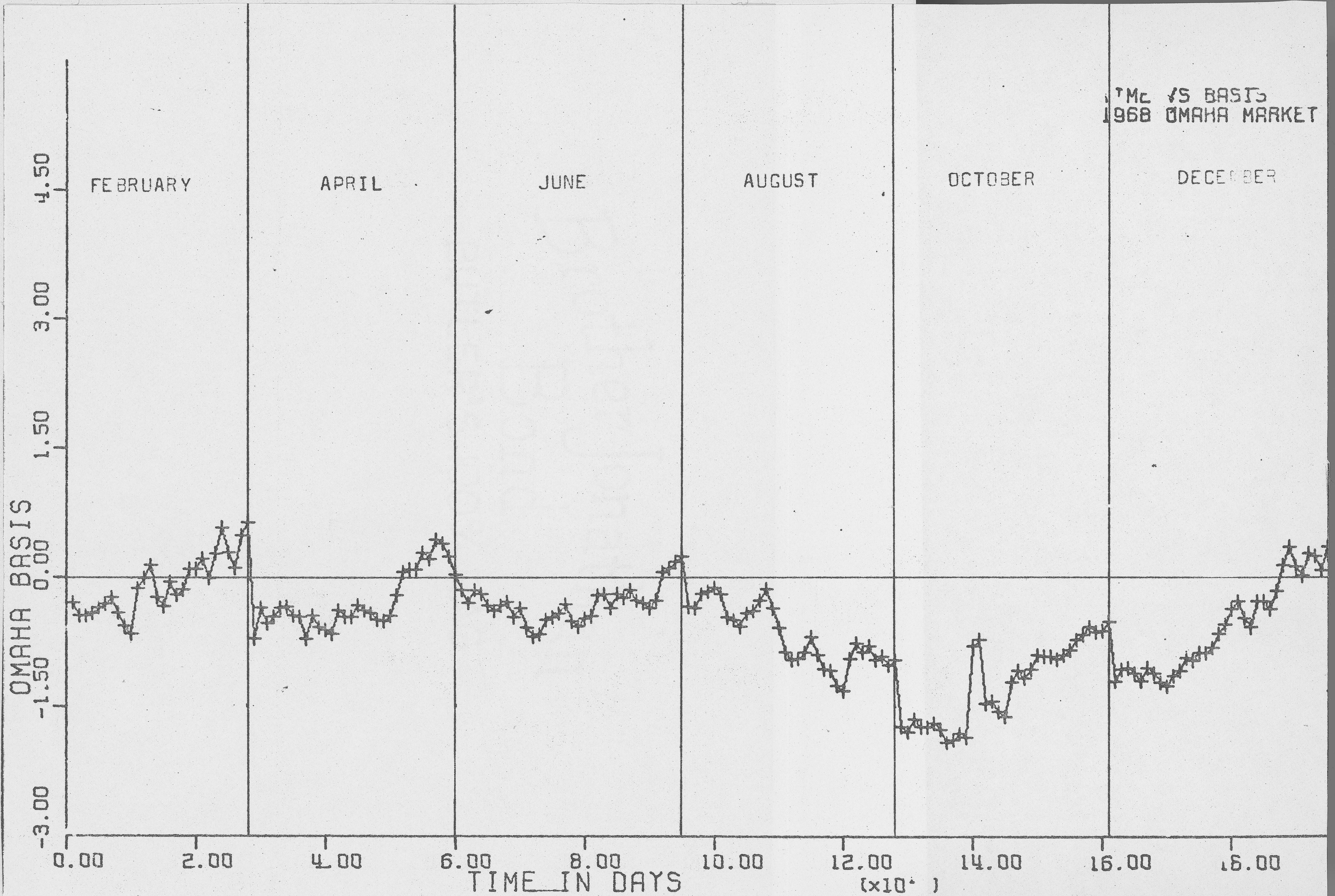

Figure 4. 1968 Omaha basis for cattle ($/cwt)

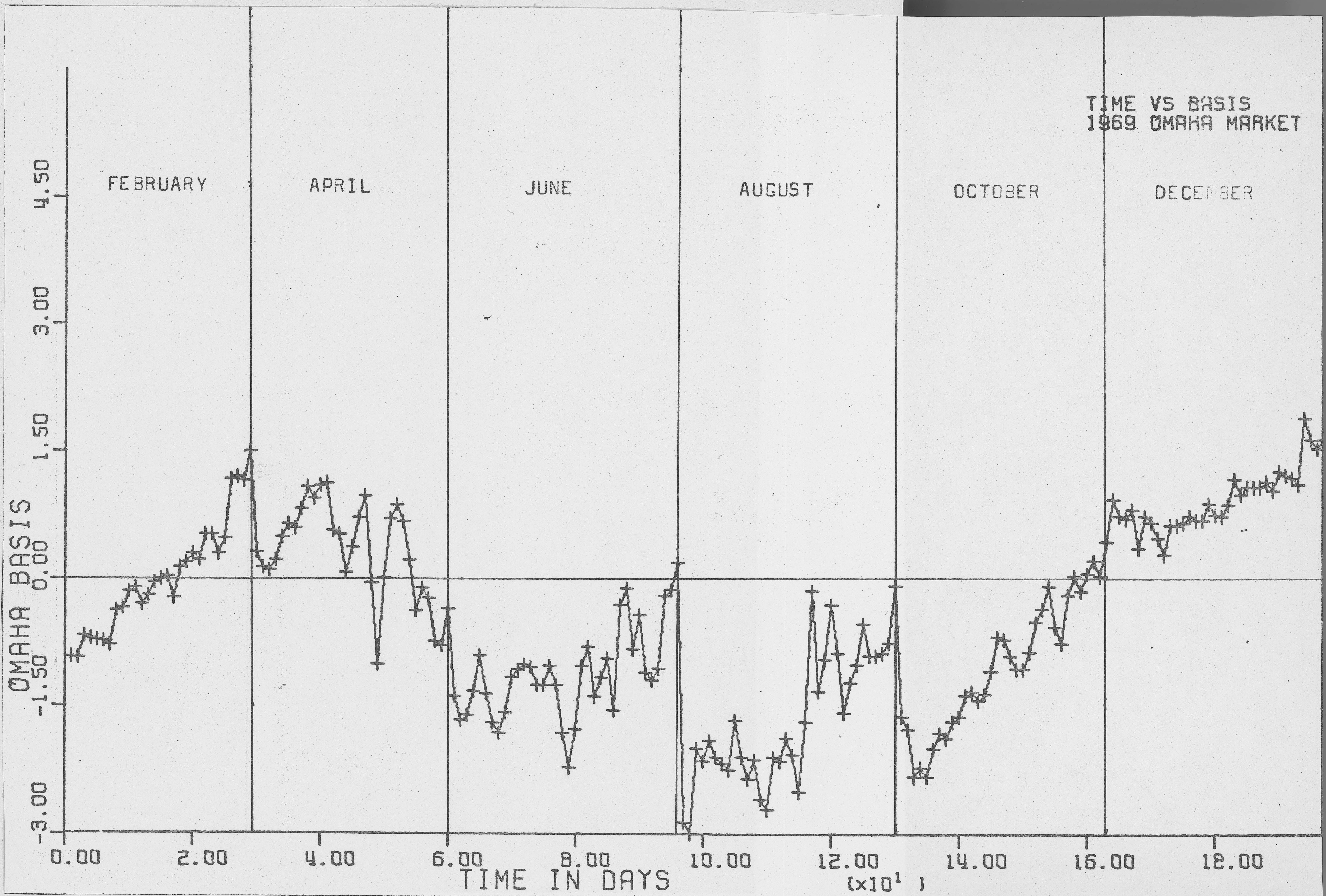

Figure 5. 1969 Omaha basis for cattle ($/cwt)

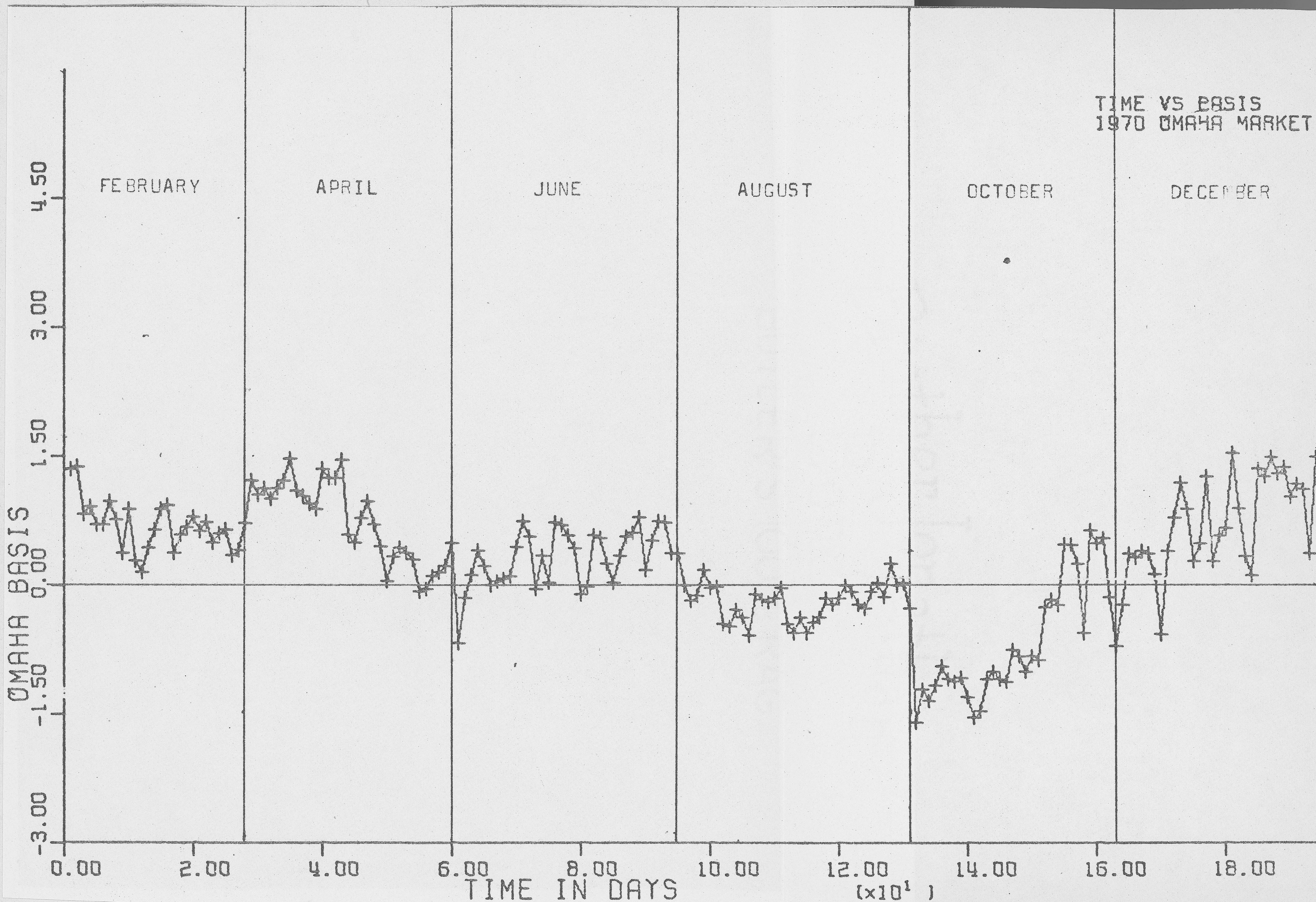

Figure 6. 1970 Omaha basis for cattle ($/cwt)

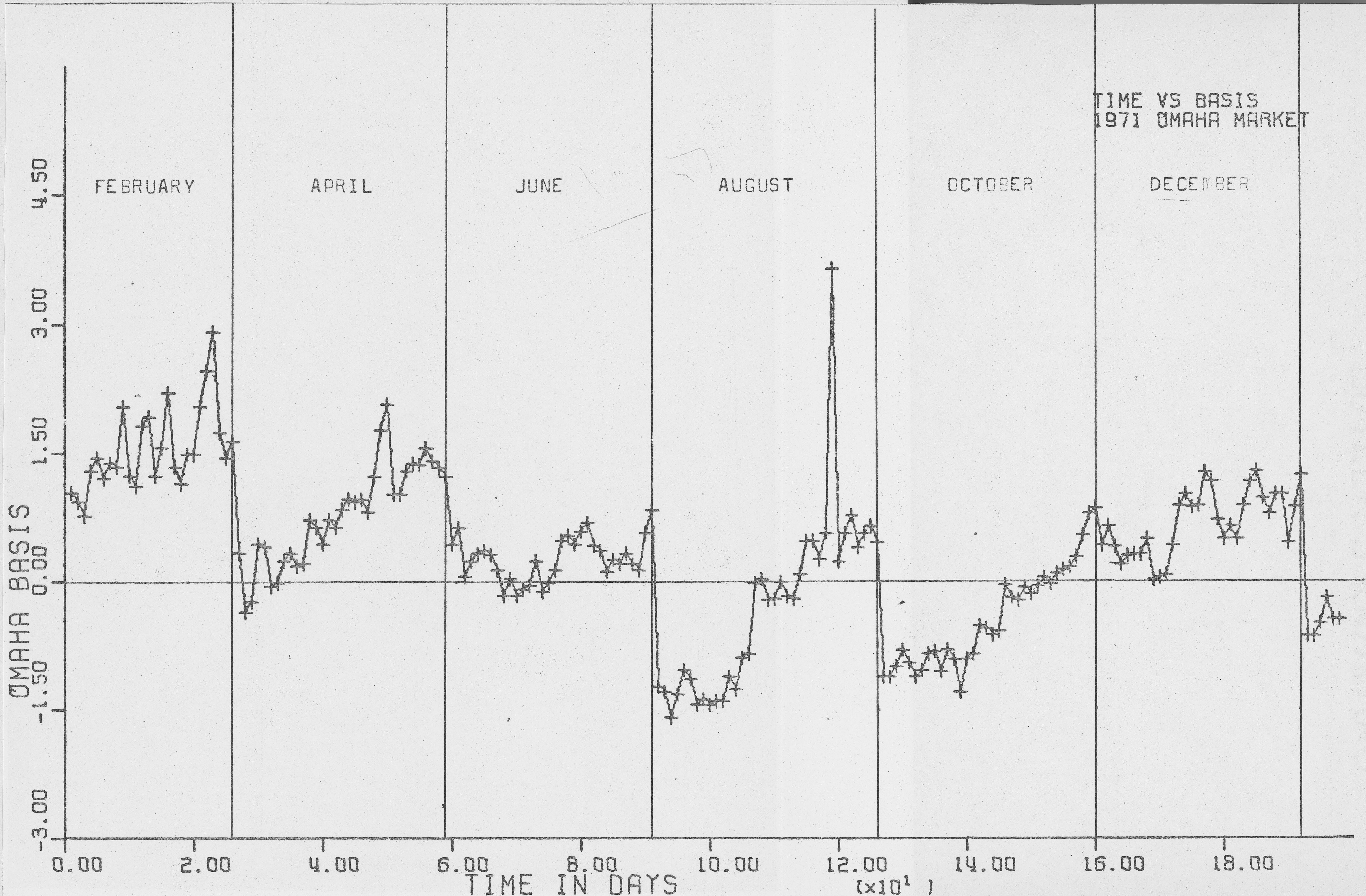

Figure 7. 1971 Omaha basis for cattle ($/cwt)

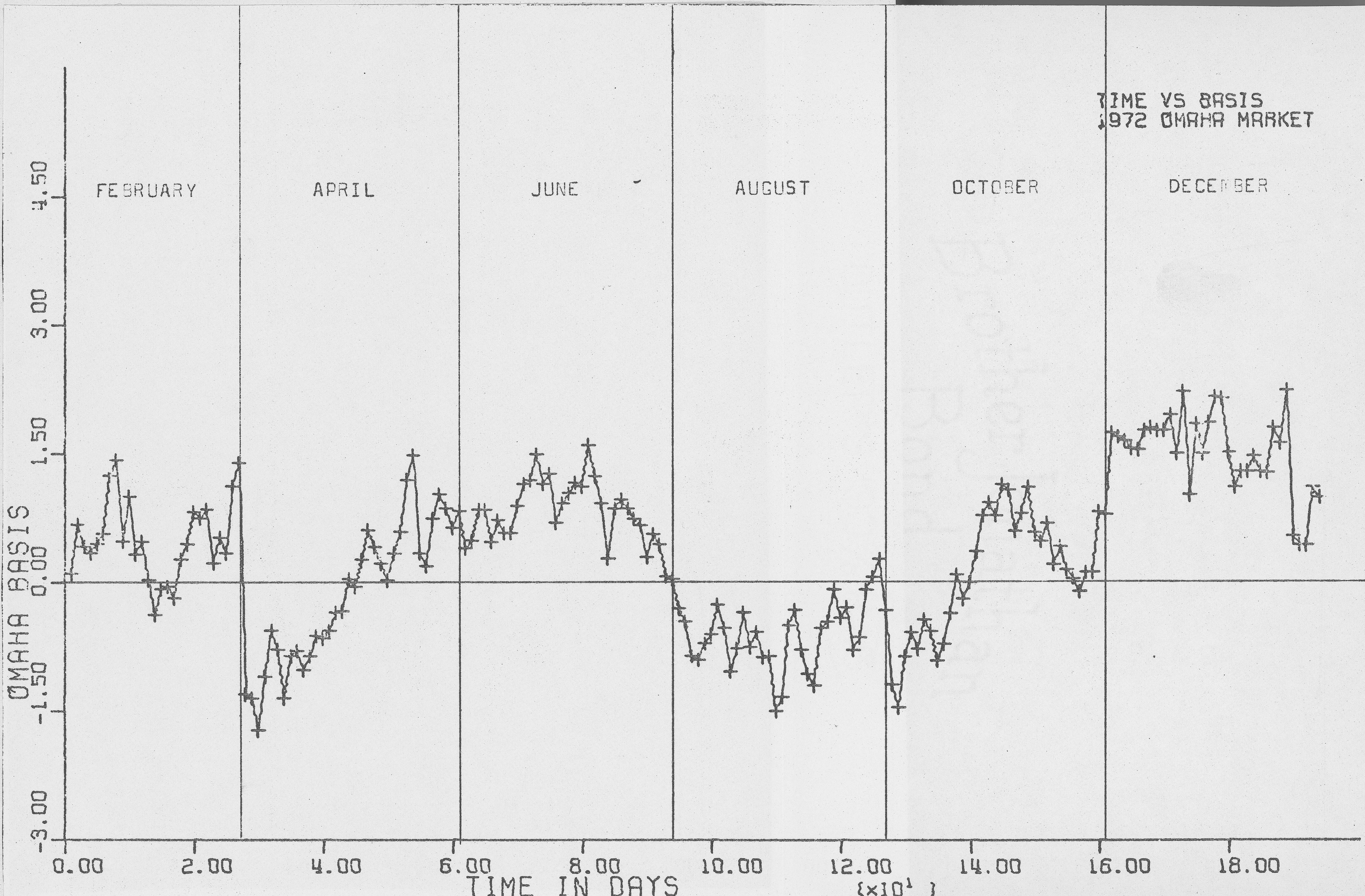

Figure 8. 1972 Omaha basis for cattle ($/cwt)

Table 11. Mean and standard deviation of the basis for cattle for each option month (1965-1972) in cents per hundredweight

	Mean (¢/cwt)	Standard Deviation (¢/cwt)
February	47.16	39.32
April	29.23	36.42
June	.19	36.38
August	-49.68	43.03
October	-51.73	34.63
December	45.47	36.25

Table 12. Mean and standard deviation of the basis for hogs each option month (1966-1972) in cents per hundredweight

	Mean (¢/cwt)	Standard Deviation (¢/cwt)
February	16.47	46.56
April	35.44	50.72
June	151.45	58.51
July	19.02	41.70
August	-55.78	43.51
October	-63.06	51.59
December	72.52	46.11

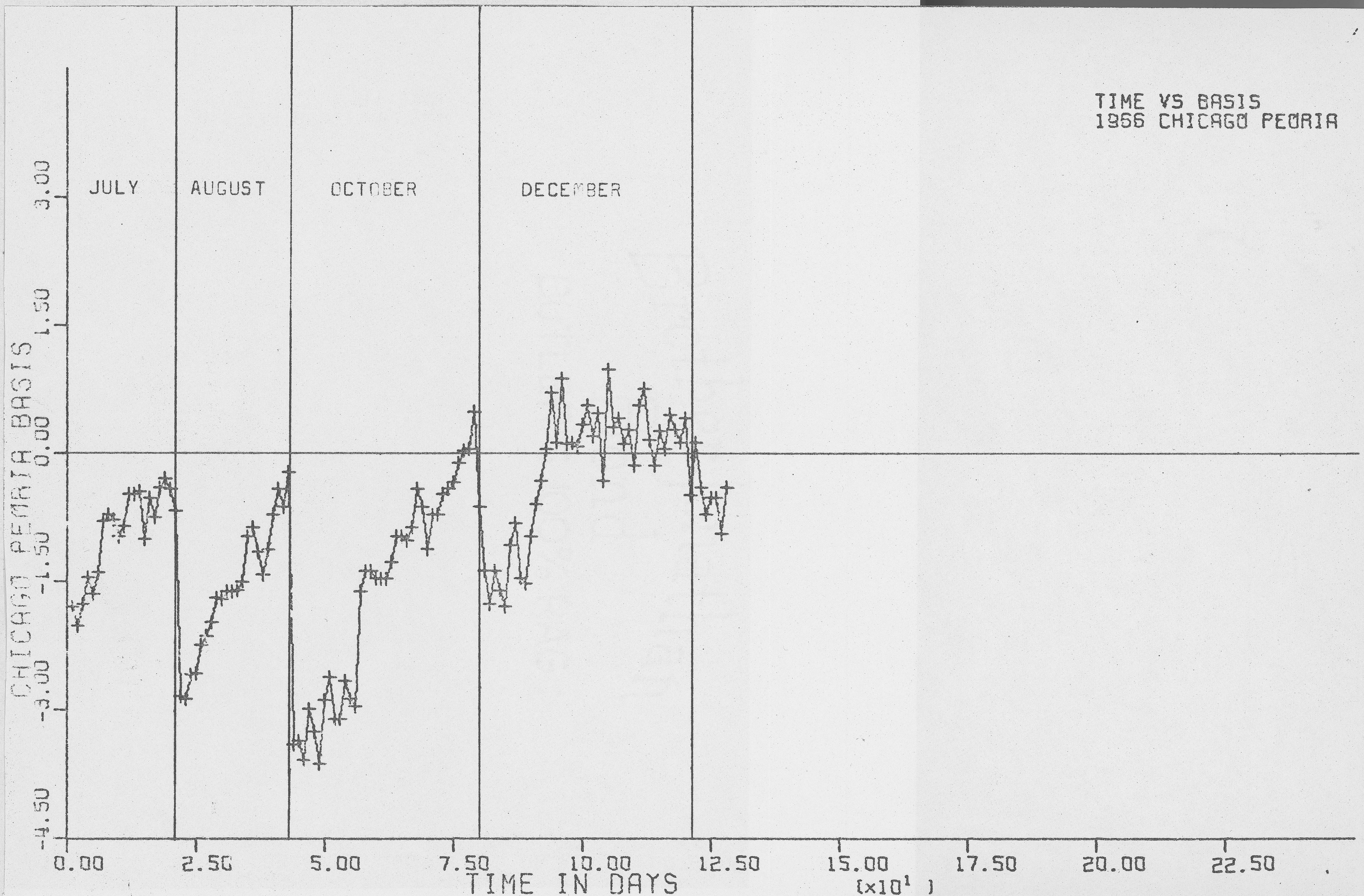

Figure 9. 1966 Chicago-Peoria basis for hogs ($/cwt)

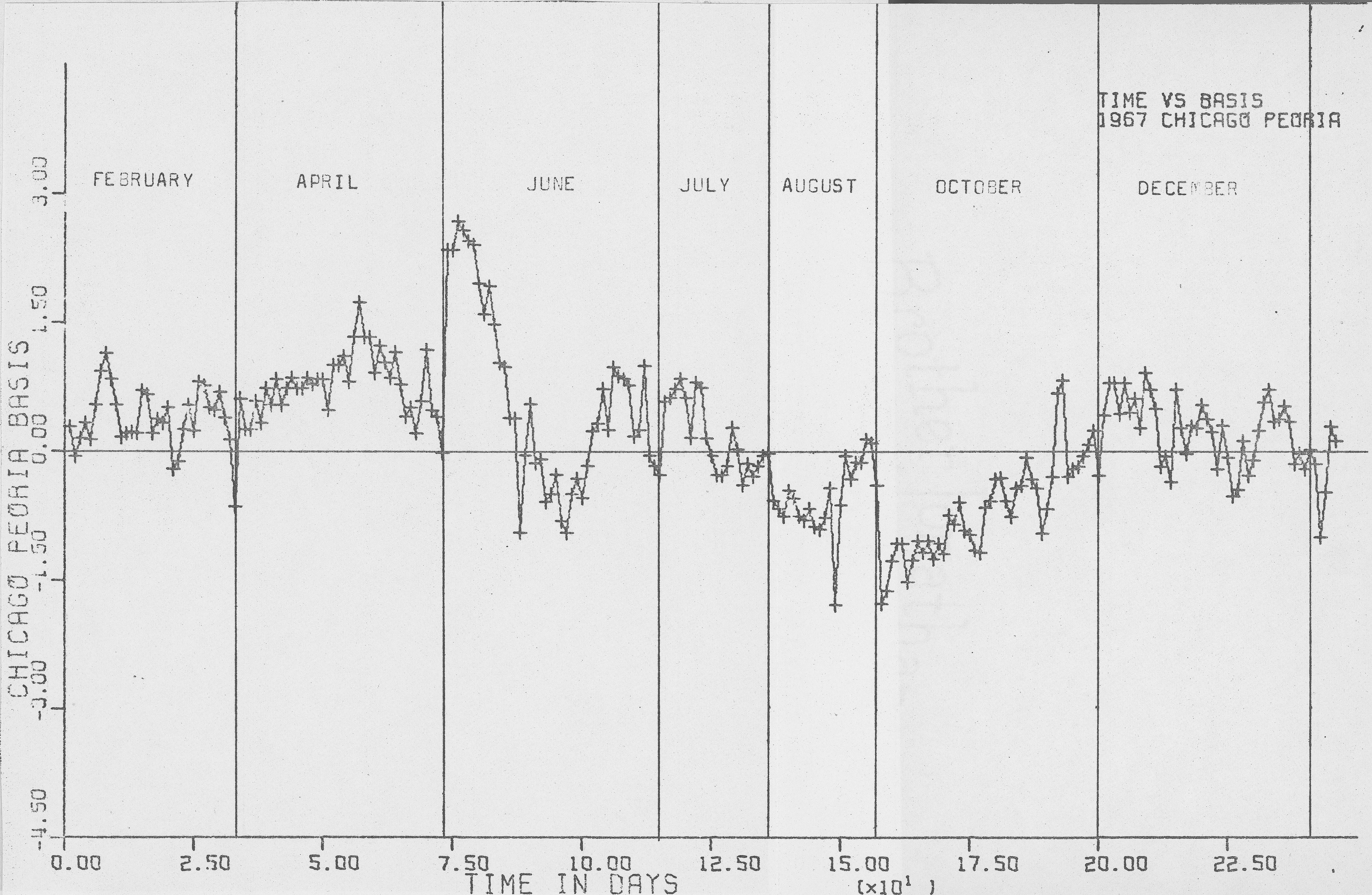

Figure 10. 1967 Chicago-Peoria basis for hogs ($/cwt)

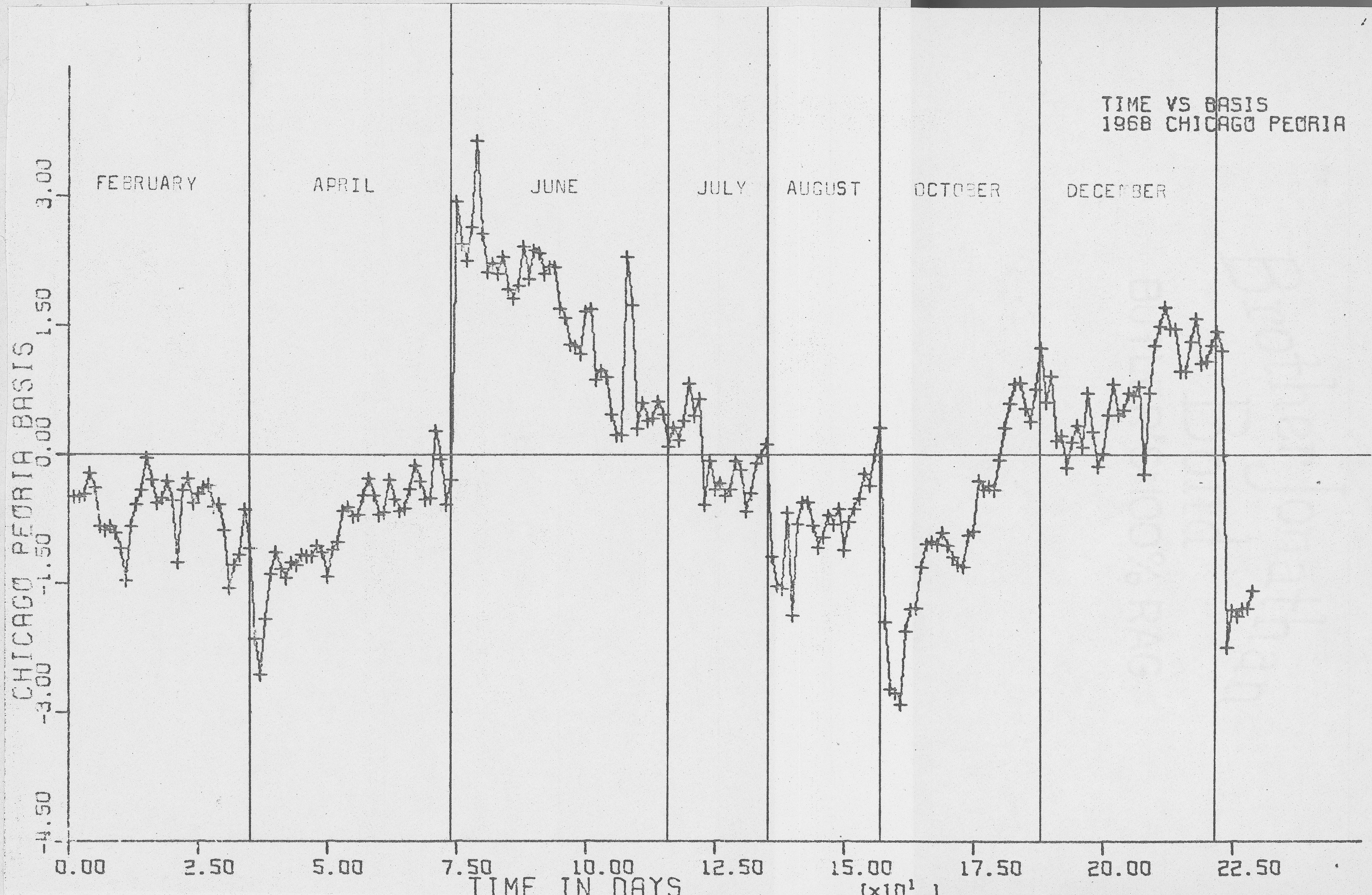

Figure 11. 1968 Chicago-Peoria basis for hogs ($/cwt)

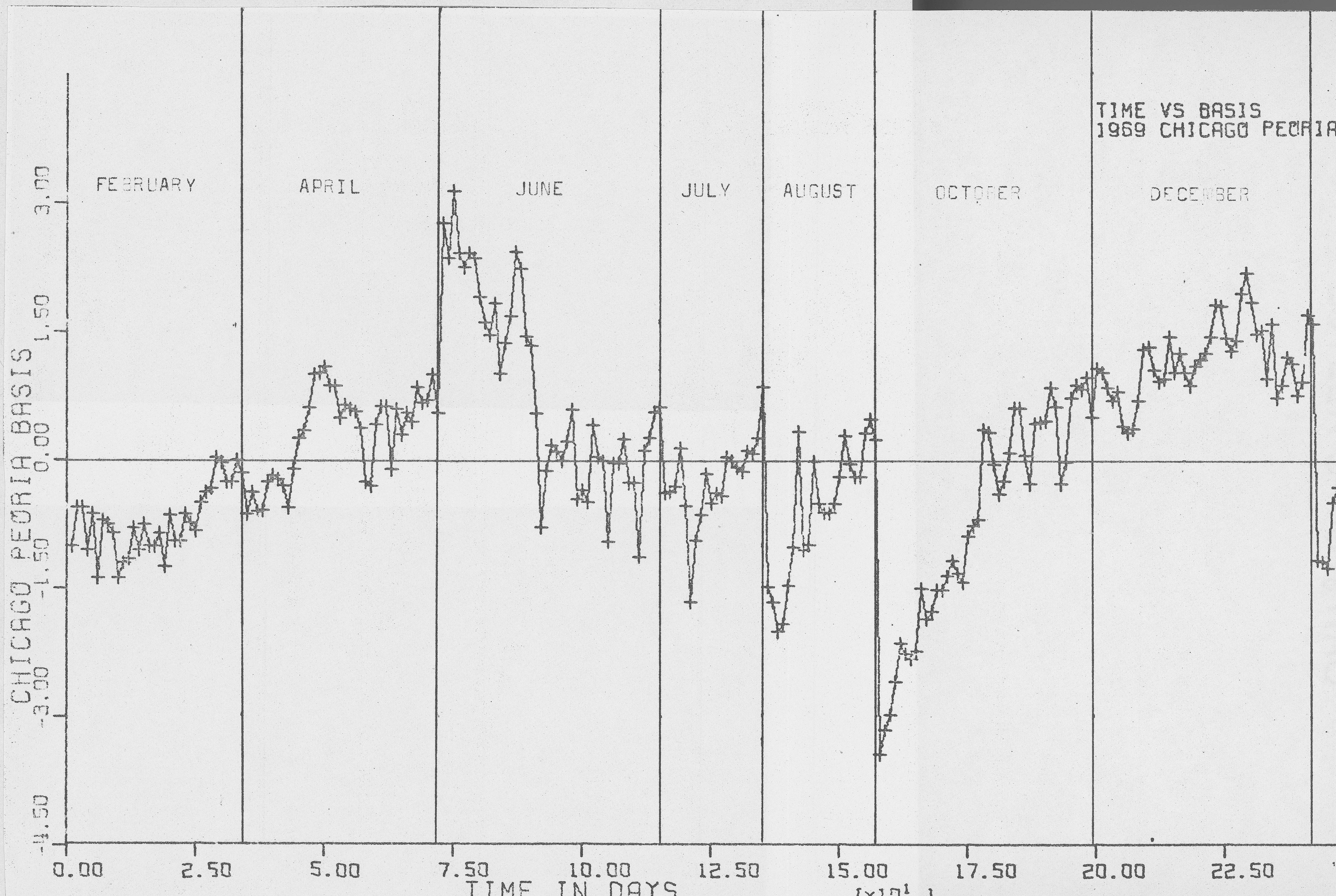

Figure 12. 1969 Chicago-Peoria basis for hogs ($/cwt)

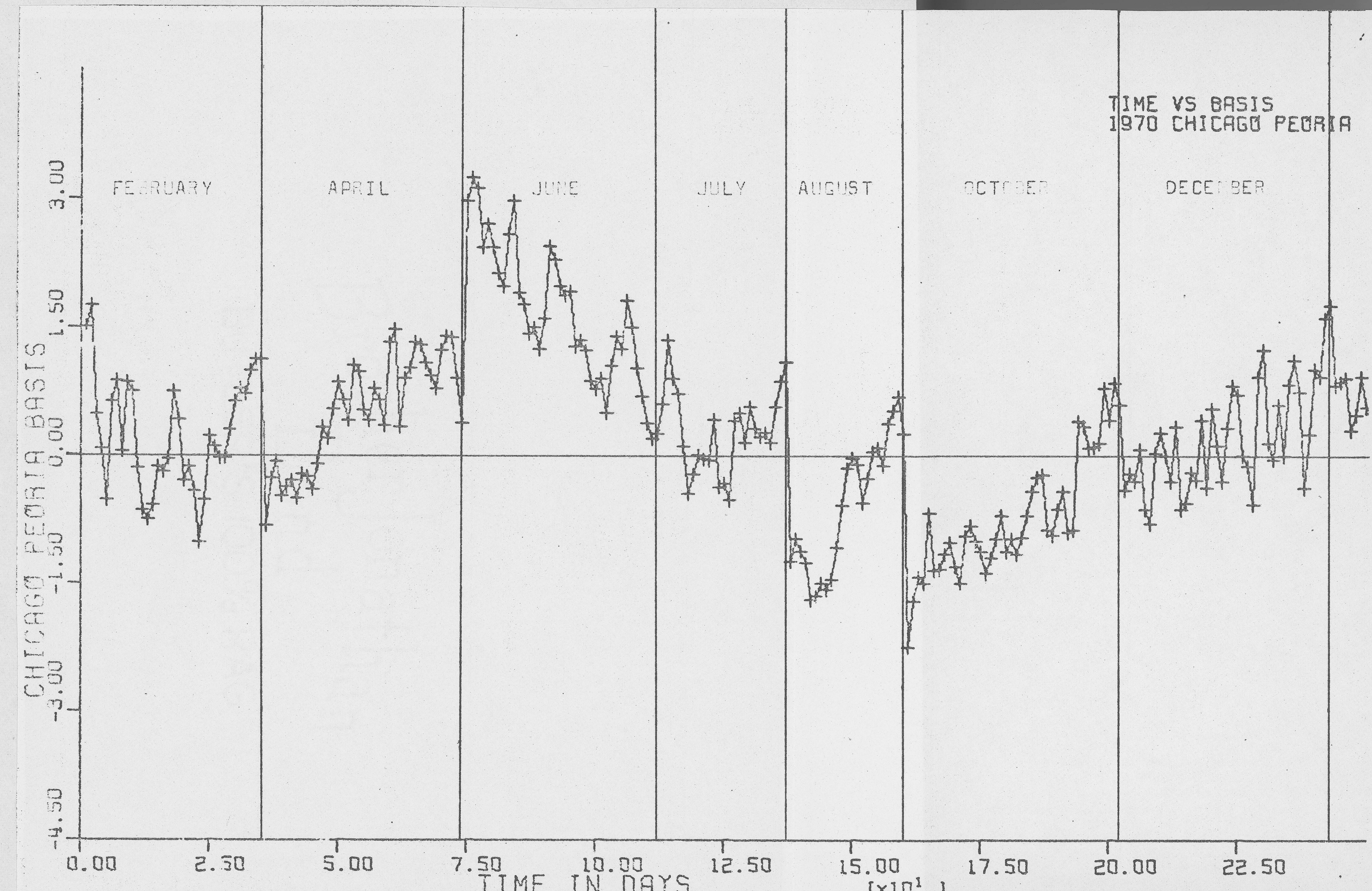

Figure 13. 1970 Chicago-Peoria basis for hogs ($/cwt)

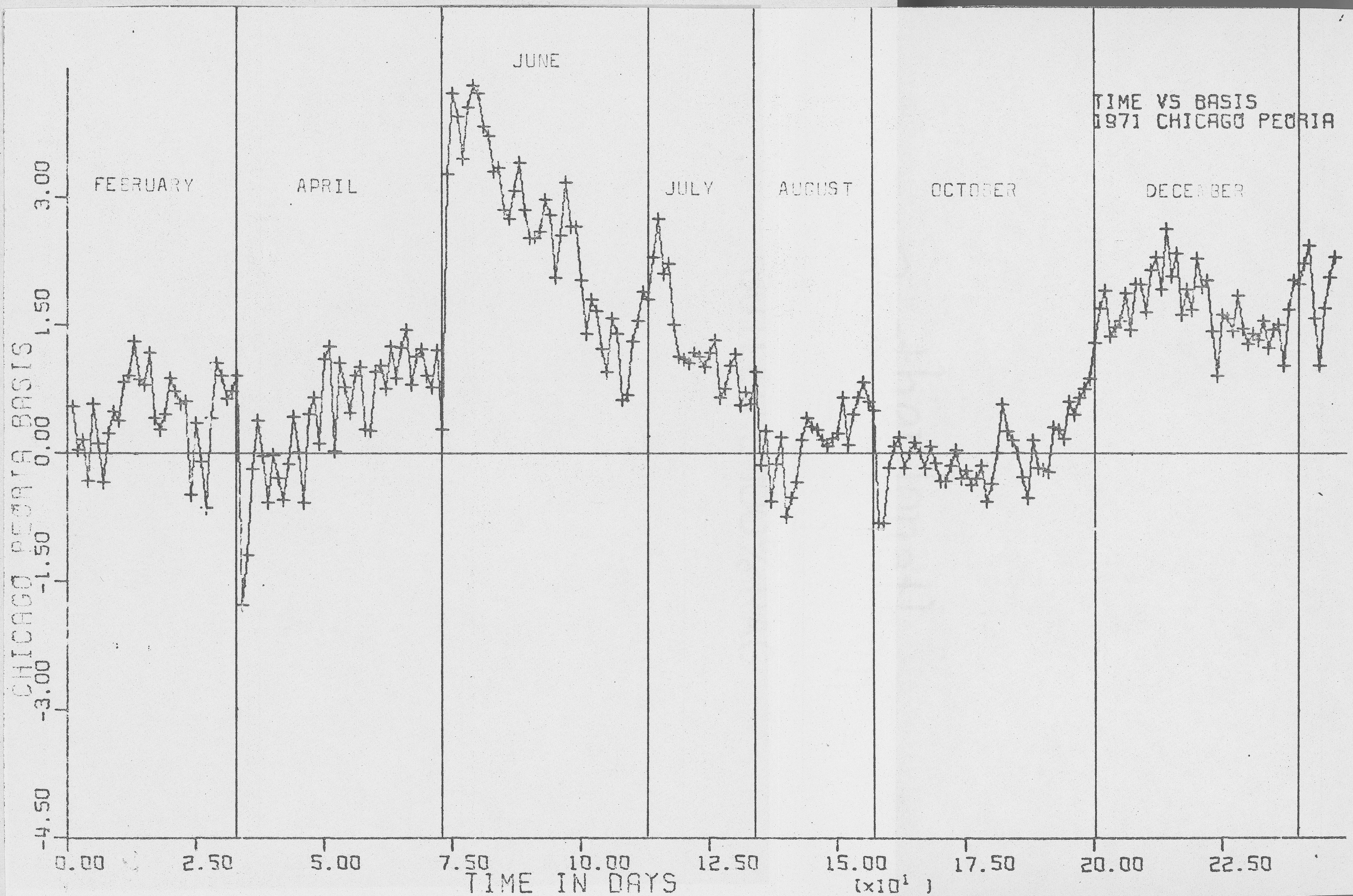

Figure 14. 1971 Chicago-Peoria basis for hogs ($/cwt)

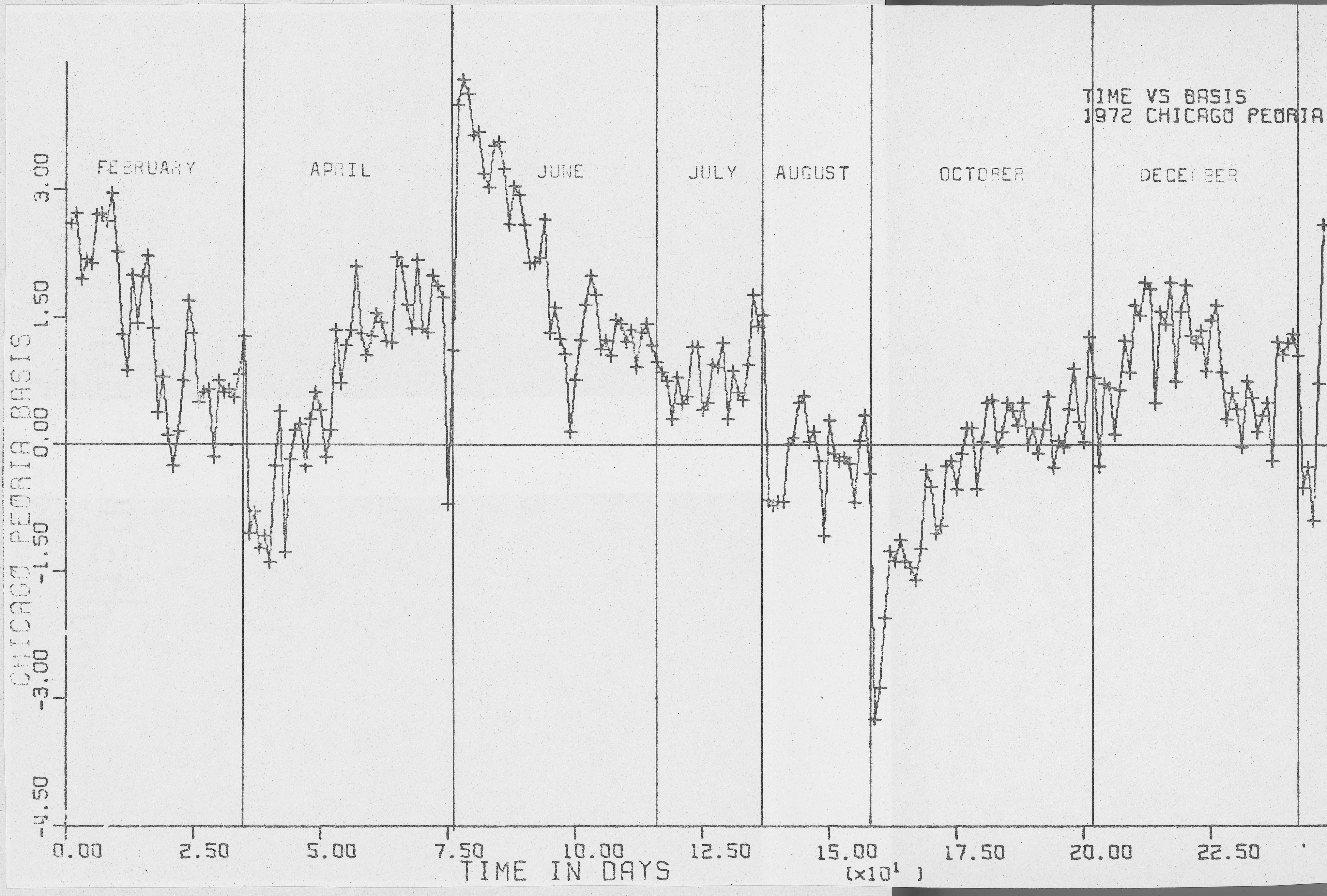

Figure 15. 1972 Chicago-Peoria basis for hogs ($/cwt)

show the seasonality of the basis and the large amount of variability in the basis in any option month.

Shown in Figures 9 through 15 is the basis for live hogs. These figures use the same format as those presented previously except in 1966 where the graph begins on June 22. In looking at these figures we can readily see a seasonal pattern with a definite peak occurring at the beginning of the near month period for the June option. The basis then declines to its low during the August and October options, peaking again during the December option. The only option that shows a definite trend towards zero, and an indication of arbitrage between the cash and futures markets is the June option. These figures also point out that there is a substantial variability in the hog basis much the same as there was for cattle. Table 12 shows the mean and standard deviation of the basis for each option month over the seven years. One can see from this table both the seasonal pattern and the large amount of variation in the basis.

Wildermuth and Gum (33) state that the close out basis (basis at the end of the feeding period) should equal zero. However, they also state that this situation is seldom achieved due to such factors as time, location, weight, and quality. We can then hypothesize that if proper weight and quality livestock (cattle or hogs) are delivered to an established delivery point during the delivery period arbitrage will cause the basis to equal zero.

A least squares regression model was used to test this hypothesis. An equation of the form:

$$(5.2) \qquad Y_{i,t} = B + B_1 Y_{i,t-1} + B_{2j} D + B_{3j} LT + E \qquad i = 1,6$$

$Y_{i,t}$ = the basis for the ith option on the t th day,

D = 1 if the t th day is a delivery day and otherwise D equals -1,

LT = linear time trend

was estimated for each option, and for all the options combined (full model). The lagged variable ($Y_{i,t-1}$) was included because the basis is a function of the previous day's basis in that the futures price is limited in the amount that it can change from day to day, and the cash price generally moves very little from day to day. The dummy variable for the delivery period (D) was included to test whether or not the basis during the delivery period is different from the basis during the rest of the final two months of the option. Since arbitrage is only possible during the delivery period, this test will indicate whether or not there is arbitrage between the cash market and the futures market during the delivery period. The linear time trend (LT) was used to test the hypothesis that the basis changes from year to year.

The left side of Table 13 shows the hypotheses that were tested using the model presented above, while the right side presents the conclusions that were drawn from

Table 13. Outline of the hypotheses tested and the conclusions drawn from them (cattle)

Hypotheses Tested			Conclusions
1.	$B_{0,1}=B_{0,2}=B_{0,3}=B_{0,4}=B_{0,5}=B_{0,6}$ $B_{1,1}=B_{1,2}=B_{1,3}=B_{1,4}=B_{1,5}=B_{1,6}$ $B_{2,1}=B_{2,2}=B_{2,3}=B_{2,4}=B_{2,5}=B_{2,6}$ $B_{3,1}=B_{3,2}=B_{3,3}=B_{3,4}=B_{3,5}=B_{3,6}$		The hypothesis was rejected at the 1 percent level.
2.	$B_{2,j} = 0$	$j = 1,6$[a]	The hypothesis was accepted at the 5 percent level for all options.
3.	$B_{3,j} = 0$	$j = 1,6$[a]	The hypothesis was accepted at the 5 percent for all the options except the December option.

[a] j = 1 = February option.
j = 2 = April option.
j = 3 = June option.
j = 4 = August option.
j = 5 = October option.
j = 6 = December option.

these tests. The first hypothesis tested examined the homogenity of the six equations. The calculated F value was calculated in the following manner:

$$F((G-1)_p;\ n-G_p) = \frac{\dfrac{\text{Constrained residual sum of squares from combined model} - \sum_{i=1}^{6} (\text{residual sum of squares from each model})}{(G-1)_p}}{\dfrac{\sum_{i=1}^{6} (\text{residual sum of squares from each model})}{n-G_p}}$$

The second hypothesis (B_2, j=0) and the third hypothesis (B_3, j=0) were tested using the t-test. The B coefficients and t values for cattle are presented in Table 14.

Turning to the right side of Table 13 we note that the six equations are not homogeneous, i.e., the first hypothesis was rejected. This would indicate that the coefficients for each option month are not equal. The acceptance of the second hypothesis would indicate that arbitrage is not a factor during the delivery period and thus the basis during the delivery period is equal to the basis during the rest of the near month period for the six live cattle options. Acceptance of the third hypothesis indicates that there is not a trend to the basis from year to year except for the December option

Table 14. Regression coefficients, t, R^2 and F values for each regression equation for each option and the full model for live cattle

	February			April		
	B	T	Prob>T	B	T	Prob>T
Intercept	-1.64	-.21		.30		
$Y_{i,t-1}$	.82	20.91	.0001	.86	25.32	.0001
D	3.79	1.18	.2365	-1.55	-.56	.5812
LT	2.43	1.66	.0953	.71	.69	.5028
R^2	.71			.74		
F	170.44			225.25		

	June			August		
	B	T	Prob>T	B	T	Prob>T
Intercept	-5.92			-4.53		
$Y_{i,t-1}$	.86	26.33	.0001	.82	22.53	.0001
D	-.22	-.08	.9335	3.71	1.15	.2488
LT	1.33	1.22	.2197	-.49	-.42	.6799
R^2	.76			.68		
F	267.46			176.33		

Table 14. Continued

	October			December		
	B	T	Prob>T	B	T	Prob>T
Intercept	-6.01			-3.89		
$Y_{i,t-1}$	.87	27.85	.0001	.82	22.02	.0001
D	4.12	1.51	.1293	5.22	1.86	.0600
LT	.53	.55	.5864	3.43	2.72	.0071
R^2	.79			.79		
F	321.70			312.41		

	Full Model		
	B	T	Prob>T
Intercept	-4.00	-1.68	.0895
$Y_{i,t-1}$	.88	71.97	.0001
D	2.06	1.72	.0813
LT	1.15	2.50	.0121
R^2	.796		
F	1910.07		

for which the hypothesis was rejected.

These same procedures were used to analyze the basis for live hogs. An outline of the hypotheses tested and the conclusions drawn from them are shown in Table 15, while the B coefficients and t values are shown in Table 16. Looking at the right side of Table 15 we see that the first hypothesis was rejected, thus indicating that the coefficients for each option month are not equal. This is surprising since hogs are supposedly more difficult to deliver than cattle due to the large number needed to fill the contract.

The second hypothesis was rejected for the June, August, and October options. The rejection of the second hypothesis for these three options would indicate that there is a difference in the equilibrium level of the basis between the delivery period and the rest of the near month period. Theoretically this difference should be due to arbitrage; whether or not it actually is, is matter that deserves investigation.

The presence of a year to year variation in the basis for each option month except April was confirmed by the rejection of the third hypothesis.

Since the variable representing the delivery period was significant in some option months and not in others, further investigation of the basis was conducted. The first step was to obtain regression

Table 15. Outline of the hypotheses tested and the conclusions drawn from them (hogs)

Hypotheses Tested			Conclusions
1.	$B_{0,1}=B_{0,2}=B_{0,3}=B_{0,4}=B_{0,5}=B_{0,6}=B_{0,7}$ $B_{1,1}=B_{1,2}=B_{1,3}=B_{1,4}=B_{1,5}=B_{1,6}=B_{1,7}$ $B_{2,1}=B_{2,2}=B_{2,3}=B_{2,4}=B_{2,5}=B_{2,6}=B_{2,7}$ $B_{3,1}=B_{3,2}=B_{3,3}=B_{3,4}=B_{3,5}=B_{3,6}=B_{3,7}$		The hypothesis was rejected at the 1 percent level.
2.	$B_{2,j} = 0$	$j = 1,7$[a]	The hypothesis was rejected at the 5 percent level for $j = 3,5,6$.
3.	$B_{3,j} = 0$	$j = 1,7$[a]	The hypothesis was rejected at the 5 percent level for $j = 1,3,4,5,6,7$.

[a]j = 1 = February option.
j = 2 = April option.
j = 3 = June option.
j = 4 = July option.
j = 5 = August option.
j = 6 = October option.
j = 7 = December option.

Table 16. Regression coefficients, t, R^2, and F values for each regression equation for each option and the full model for live hogs

	February			April		
	B	T	Prob>T	B	T	Prob>T
Intercept	-.20	-1.92	.0530		.03	.9750
$Y_{i,t-1}$	.83	21.89	.0001	.79	18.06	.0001
D	.03	.76	.5440	.03	.67	.5100
T	.05	2.44	.0150	.02	.90	.6250
R^2	.77			.65		
F	248.28			137.49		

	June			July		
	B	T	Prob>T	B	T	Prob>T
Intercept	-.06	-.57	.5733	-.25	-2.51	.0130
$Y_{i,t-1}$	.80	20.46	.0001	.68	10.80	.0001
D	-.10	-2.05	.0387	.02	.47	.6440
T	.07	2.78	.0060	.08	3.15	.0020
R^2	.76			.72		
F	250.39			105.31		

Table 16. Continued

	August			October		
	B	T	Prob>T	B	T	Prob>T
Intercept	-.53	-4.23	.0002	-.29	-3.05	.0029
$Y_{i,t-1}$	.57	8.88	.0001	.69	18.83	.0001
D	.17	4.13	.0002	.23	5.36	.0001
T	.08	3.31	.0016	.05	2.72	.0069
R^2	.67			.71		
F	89.55			217.43		

	December			Full Model		
	B	T	Prob>T	B	T	Prob>T
Intercept	.03	.46	.6500	-.07	-2.05	.0377
$Y_{i,t-1}$	.73	17.93	.0001	.87	68.43	.0001
D	.04	1.16	.2440	.03	2.24	.0239
T	.05	2.88	.0050	.03	3.80	.0004
R^2	.67			.79		
F	174.99			1905.95		

coefficients from the first-order difference equation 5.2 for each option month eliminating all insignificant variables. The regression coefficients from each of the thirteen first-order difference equations are shown in Table 17. The second step was to solve each of the equations. The general solution of a first-order difference equation ($Y_{t+1} + aY_t = c$; where a, c are constants) is of the form $Y_t = A(b)^t + Y_p$. This solution is obtained by summing two components: a) an equilibrium value (Y_p), and b) the general solution of $Y_{t+1} + aY_t = 0$, which is $A(b)^t$. To find b in $A(b)^t$ we assume that A, b $\neq$ 0 so we have $Ab^{t+1} + aAb^t = 0$, which after cancelling becomes $b = -a$. Y_p equals c divided by 1 plus a. For example, the general solution of the first-order difference equation $Y_{t+1} = 2.5 + .80Y_t$ is $Y_t = A(.80)^t + .125$. To find a particular solution the value of A must also be derived. A equals $Y_o - \frac{c}{1+A}$ or $Y_o - Y_p$, where Y_o is the initial value of Y.

From the general solution several conclusions can be drawn. First, the value of b indicates what time path the equation will follow. There are seven regions into which the value of b can fall, each indicating a different time path. See Figure 16. Second, the value of Y_p is the value that the time path converges to, or the equilibrium value. So, in our example the time path converges

Table 17. Regression coefficients for each option month after removing the insignificant variable

	February	April	June	July	August	October	December
			Cattle				
Intercept	7.280	4.260	.187		-8.430	-4.720	-5.499
$Y_{i,t-1}$	.839	.858	.872		.823	.892	.836
D							
LT							3.000
			Hogs				
Intercept	- .210	.066	-.063	-.204	-.533		.013
$Y_{i,t-1}$	.827	.804	.795	.716	.571		.737
D			.100		.167		
LT	.054		.071	.069	.078		.046

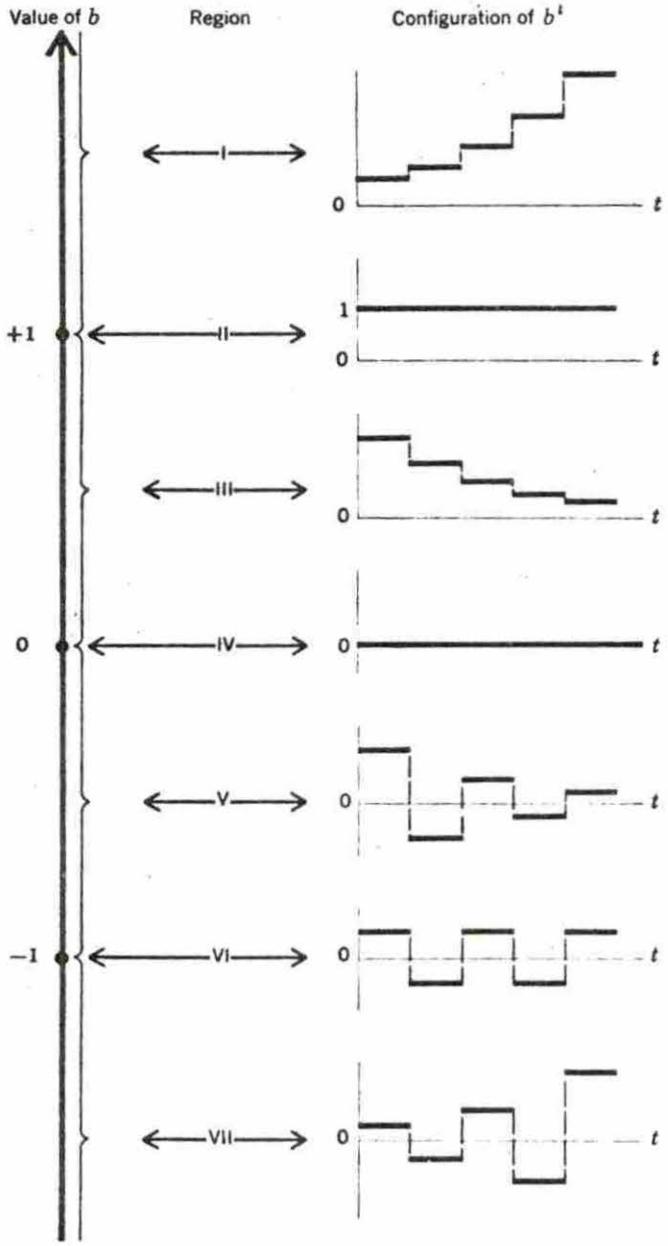

Figure 16. Time paths for various values of b (3)

to .125 from above. Third, the value of A has two effects on the general solution: 1) the magnitude of A will cause a scale effect on values of b^t without changing the basic configuration of the time path, and 2) a negative value of A will produce the minor image of the time path.

The parameters for each of the thirteen first-order difference equations are presented in Table 18. From the value of b presented in Table 18, we see that the time path is always convergent, i.e., it always converges to an equilibrium value Y_p. The values of Y_p are quite different than what we would expect. We would expect the basis to converge towards zero, however, as one can see from Table 18, there are only two options in which Y_p is anywhere near zero (June: cattle; February: hogs). In fact in some options the basis converges to a value of over one dollar.

Looking at the three hog options in which the delivery day variable was significant, we find that in two of the options the values of Y_p was farther away from zero during the delivery period than during the rest of the near month period.

The above analysis would seem to indicate that arbitrage is not doing an adequate job of bringing the futures and cash prices together during the delivery

Table 18. Parameters from the general solution of the thirteen first-order differences equation (\$/cwt)[a]

	Cattle		Hogs	
	b	Y_p	b	Y_p
February	.839	.449	.827	-.067
February Delivery				
April	.858	.300	.804	.337
April Delivery				
June	.872	.015	.795	2.605
June Delivery			.795	1.629
July			.716	.982
July Delivery				
August	.823	-.476	.571	-.359
August Delivery			.571	.420
October	.892	-.437	.688	-.580
October Delivery			.688	.875
December	.836	1.128	.737	1.274
December Delivery				

[a]Where the time trend is included 1972 was used. Using past years would cause the value of Y_p to decrease.

period. This disparity could be due to several factors. One such factor may be that it is difficult to deliver on the contract. Such difficulty may arise from such factors as the grades and quality of the livestock, or the number of head needed per contract. A second possible explanation might be that the number of livestock hedged, and thus deliverable, is not sufficient in relation to the number of futures contracts outstanding, to cause arbitrage to function.

Determination of the Target Price

As we mentioned earlier, five variables are used in calculating the target price: a) the futures contract selling price (FP_s), b) the estimated basis (B), c) the estimated additional delivery costs (ADC), d) the estimated local marketing costs (LMC), and e) the estimated hedging costs (HC).

Futures contract selling price

The futures contract that will be used in calculating the target price is the futures contract maturing nearest to but not before the expected marketing date. By using this futures option the feeder is given the opportunity to lift the hedge either by delivering on the contract or by offsetting and delivering locally. The futures price is the closing price of the relevant futures contract on the day the target price is calculated. An important point to remember is that the futures contract selling price is the only variable used in calculating the target price that is known at the time the calculation is made.

<u>Estimated basis</u>

To forecast the basis we estimated a least squares regression equation for each of the last six days of trading for a contract. The form of each equation is:

$$Y_j = \alpha + \Sigma B_i O_i + B_6 T + E \qquad \begin{array}{l} j = 0,9; \quad i = 1,5 \\ n = 5 \text{ for cattle;} \\ n = 6 \text{ for hogs;} \end{array}$$

where:

Y_j = the basis on the jth day before the end of trading of each option month

$$O_1 = \begin{cases} 1 \text{ if } Y_j \text{ is the February basis} \\ -1 \text{ if } Y_j \text{ is the December basis} \\ 0 \text{ otherwise} \end{cases}$$

$$O_2 = \begin{cases} 1 \text{ if } Y_j \text{ is the April basis} \\ -1 \text{ if } Y_j \text{ is the December basis} \\ 0 \text{ otherwise} \end{cases}$$

$$O_3 = \begin{cases} 1 \text{ if } Y_j \text{ is the June basis} \\ -1 \text{ if } Y_j \text{ is the December basis} \\ 0 \text{ otherwise} \end{cases}$$

$$O_4 = \begin{cases} 1 \text{ if } Y_j \text{ is the August basis} \\ -1 \text{ if } Y_j \text{ is the December basis} \\ 0 \text{ otherwise} \end{cases}$$

$$O_5 = \begin{cases} 1 \text{ if } Y_j \text{ is the October basis} \\ -1 \text{ if } Y_j \text{ is the December basis} \\ 0 \text{ otherwise} \end{cases}$$

T = linear time trend.

For hogs a sixth variable for the option months is added for the July option. This variable has the following form:

$$\begin{cases} 1 \text{ if } Y_j \text{ is the July basis} \\ -1 \text{ if } Y_j \text{ is the December basis} \\ 0 \text{ otherwise} \end{cases}$$

The regression coefficients, F and R^2 values, and the mean and standard deviation of the dependent variable, for each of the six equations used to forecast the basis, are shown in Tables 19 (cattle), and 20 (hogs).

These forecasting equations were used rather than those presented earlier because the equations presented earlier were unsuitable for forecasting more than one day ahead. This inability to forecast more than one day ahead is due to the inclusion of the lagged dependent variable in the previous model.

The dummy variables for the option months were included because, as we saw previously, the coefficients in the basis equations are not equal between the option months. The time trend was included because it also was significant in some of the previous models.

Although the R^2 values were not exceptionally high for these equations, they did do a better job of forecasting than could have been obtained by using the past mean values.

Table 19. Regression coefficients, F, R^2, means and standard deviation for the ten equations used to forecast the basis for cattle

j		Days Before Trading Stops 0	1	2	3	4	5
F		3.01	4.83	3.86	5.08	3.98	6.13
Prob F		.0158	.0011	.0042	.0008	.0035	.0003
R^2		.31	.42	.37	.43	.37	.48
Mean		46.68	31.43	26.30	29.70	23.49	20.45
Standard Deviation		64.89	53.01	53.92	58.25	55.50	55.44
Regression Coefficients							
B_0		20.38	-14.41	-11.51	-16.63	- 9.50	-28.32
B_1	(T)	5.95	10.19	8.40	10.37	7.39	12.60
B_2	(a_1)	44.13	37.30	29.78	52.76	39.38	37.11
B_3	(a_2)	20.29	7.54	16.69	19.94	20.72	5.70
B_4	(a_3)	-31.18	-28.21	-18.06	-29.93	-25.40	-30.30
B_5	(a_4)	-60.43	-40.21	-40.43	-59.93	-52.65	-56.42
B_6	(a_5)	-10.05	-25.46	-32.68	-21.05	-22.15	-14.42

Table 20. Regression coefficients, F, R^2, means and standard deviations for the six equations used to forecast the basis for hogs

	Days Before Trading Stops					
	0	1	2	3	4	5
F	8.095	6.422	7.832	7.626	8.296	3.509
Prob F	.0001	.0001	.0001	.0001	.0001	.0055
R^2	.599	.542	.591	.584	.604	.393
Mean	.448	.595	.516	.467	.378	.228
Standard Deviation	.519	.497	.439	.459	.479	.566
Intercept	-.668	-.236	-.318	-.134	-.432	-.400
B_1 (a_1)	-.274	-.281	-.385	-.285	-.215	-.041
B_2 (a_2)	-.176	-.270	.264	.530	.458	.284
B_3 (a_3)	-.120	.149	.265	.427	.059	.039
B_4 (a_4)	.177	-.164	-.107	-.357	-.301	-.100
B_5 (a_5)	-.327	-.309	-.317	-.575	-.600	-.535
B_6 (a_6)	.073	.227	-.120	-.025	.083	-.060
B_7 (T)	.263	.196	.200	.47	.195	.151

Additional delivery costs

Since we are using Omaha for cattle and Chicago-Peoria for hogs as the local market, the additional delivery costs are zero.

Estimated hedging costs

The equation used to calculate the estimated hedging costs was:

$$\widehat{HC} = (C + Int(750))/W$$

where:

$\widehat{HC}$ = the estimated hedging cost,

Int = the interest rate for the length of the feeding period assuming a 9% annual rate,

C = the commission charge: \$40 for cattle, \$35 for hogs,

\$750 = the initial margin, and

W = the coefficient to convert the HC to dollars per hundredweight.

The estimated hedging costs for cattle were \$ .23 per hundredweight for November - August feeding period, \$ .18 per hundredweight for the January - June feeding period and \$ .23 per hundredweight for the April - December feeding period. The estimated hedging cost for hogs was \$ .16 per hundredweight for the three feeding systems.

The estimates for cattle, on the average, were quite accurate in that for the November - August feeding system the estimate was only \$ .04 per hundredweight lower than the average. For the January - June feeding system HC was only

$ .02 per hundredweight lower than average hedging cost, while HC was only $ .01 higher than the average hedging cost for the April - December feeding system. See Table 21.

The target price for cattle and hogs for each feeding system in each year is shown in Table 22.

The estimated hedging cost was even more accurate for hogs than it was for cattle. In the July - October and January - April feeding systems the actual average hedging cost was $ .01 per hundredweight above the estimate for the September - December feeding system. See Table 21.

Table 21. Actual hedging costs for cattle and hogs

	Cattle			Hogs		
	Feeding Systems			Feeding Systems		
	Nov.-Aug.	Jan.-June	April-Dec.	July-Oct.	Sept.-Dec.	Jan.-April
1965		.21	.24			
1966		.11	.14	.20	.15	
1967	.13	.09	.17	.09	.15	.12
1968	.25	.21	.22	.14	.16	.15
1969	.37	.29	.19	.20	.24	.19
1970	.19	.20	.16	.13	.10	.14
1971	.29	.25	.29	.12	.22	.18
1972	.36	.23	.36	.17	.18	.12
Mean	.27	.20	.22	.15	.17	.15
Standard Deviation	.095	.068	.07	.042	.047	.030

Table 22. Target price and estimated hedging cost for each cattle and hog feeding system

	Cattle (1965-1972)			Hogs (1966-1972)		
	Feeding System			Feeding System		
	Nov.-Aug.	Jan.-June	April-Dec.	July-Oct.	Sept.-Dec.	Jan.-April
1965		23.63	24.57			
1966		28.37	27.32	20.00	21.34	
1967	28.19	28.01	27.47	21.84	19.26	21.36
1968	25.60	24.87	25.89	19.64	18.59	18.64
1969	25.97	26.52	28.57	22.39	22.64	18.39
1970	29.61	30.04	29.47	20.11	19.39	26.64
1971	29.33	29.37	29.97	20.16	18.79	16.24
1972	31.02	32.34	32.37	27.04	28.34	24.34
HC	.23	.18	.23	.15	.15	.15

CHAPTER VI: THE SIMULATION MODEL

A computer simulation model was developed to generate results for the hedging strategies. A simple flow chart of the model is shown in Figure 16. Once the hedge was placed, the first step was to calculate the gain or loss in the futures market from the preceding day. If there was a loss in the futures market and more margin was required, the amount of the additional margin was recorded as a deposit; otherwise no additional margin was added. If a gain occurred, which caused the feeder's account to move above the required margin, the amount of money above the required extra margin was withdrawn; otherwise no action was taken. The second step in the simulation was to calculate the net deposits. The net deposits are equal to $750 plus the deposits minus the withdrawals. The third step is to calculate the daily interest costs, which equal the net deposits times the daily interest rate. The daily hedging costs are then summed to form a running interest cost. Each day the program prints the date, futures price, current deposits (the amount in the feeder's account), deposits, withdrawals, net deposits, running interest cost, maximum investment (maximum amount that the feeder has had in his account to date). At the end of the feeding period the basis and the average hedging cost per hundredweight and the maximum investment were calculated.

This is all the information that is needed to calculate the net price from not hedging and hedging. The net price from not hedging is the ending cash price. The net price from lifting the hedge by offsetting is the ending cash price plus or minus the gain or loss from the futures transaction minus the average hedging cost per hundredweight; the net price from delivering is the beginning futures price minus the average cost of hedging per hundredweight minus any adjustments for nonpar delivery.

This simulation was used to obtain the net prices for the routine nonhedging strategy, the routine hedging strategy, the FFCP strategy, and the Bayesian strategy. For the ten-day moving average strategy the computer program had to be altered slightly to allow the ten-day moving average rules to determine the starting and ending dates of the hedges. So, the only difference between the program presented in the flow-chart and the program used with the ten-day moving average strategy is the method used in determining when to place and when to lift a hedge.

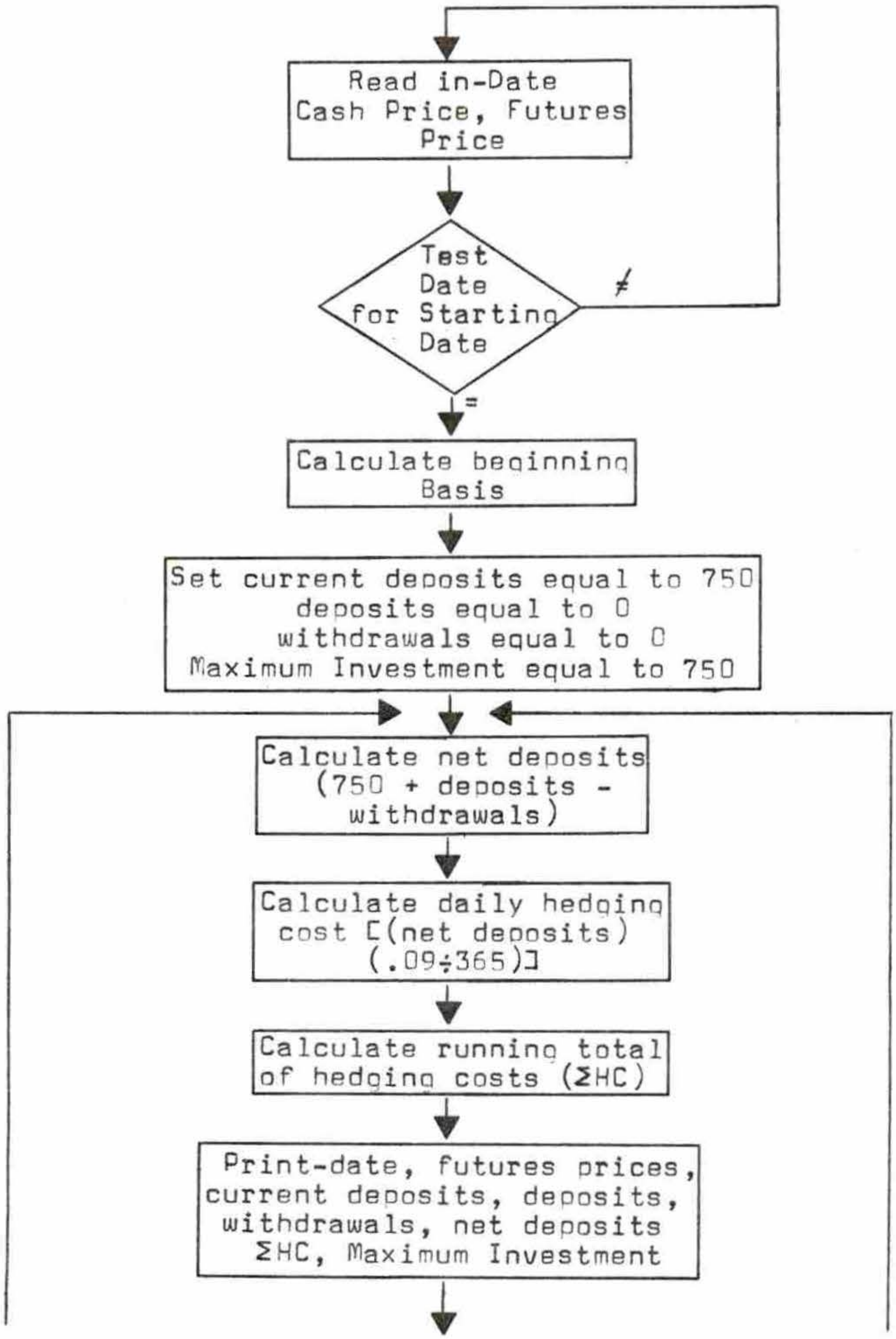

Figure 17. Simulation model

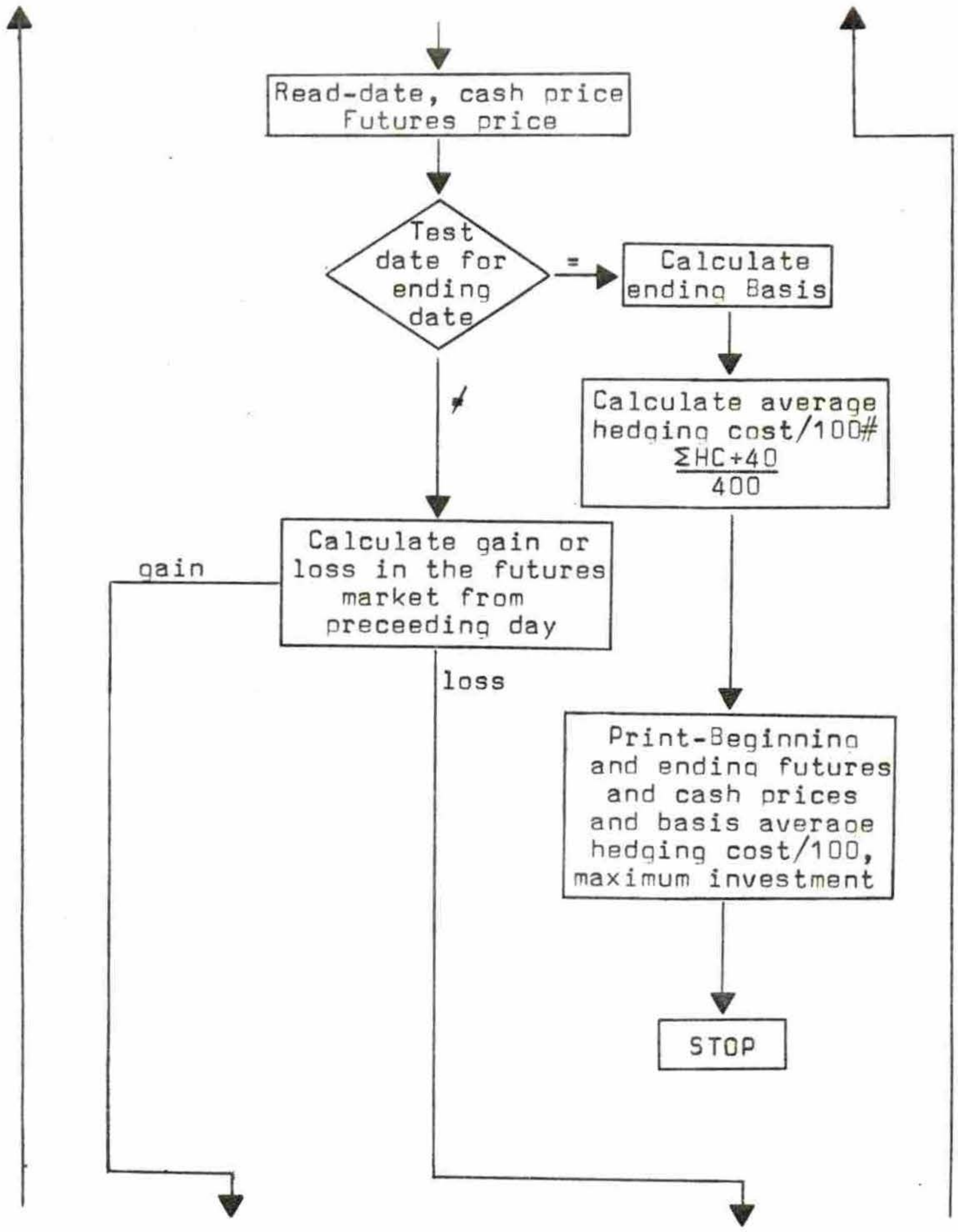

Figure 17. Continued

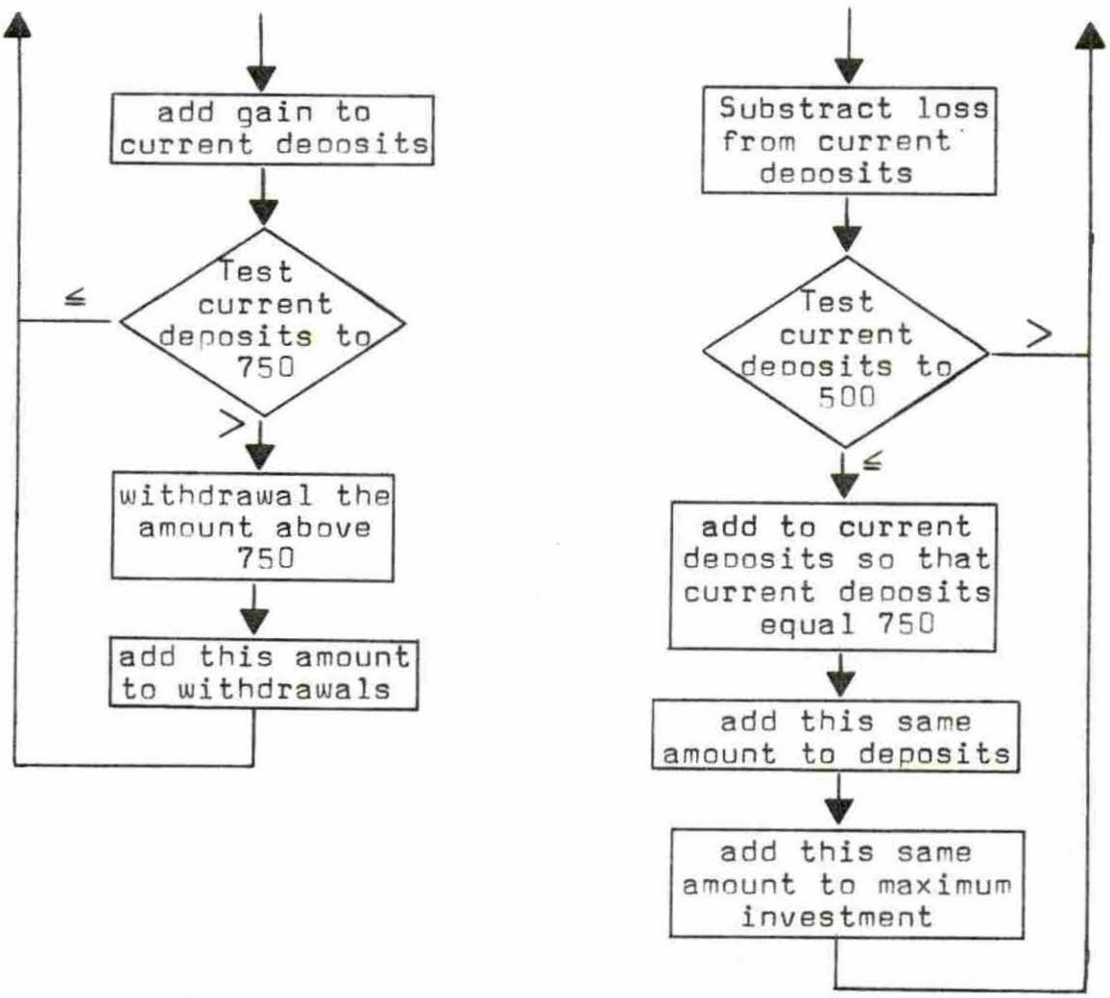

Figure 17. Continued

CHAPTER VII: ANALYSIS OF THE HEDGING STRATEGIES

Analysis of the Cattle Hedging Strategies

Naive strategies

The bottom two lines of Table 23 show the mean net price and the variance of price using a strategy of routine nonhedging and a strategy of routine hedging. Looking first at the mean net price we find that the routine nonhedging strategy gives a higher mean net price than the routine hedging strategy for all three feeding systems. This increase in the mean net price amounted to $2.91 for the November - August feeding system, $1.97 for the January - July feeding system, and $ .60 for the April - December feeding system. The variance of these net prices is shown in the last line of Table 23; though the mean net price was higher with routine nonhedging so was the variance of that price.

Hedging returned a higher net price in only seven of the twenty-two periods tested; 1967 for the November - August feeding system; 1966, 1967 for the January - July feeding system; and 1966, 1967, 1969, and 1970 for the April - December feeding period. Even though hedging returned a higher net price only thirty-two percent of the time, it returned a higher net price in every instance in which the cash price decreased over the feeding period.

Table 23. Net price received at Omaha using two naive strategies (1965-1972)

	Feeding System					
	November - August Strategy		January - June Strategy		April - December Strategy	
Year	No Hedge $/cwt	Routine Hedge $/cwt	No Hedge $/cwt	Routine Hedge $/cwt	No Hedge $/cwt	Routine Hedge $/cwt
1965	---[a]	---	26.00	22.64	25.39	23.81
1966	---	---	25.38	28.09	23.25	26.66
1967	26.75	27.27	25.25	27.31	25.38	27.20
1968	27.75	25.55	26.25	24.04	28.25	25.15
1969	30.63	25.86	34.25	27.89	27.50	27.86
1970	30.13	28.52	29.75	29.27	26.25	28.79
1971	33.50	28.81	32.00	29.30	34.38	29.01
1972	36.00	31.04	37.75	32.29	36.00	32.24
Mean	30.79	27.88	29.57	27.60	28.30	27.70
Variance	12.10	4.30	22.10	9.34	20.52	7.10

[a]There were no August futures prices at the beginning of the feeding period for these two years.

The above results were obtained assuming that the hedge was lifted using the method giving the highest net price. If the feeder was forced to lift the hedge by offsetting or by delivering there would be a change in the net price received. The next to the last line in Table 24 shows the mean net price received from offsetting as compared with delivering on the contract for each feeding system. The last line of Table 24 shows the variance of the net price. For the November - August feeding system lifting the hedge by offsetting yielded a mean net price of $27.72, which was $ .21 greater than the mean net price from delivering on the contract. The variance of the net price from offsetting was 2.05 less than the variance of the net price from delivering.

The other two feeding systems did not show such a wide range in their variance. With the January - June feeding system delivering on the contract gave a slightly higher price than offsetting ($27.41 vs. $27.32), and had a greater variance (9.33 vs. 9.17). The difference between offsetting and delivering on the contract for the April - December feeding period was $ .70, with delivering having the higher mean net price at $27.65. Besides giving the higher net price, delivering on the contract had the smaller variance of price (7.18 vs. 7.37).

Table 24. Net price received and variance of net price received from delivering on the contract and offsetting (1965-1972)

	Feeding System					
	November - August Strategy		January - June Strategy		April - December Strategy	
Year	Offset $/cwt	Delv. $/cwt	Offset $/cwt	Delv. $/cwt	Offset $/cwt	Delv. $/cwt
1965	---[a]	---	22.14	22.64	22.99	23.81
1966	---	---	28.09	27.56	26.09	26.66
1967	27.25	27.27	27.06	27.31	27.20	26.78
1968	25.55	24.65	23.97	24.04	24.86	25.15
1969	25.86	24.88	27.89	26.84	25.96	27.86
1970	28.52	28.76	28.52	29.27	27.29	28.79
1971	28.21	28.43	29.15	29.30	29.45	29.91
1972	30.97	31.04	31.84	32.29	31.79	32.24
Mean	27.72	27.51	27.32	27.41	26.95	27.65
Variance	3.97	6.02	9.17	9.33	7.37	7.18

[a]There were no August futures prices at beginning of the feeding period for these two years.

There is a rather interesting observation that can be made about the results presented in Table 24. Lifting the hedge by offsetting gave a higher net price than lifting the hedge by delivering in only 22.7 percent of the feeding periods studied. This is assuming that the feeders local market alternative is the Omaha terminal market, and thus ADC is equal to zero.

Selective strategies

Accuracy of the target price for cattle The target price is only useful if it accurately estimates the net price that the feeder will receive. In this respect the target price for cattle does a respectable job, as is shown in Tables 25 and 26. Table 25 shows the correlation coefficient between the target price and the net price from hedging, if the feeder lifted the hedge by offsetting, delivering and by using the optimal method of lifting the hedge. Table 26 shows the mean and variance of the target price and the net price that the feeder would have received if he had hedged. In Table 26 we see that the target price has a tendency to overestimate the net price.

The amount of the overestimation ranges from \$ .29 to \$1.25 with only one observation over \$ .80, and an average overestimation of \$ .59, again indicating that the target price is a good estimator of the net price

Table 25. Correlation coefficients

	Net Price		
	Offset	Deliver	Optimal
Target Price	.946	.992	.980

received from hedging.

Futures-forecasted cash price strategy (FFCP) The decision criteria for this strategy was to hedge if the target price was greater than the forecasted cash price, otherwise no hedge was placed. The first column of Table 27 shows the target price for the ending date of each feeding system calculated at the beginning of the feeding period (from Table 22, page 85). The second column of Table 27 gives the forecasted cash price from the model presented in the Appendix.

Following the decision criteria for this strategy, the feeder would have hedged only in the years indicated in column 3 of Table 27, where H indicates a hedge was placed and NH indicates a hedge was not placed. The resulting net prices are shown in the last column of Table 27.

If a hedge was placed, then the net price is the net price from lifting the hedge by the alternative

Table 26. Mean and variance of the target price and net price received by feeding systems

	Feeding Systems					
	November - August		January - June		April - December	
	Mean	Variance	Mean	Variance	Mean	Variance
Target Price	28.29	4.580	27.89	8.000	28.20	6.010
Net price - Offset	27.72	3.970	27.32	9.170	26.95	7.370
Net price - Deliver	27.51	6.020	27.41	9.330	27.65	7.180
Net price - Optimal	27.88	4.300	27.60	9.340	27.70	7.100

Table 27. Decision information and results of the futures - forecasted cash price strategy

Year	Target price	Forecasted cash price	Decision[a]	Net price
		November - August Strategy		
1967	28.19	25.98	H	27.27
1968	25.60	27.16	NH	27.75
1969	25.97	30.99	NH	30.63
1970	29.61	30.73	NH	30.13
1971	29.33	32.90	NH	33.50
1972	31.17	37.18	NH	36.00
		January - June Strategy		
1965	23.63	26.56	NH	26.00
1966	28.37	25.26	H	28.09
1967	28.01	25.98	H	27.31
1968	24.37	27.16	NH	26.25
1969	25.52	30.99	NH	34.25
1970	30.04	30.73	NH	29.75
1971	29.37	32.90	NH	32.00
1972	32.34	37.18	NH	37.75
		April - December Strategy		
1965	24.57	25.44	NH	25.38
1966	27.32	24.18	H	26.65
1967	27.47	25.75	H	27.20
1968	25.89	27.99	NH	28.25
1969	28.57	28.19	H	27.85
1970	29.47	29.41	H	28.79
1971	29.97	35.55	NH	34.38
1972	32.37	40.07	NH	36.00

[a]H = hedge; NH = no hedge.

that gives the highest net price. So for the November - August feeding system the hedge was lifted by delivering on the contract. For the January - June feeding system, the hedge placed in 1966 was lifted by offsetting, while the hedge placed in 1967 was lifted by delivering on the contract. For the April - December feeding system 1967 was the only year in which the hedge was lifted by offsetting. In the other three years (1966, 1969, 1970) the hedge was lifted by delivering on the contract. If a hedge was not placed then the net price was the Omaha cash price.

The ability of this strategy to determine when to hedge and when not to hedge was excellent. In each case where the decision was to hedge, hedging gave the highest net price. And when the decision was to not hedge, nonhedging gave the highest net price in each instance.

The futures-forecasted cash price hedging strategy compares favorably with the two naive strategies presented earlier. Table 28 presents the mean net price and the variance of price of the naive strategies and the futures-forecasted cash price strategy. If we look at the top half of Table 28 we see that by using the futures-forecasted cash price strategy the feeders mean net price could have been increased above

Table 28. Mean and variance of naive strategies and the futures-forecasted cash price strategy

Period	No hedge	Hedge		FFCP	
	$/cwt	Offset $/cwt	Optimal $/cwt	Offset $/cwt	Optimal $/cwt
			MEAN		
November - August	30.79	27.72	27.88	30.88	30.88
January - June	29.57	27.32	27.60	30.14	30.18
April - December	28.30	26.95	27.30	28.82	29.32
			VARIANCE		
November - August	12.10	3.97	4.30	11.34	11.31
January - June	22.10	9.17	9.34	17.77	17.56
April - December	20.52	7.37	7.10	15.46	14.41

the mean net prices from the naive strategies. This increase was from $ .09 (routine nonhedge) to $3.00 (routine hedge) for the November - August feeding system, $ .61 (routine nonhedge) to $2.58 (routine hedge) for the January - June feeding system, and $1.02 (routine nonhedge) to $2.02 (routine hedge) for the April - December feeding period.

However, even though the mean net price for the futures-forecasted cash price strategy was the highest of all the strategies so far presented, the variance of the price fell between the variances of the other strategies. This is shown in the bottom half of Table 28. Thus we can conclude that the futures-forecasted cash price strategy is superior to the naive strategy of routine nonhedging. This selective strategy is superior in that by using it the feeder could obtain a greater mean net price and a lower variance of price than could have been obtained by using a strategy of routine non-hedging. On the other hand the feeder must evaluate his objectives before choosing between the futures-forecasted cash price strategy and routine hedging.

<u>Bayesian strategy</u> The application of Bayesian decision theory to hedging, using the actions, states of nature, and experiments presented earlier, yielded the same results as the FFCP strategy. Although the

Bayesian strategy did not contribute any new results, it did give sound support to the FFCP strategy. The maximizing action, given the relationship of the target price and the forecasted cash price, was identical to the decision rule used in the FFCP strategy.

Table 29 shows the development of the Bayesian strategy for hedging cattle. Part A of Table 29 shows the payoff table and the subjective or prior probabilities. The payoffs were obtained by averaging the net prices, for each combination of actions and states of nature, from the FFCP strategy. Thus, the payoff for A_i, θ_i was found by averaging the net prices that were obtained using the FFCP strategy when a hedge was placed and the actual net price was higher with a hedge. The subjective probabilities are the percentage of times that the net price was higher with a hedge and the percentage of times that the net price was lower with a hedge using the net prices from the naive strategies. The calculation of the expected payoff using the prior probabilities is shown in Table 29B.

The values for $P(Z \mid \theta_i)$ are shown in Table 29C. They were calculated from the FFCP strategy by calculating the percentage of times that Z_i occurred given θ_i. So for $Z_1\theta_1$, the target price was greater than the forecasted cash price each time the net price was higher

Table 29. Computation of the Bayesian strategy

A.

	Payoff table ($/cwt) $U(\theta_i,a_i)$ a_1	a_2	Prior probabilities $P(\theta_i)$
θ_1	27.60	25.68	.32
θ_2	27.77	31.20	.68

B.

	$U(\theta_i,a_i)$ a_1	a_2	$P(\theta_i)$	$(P(\theta_i)U(\theta_i,a_i))$ a_1	a_2
θ_1	27.60	25.68	.32	8.83	8.22
θ_2	27.77	31.20	.68	18.88	21.22
Expected payoff using prior probabilities				27.71	29.44

C.

	$P(Z\mid\theta_i)$ Z_1	Z_2
θ_1	1.0	0.0
θ_2	0.0	1.0

D.

Strategies	Action taken after Z_i: Z_1	Z_2
S_1	a_1	a_1
S_2	a_1	a_2
S_3	a_2	a_1
S_4	a_2	a_2

Table 29. Continued

E.

	$P(Z\mid\theta_i)$		$P(\theta_i)$			
	Z_1	Z_2			Z_1	Z_2
θ_1	1.0	0.0	.32	$P(\theta_1)P(Z\ \theta_1)$	.32	.00
θ_2	0.0	1.0	.68	$P(\theta_2)P(Z\ \theta_2$	.00	.68
				$P(Z)$	.32	.68

Action probabilities $P(\theta_i\ \ Z)$

P_1 $\frac{.32}{.32} = 1.0$ $\frac{.00}{.68} = 0.0$

P_2 $\frac{.00}{.32} = 0.0$ $\frac{.68}{.68} = 1.0$

F.

$G(P(\theta_i \mid Z),a)$

	Z_1	Z_2
a_1	27.60	27.77
a_2	25.68	31.20

Maximizing Strategy

a_1	a_2
27.60	31.20

Weighted average payoff corresponding to the Bayesian Strategy

$$27.60(.32) + 31.20(.68) = 30.05$$

G. Value of the experiment

$30.05 - $29.44 = $.61

with a hedge. In looking at these values we see that the experiment was perfect in that each time θ_1 occurred the experiment was Z_1 and each time θ_2 occurred the experiment was Z_2. The strategies available to the feeder are shown in Table 29D, while the calculation of the action probabilities $(P(\theta_i \mid Z))$ is shown in Table 29E. Part F of Table 29 gives the results of calculating $G(P(\theta_i \mid Z),A)$, the maximizing action, and the weighted average utility corresponding to the Bayesian strategy. From these results, and using the feeders objective of maximizing price, the Bayesian strategy is S_2, i.e., if the target price is greater than the forecasted cash price then hedge, if the target price is less than the forecasted cash price, then don't hedge. The value of the experiment was $ .61 (Part G, Table 29); thus indicating that by using the experiment the feeder could raise his expected net price by $ .61.

Ten-day moving average strategy   Table 30 shows the net price received and the mean and variance of the net price received using the ten-day moving average strategy (10-DMA) for each cattle feeding system and year. Also included in Table 30 is the number of times a hedge was placed during the feeding period. Even with the large number of hedges placed during the feeding periods, a hedge was in affect at the end of the feeding

Table 30. Net price received using the 10-day moving average strategy and the number of times that a hedge was placed (cattle)

	Feeding Systems					
	November - August		January - June		April - December	
	$/cwt	x[a]	$/cwt	x	$/cwt	x
1965			25.98	4	25.22	5
1966			27.56	3	25.22	7
1967	25.83	8	27.87	3	25.96	6
1968	26.33	7	25.38	4	26.96	7
1969	30.41	5	33.00	1	26.50	8
1970	28.74	8	28.83	5	22.87	11
1971	32.34	6	32.59	3	32.61	7
1972	34.49	6	35.39	4	36.75	4
Mean	29.69		29.58		27.76	
Variance	11.43		13.24		20.95	

[a]Number of times hedge was placed.

period only fifty-five percent of the time. This effectively eliminated any opportunity for the feeder to deliver on the futures contract in over half of the feeding periods, even though the cattle had been hedged previously.

In looking at the top half of Table 31 we see that the 10-DMA strategy gives a net price greater than the net price using the routine hedging strategy. In addition, the net price using the 10-DMA strategy in the January - June period was greater than the net price using the routine nonhedging strategy. The other two selective strategies and the November - August and April - December feeding periods of the routine nonhedging strategy returned a higher mean net price than the 10-DMA strategy.

One reason for the relatively poor price performance of the 10-DMA strategy can be directly attributed to the number of times a hedge was placed and the resulting hedging cost. The average hedging cost was $ .43 per hundredweight greater for the 10-DMA strategy than for the routine hedging strategy over the November - August feeding period. Increases in hedging costs of $ .15 per hundredweight, and $ .48 per hundredweight were recorded between these two strategies (routine hedging and 10-DMA) over the January - June and April - December feeding

Table 31. Mean and variance of the five hedging strategies by cattle feeding systems

Feeding System	Strategy				
	No Hedge	Routine Hedge	FFCP	Bayesian	10-DMA
	Mean				
November - August	30.79	27.88	30.88	30.88	29.69
January - June	29.57	27.60	30.18	30.18	29.58
April - December	28.30	27.70	29.32	29.32	27.77
	Variance				
November - August	12.10	4.30	11.31	11.31	11.53
January - June	22.10	9.34	17.56	17.56	13.24
April - December	20.52	7.10	14.41	14.41	20.91

periods, respectively. A second reason is that in fifty-nine percent of the feeding periods tested (22 total observations) there was a net loss in the futures market, which reduced the net price correspondingly.

Looking now at the bottom half of Table 31 we see that the variance of the net price for the 10-DMA strategy was rather erratic when compared to the other strategies. For instance, the net price for the April - December feeding period is the second smallest mean net price of the five strategies, while the variance of that price is the largest of the five strategies.

Maximum investment A discussion of hedging is not entirely complete without discussing the amount of margin that is needed to maintain the futures position. Table 32 shows the maximum amount of margin that the feeder would have needed at any one time during each feeding period. There are several interesting observations that can be obtained from this table. First, there was only one year and feeding system in which the feeder did not need to deposit more margin. This was in 1967 with the January - June feeding system. Second, the feeder would have had to deposit a total margin of twice his initial margin fifty-five percent of the time. Third, and somewhat surprisingly, forty-one percent of the time the feeders total margin needs were three

Table 32. Maximum margin needed at any one time with routine hedging (cattle)

	Feeding Systems		
	November - August	January - June	April - December
1965		2558	1530
1966		818	998
1967	870	750	958
1968	1470	1442	1678
1969	3090	3950	1170
1970	990	1550	842
1971	2442	2230	2790
1972	3010	2770	3410
Mean	1979	2009	1672
Standard Deviation	998	1084	940

times the initial margin.

So even though hedging does reduce the variance of the net price received, and thus reduces the price risk involved in cattle feeding, a large amount of capital is needed to hedge, using a strategy of routine hedging.

The FFCP strategy and the Bayesian strategy substantially reduce the margin requirements in that in many of the years when high margin levels are needed, no hedge is placed; thereby reducing the capital needed to hedge. Shown in Table 33 are the maximum margins needed at any one time using the FFCP or Bayesian strategies.

With the 10-DMA strategy additional margin was needed in only two of the years tested, 1966 and 1972 with the April - December feeding system. The additional margin was $52 and $102, respectively.

Analysis of the Hog Hedging Strategies

Naive strategies

In Table 34 the net prices received using the routine nonhedging strategy and the routine hedging strategy are presented. The mean and variance of these net prices are shown at the bottom of Table 34. Turning our attention first to the mean net prices we find that in the January - April feeding system the routine

Table 33. Maximum margin needed at any one time with the FFCP or Bayesian strategy (cattle)

	Feeding Systems		
	November - August	January - June	April - December
1965		NH[a]	NH
1966	NH	818	998
1967	870	750	958
1968	NH	NH	NH
1969	NH	NH	1170
1970	NH	NH	842
1971	NH	NH	NH
1972	NH	NH	NH
Mean	870	784	992
Standard Deviation	---	48.08	135.86

[a]NH = No hedge placed.

Table 34. Net price received at Chicago - Peoria using two naive strategies (1966-1972) (hogs)

	Feeding System					
	July - October Strategy		September - December Strategy		January - April Strategy	
	No Hedge $/cwt	Routine Hedge $/cwt	No Hedge $/cwt	Routine Hedge $/cwt	No Hedge $/cwt	Routine Hedge $/cwt
1966	21.88	19.95	21.75	21.35	---[a]	---[a]
1967	19.50	22.06	19.43	19.40	18.00	21.40
1968	19.13	19.16	19.75	18.59	20.50	19.13
1969	25.25	22.35	27.75	22.56	20.88	18.36
1970	18.38	20.14	16.39	19.45	24.63	26.66
1971	21.00	20.20	21.88	18.73	16.38	16.22
1972	28.50	27.03	32.25	28.22	23.38	24.38
Mean	21.95	21.56	22.74	21.19	20.63	21.03
Variance	13.57	7.17	29.60	11.73	9.72	15.39

[a]There were no April futures prices at the beginning of the feeding period.

hedging strategy yielded a mean net price $ .40 greater than the mean net price from the routine nonhedging strategy. This is rather unusual in that both the July - October and September - December feeding systems showed the opposite outcome, i.e., the routine nonhedging strategy returned a higher net price than the routine hedging strategy. This higher return amounted to $ .61 for the July - October feeding system and $1.55 for the September - December feeding system. The variance of these net prices is shown in the last line of Table 34. As we saw with the cattle, the strategies with the higher mean prices also give a higher variance of price. This includes the routine hedging strategy for the January - April feeding systems.

Although hedging hogs returned a higher net price a greater percentage of the time than did hedging cattle, hedging did not protect the hog feeder from a declining market as well as it did the cattle feeder. This is because routine hedging returned a larger net price than did routine nonhedging each time the cash cattle market declined. This was not however the case with the hogs. The method of lifting the hedge made a greater difference with hogs than it did with cattle. This is shown in Table 35 by the larger differences in the mean net prices and variances between the methods of lifting the hedge. The difference in the mean net prices received

Table 35. Net price received and variance of net price received from delivering on the contract and offsetting (1966-1972) (hogs)

	Feeding Systems					
	July - October		September - December		January - April	
	Offset $/cwt	Delv. $/cwt	Offset $/cwt	Delv. $/cwt	Offset $/cwt	Delv. $/cwt
1966	19.93	19.95	21.08	21.35		
1967	22.06	21.91	19.40	19.27	20.18	21.40
1968	18.59	19.16	17.49	18.59	19.13	18.65
1969	21.45	22.35	21.41	22.56	17.69	18.36
1970	19.35	20.14	18.43	19.45	25.27	26.66
1971	19.75	20.20	17.71	18.73	15.33	16.22
1972	25.13	27.03	27.15	28.22	22.64	24.38
Mean	20.89	21.53	20.38	21.17	20.04	20.94
Variance	4.92	7.15	11.27	11.81	12.53	15.79

from lifting the hedge by offsetting and from delivering ranged from $ .64 for the July - October feeding system to $ .90 for the January - April feeding system, with the September - December feeding period having a difference of $ .79. For each feeding system delivering on the contract gave a higher mean net price than offsetting.

When compared to the other feeding systems, the difference in the variance of the mean net price (September - December feeding system) between offsetting and delivering on the contract was quite small (.54). The difference between the variance of the net price from offsetting and delivering was 2.23 for the July - October feeding system, while the difference in the variance for the January - April feeding system was 3.26 (See Table 35). In all cases, delivering gave the highest variance in the mean net price.

Assuming that the feeder's local market alternative is the Chicago-Peoria terminal market, and thus ADC is equal to zero, lifting the hedge by offsetting gave a higher net price than lifting the hedge by delivering in only fifteen percent of the feeding periods studied. This is approximately eight percent less than the same comparison for cattle.

Selective strategies

Accuracy of the target price for hogs   The accuracy of the target price for hogs was even better than it was for cattle. Presented in Table 36 are the correlation coefficients between the target price and the net price from hedging, while Table 37 shows the mean and variance of the target price and the net prices from offsetting, delivering, and the optimal method of lifting the hedge.

Table 36. Correlation coefficients between the target price and various methods of lifting the hedge

	Net Price		
	Offset	Deliver	Optimal
Target Price	.982	.999	.999

And, unlike the cattle, we do not see a tendency towards overestimation by the target price, except when the hedge is lifted by offsetting. In fact, in two of the feeding systems the net price from offsetting was greater than the target price.

Table 37. Mean and variance of the target price and net price received from hedging by feeding systems (hogs)

	Feeding Systems					
	January - April		July - October		September - December	
	Mean	Variance	Mean	Variance	Mean	Variance
Target Price	20.94	15.62	21.59	6.83	21.18	11.88
Net Price - Offset	20.04	12.53	20.89	4.92	20.38	11.27
Net Price - Deliver	20.94	15.79	21.53	7.15	21.17	11.81
Net Price - Optimal	21.03	15.39	21.56	7.17	21.19	11.73

Futures-forecasted cash price strategy   The target price (from Table 22, page 85) for the ending date of each hog feeding system calculated at the beginning of the feeding period is shown in the first column of Table 38. The forecasted cash price from the model presented in the Appendix is shown in column 2 of Table 38. Shown in column 3 of Table 38 is the decision that was made for each year, with H indicating that a hedge was placed and NH indicating that a hedge was not placed. The resulting net prices are shown in the last column of Table 38.

Like the cattle, if a hedge was placed it was lifted by the method giving the highest net price, if no hedge was placed then the Chicago-Peoria cash price was used. Of the six times that hedges were placed using this strategy the hedge was lifted by offsetting twice; in 1966 for both the September - December and July - October feeding systems. In the other four cases the hedge was lifted by delivering on the contract.

This strategy did not perform nearly as well for hogs as it did for cattle. In fact, the FFCP strategy, when applied to hogs, "missed" twenty-five percent of the time. That is, when the decision was to hedge, nonhedging gave a higher net price twenty-five percent of the time.

However, even with this somewhat poor showing by the

Table 38. Decision information and results of the futures-forecasted cash price strategy

	Target Price	Forecasted Cash Price	Decision	Net Price
		January - April		
1967	21.36	19.34	H[a]	21.40
1968	18.64	19.58	NH	20.50
1969	18.39	21.96	NH	20.88
1970	26.64	25.88	H	26.66
1971	16.24	18.82	NH	16.38
1972	24.34	25.05	NH	23.38
		September - December		
1966	21.34	20.34	H	21.35
1967	19.26	18.95	H	19.40
1968	18.59	20.92	NH	19.75
1969	22.64	28.33	NH	27.75
1970	19.39	19.58	NH	16.38
1971	18.79	24.76	NH	21.88
1972	28.24	33.68	NH	32.25
		July - October		
1966	20.00	22.05	NH	21.88
1967	21.84	18.78	H	22.06
1968	19.64	19.61	H	19.16
1969	22.39	26.75	NH	25.25
1970	20.11	20.42	NH	18.38
1971	20.16	21.21	NH	21.00
1972	27.04	30.55	NH	28.50

[a]H = hedge; NH = no hedge.

FFCP strategy it did compare rather favorably to the naive strategies. Table 39 presents the mean and variance of the net price for the two naive strategies and for the FFCP strategy. In looking at the top half of the table we see that the FFCP strategy gives a higher net price than the routine hedging strategy over all feeding systems. This increase in price ranged from $ .50 for the January - April feeding system to $1.45 for the September - December feeding system. When we compare the FFCP strategy to the routine nonhedging strategy we find that the FFCP strategy gives a higher net price for only two of the feeding systems. The third feeding system, September - December, returns a higher mean net price by using the routine nonhedging strategy than by using the FFCP strategy.

The variance of the net price for the FFCP strategy fell between the variance of the net price from the routine hedging and the routine nonhedging strategies for the January - April and the July - October feeding systems. For the September - December feeding period the variance of the FFCP strategy was greater than the variance of the routine nonhedging strategy. This is shown in the bottom half of Table 39. Unlike cattle, we cannot call one of these three strategies, when applied to hogs, superior in all cases. We can say that the FFCP strategy is superior to the routine hedging strategy for the

Table 39. Mean and variance of the naive strategies and the futures-forecasted cash price strategy (hogs)

Period	No hedge $/cwt	Hedge Offset $/cwt	Hedge Optimal $/cwt	FFCP Offset $/cwt	FFCP Optimal $/cwt
			MEAN		
January - April	20.63	20.04	21.03	21.10	21.53
July - October	21.95	20.89	21.56	22.24	22.32
September - December	22.74	20.38	21.19	22.64	22.68
			VARIANCE		
January - April	9.72	12.53	15.39	9.22	11.55
July - October	13.57	4.92	7.17	13.03	12.87
September - December	29.60	11.27	11.73	29.92	29.79

January - April feeding system, and to the routine non-hedging strategy in the July - October feeding system. Beyond this the choice of hedging strategies depends on the feeder's objectives.

<u>Bayesian strategy</u> The computation of the Bayesian strategy for hogs is shown in Table 40. The procedure used is identical to the one presented for the cattle. Like the cattle, the Bayesian strategy for hogs was identical to the FFCP strategy. That is, this Bayesian strategy is S_2: if the target price is greater than the forecasted cash price then don't hedge. The value of the experiment for hogs was $1.03, which is quite a bit larger than the value of the experiment for cattle.

<u>Ten-day moving average strategy</u> The net price received and the mean and variance of that net price, along with the number of times a hedge was placed, for the 10-DMA strategy is shown in Table 41. Because a hedge was in effect at the end of the feeding period only fifty-three percent of the time, the feeder did not have the opportunity to choose which method to use in lifting the hedge in slightly under half of the feeding periods. This percentage was slightly above the same percentage for cattle where a hedge was in effect at the end of the feeding period fifty percent of the time.

Presented in Table 42 is the mean and variance of

Table 40. Computation of the Bayesian Strategy (hogs)

A.

	Payoff table ($/cwt) $U(\theta_i, a_i)$		Prior probabilities $P(\theta_i)$
	a_1	a_2	
θ_1	22.32	21.32	.35
θ_2	20.38	22.82	.65

B.

	$U(\theta_i a_i)$		$P(\theta_i)$	$(P(\theta_i)U(\theta_i a_i))$	
	a_1	a_2		a_1	a_2
θ_1	22.32	21.32	.35	7.81	7.46
θ_2	20.38	22.82	.65	13.25	14.83
Expected payoff using prior probabilities				21.06	21.29

C.

	$P(Z\|\theta_i)$	
	Z_1	Z_2
θ_1	.67	.33
θ_2	.36	.65

D.

Strategies	Action taken after Z_i:	
	Z_1	Z_2
S_1	a_1	a_1
S_2	a_1	a_2
S_3	a_2	a_1
S_4	a_2	a_2

Table 40. Continued

E.

	$P(Z1\theta_i)$		$P(\theta_i)$			
	Z_1	Z_2				
θ_1	.67	.33	.35	$P(\theta_1)P(Z,1\theta_1)$	.23	.12
θ_2	.86	.65	.65	$P(\theta_2)P(Z1\ \theta_2)$	.09	.56
					.32	.68

Action Probabilities

P_1 $\frac{.23}{.32} = .72$ $\frac{.12}{.68} = .18$

P_2 $\frac{.09}{.32} = .28$ $\frac{.56}{.68} = .82$

F.

	$G(P(\theta_i 1Z),a)$	
	Z_1	Z_2
a_1	21.78	21.74
a_2	20.73	22.55

Maximizing Strategy

a_1	a_2
21.78	22.55

Weighted average payoff corresponding to the Bayesian Strategy

$$21.78(.32) + 22.55(.65) = 22.32$$

G. Value of the experiment

$22.32 - $21.29 = $1.03

Table 41. Net price received using the 10-day moving average strategy and the number of times that a hedge was placed (hogs)

	Feeding Systems					
	January - April		July - October		September - December	
	$/cwt	x[a]	$/cwt	x	$/cwt	x
1966					21.51	2
1967	20.38	4	19.80	5	19.70	5
1968	18.89	5	19.93	2	19.59	1
1969	21.24	2	24.32	3	26.66	4
1970	24.92	2	19.14	5	18.50	3
1971	16.15	4	21.55	3	20.83	2
1972	26.54	2	27.26	4	31.92	1
Mean	21.35		22.00		22.67	
Variance	14.74		10.11		23.65	

[a]Number of times hedge was placed.

the net price for each feeding system and hedging strategy. In the top half of this table we see that the 10-DMA strategy performed much better when applied to hogs than it did when applied to cattle. The 10-DMA strategy returned a higher net price than both naive strategies for the feeding systems, except for the routine nonhedging strategy in the September - December feeding period. The FFCP and Bayesian strategies gave a higher mean net price in all feeding systems when compared to the 10-DMA strategy.

As one can see from the bottom of Table 42, the variance of the net prices is somewhat erratic with the 10-DMA strategy. In the January - April feeding system the variance is the second largest of those presented, while in the July - October and September - December feeding systems it is the second smallest.

As with the cattle, the 10-DMA strategy when applied to hogs was plagued by large average hedging costs. Using routine hedging the average hedging costs were $ .15 for the July - October and January - April feeding systems and $ .17 for the September - December feeding system. This cost is approximately one-half the average hedging costs if the 10-DMA strategy is used ($ .39 for the July - October feeding system, $ .34 for the January - April feeding system, and $ .27 for the September - December feeding system). A second factor which affected

Table 42. Mean and variance of the five hedging strategies by hog feeding systems

Feeding System	Strategy				
	No Hedge	Routine Hedge	FFCP	Bayesian	10-DMA
	Mean				
January 1 - April 15	20.63	21.03	21.53	21.53	21.35
July 1 - October 15	21.95	21.56	22.32	22.32	22.00
September 1 - December 15	22.74	21.19	22.68	22.68	22.67
	Variance				
January 1 - April 15	9.72	15.39	11.55	11.55	14.74
July 1 - October 15	13.57	7.17	12.87	12.87	10.11
September 1 - December 15	29.60	11.73	29.79	29.79	23.65

the mean net price from the 10-DMA strategy was that a net loss in the futures market occurred in fifty-eight percent of the years, consequently reducing the net price.

Maximum investment   Shown in Table 43 is the maximum amount of margin needed to maintain a hedge using the routine hedging strategy. From this table we see that in twenty percent of the cases only the initial margin was required. However, over three times the initial margin was required in twenty percent of the cases.

As we pointed out in discussing cattle, the mean maximum investment is reduced when the FFCP strategy is used. This is primarily because no hedge is placed in the years when a large amount of margin is required. Table 44 shows the maximum investment for the FFCP and Bayesian strategies.

By using the 10-DMA strategy the amount of additional margin required can be reduced even further. In only one case was additional margin required, and then only $52 was required. In all of the other years the only margin needed was the initial margin.

Table 43. Maximum margin needed at any one time with routine hedging (hogs)

	Feeding System		
	July - October	September - December	January - April
1966	2190	1050	
1967	750	902	750
1968	810	1450	930
1969	2530	3302	2090
1970	750	750	1030
1971	1030	2298	1682
1972	1698	2510	1190
Mean	1394	1751	1278
Standard Deviation	744	965	508

Table 44. Maximum margin needed at any one time with the FFCP or Bayesian strategy (hogs)

	Feeding System		
	July - October	September - December	January - April
1966		1050	
1967	750	902	750
1968	810	NH[a]	NH
1969	NH	NH	NH
1970	NH	NH	1030
1971	NH	NH	NH
1972	NH	NH	NH
Mean	780	976	890
Standard Deviation	42	104	197

[a]NH = no hedge.

CHAPTER VIII: SUMMARY

The objectives of this study were: a) to develop a framework for defining and comparing hedging strategies, b) to test selected hypotheses concerning the level and variability of the cash-futures price difference (basis), c) to use the results of the basis analysis to formulate alternative hedging strategies that may be used by midwestern livestock feeders, d) and to use simulation analysis to compare the mean and variability of net returns from alternative hedging strategies.

A hedging strategy was defined as a set of rules for making decisions. These decisions were:

a) whether or not to place a hedge,

b) which contract to use in placing the hedge,

c) when to place the hedge,

d) what proportion of the livestock to hedge,

e) how to lift the hedge,

f) when to lift the hedge, and

g) whether and when to replace the hedge.

Different hedging strategies use different rules for making these decisions.

Three basic hypotheses were tested concerning the basis. They were: a) the basis is equal between option months, b) the basis during the delivery period is not significantly different from the basis during the rest of the near month period, and c) there is no variation in the basis from year to year. The first hypothesis was rejected for the December cattle option and for all of the hog options except April. The second hypothesis was rejected for the six cattle options and for three of the hog options, while the third hypothesis was accepted for five of the cattle options and rejected for six of the hog options.

Five hedging strategies were then formulated: two naive strategies, and three selective strategies. The naive strategies were: routine hedging and routine non-hedging. The first two selective strategies used the results of the analysis of the basis to calculate a target price. These strategies were the futures-forecasted cash price strategy and the Bayesian strategy. The third selective strategy used, the ten-day moving average strategy, uses a mechanical criteria for placing and lifting a hedge.

Two simulation models were developed and used to calculate the net price received from each of the hedging strategies. Besides the net price received, the simulations were also used to calculate the actual hedging cost taking into account the daily interest. The maximum amount of margin required at any one time was also calculated.

Choosing a Strategy

In deciding which strategy to choose we assume the feeder considers two factors: a) the expected return, and b) the risk involved. In this case risk is measured by the variance of the net return. In Figures 18 to 23 the variance of the net price is plotted against the mean net price for each hedging strategy. The solid line is a variance-expected price frontier, with the portion between strategies representing linear combinations of two strategies. So, point A in Figure 18 is a linear combination of the FFCP or Bayesian strategy and the routine hedging strategy. Specifically, point A represents a strategy in which the FFCP or Bayesian strategy is used three-fourths of the time or for three-fourths of the livestock and the routine hedging strategy is used one-fourth of the time or for one-fourth of the livestock.

A feeder with diminishing marginal utility for money can automatically disregard any strategy that lies above the frontier. These strategies are inferior to any strategies occurring along the frontier because they yield both a lower price and a higher variance than any strategy along the frontier.

To choose a strategy the feeder first needs to develop a set of indifference curves between expected return and risk. Indifference curve AA, in Figure 18,

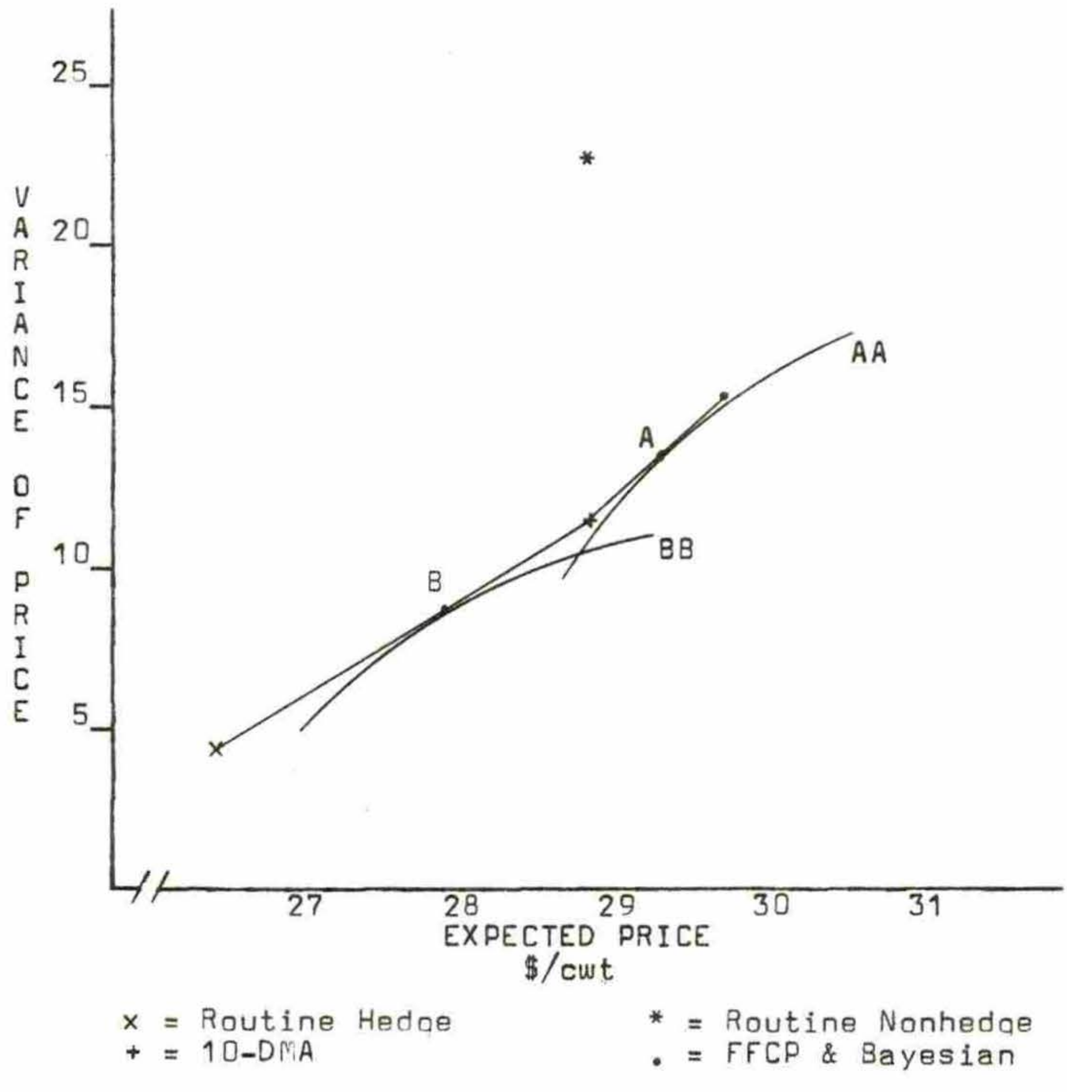

Figure 18. Variance-expected price for the January - June cattle feeding system

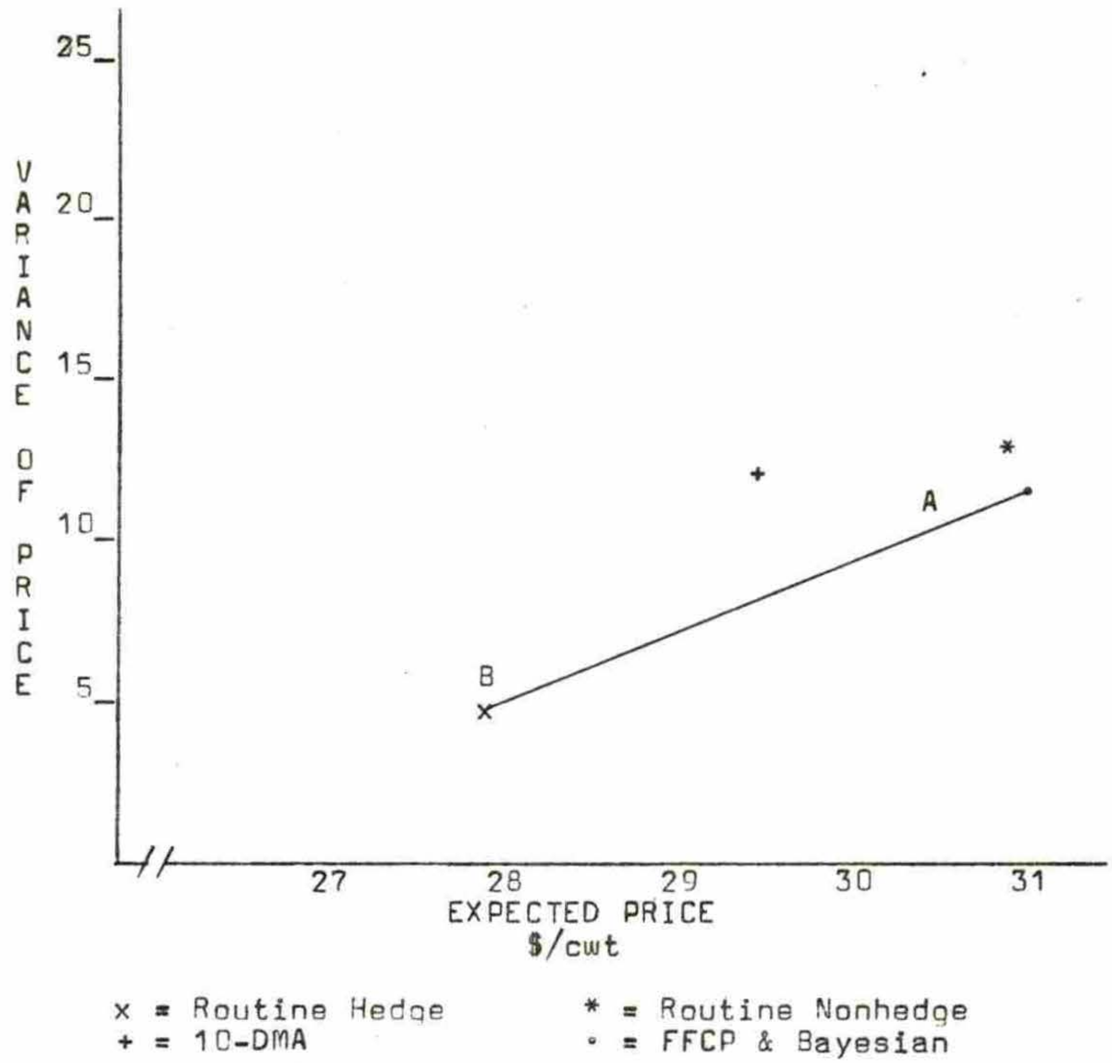

Figure 19. Variance-expected price for the November - August cattle feeding system

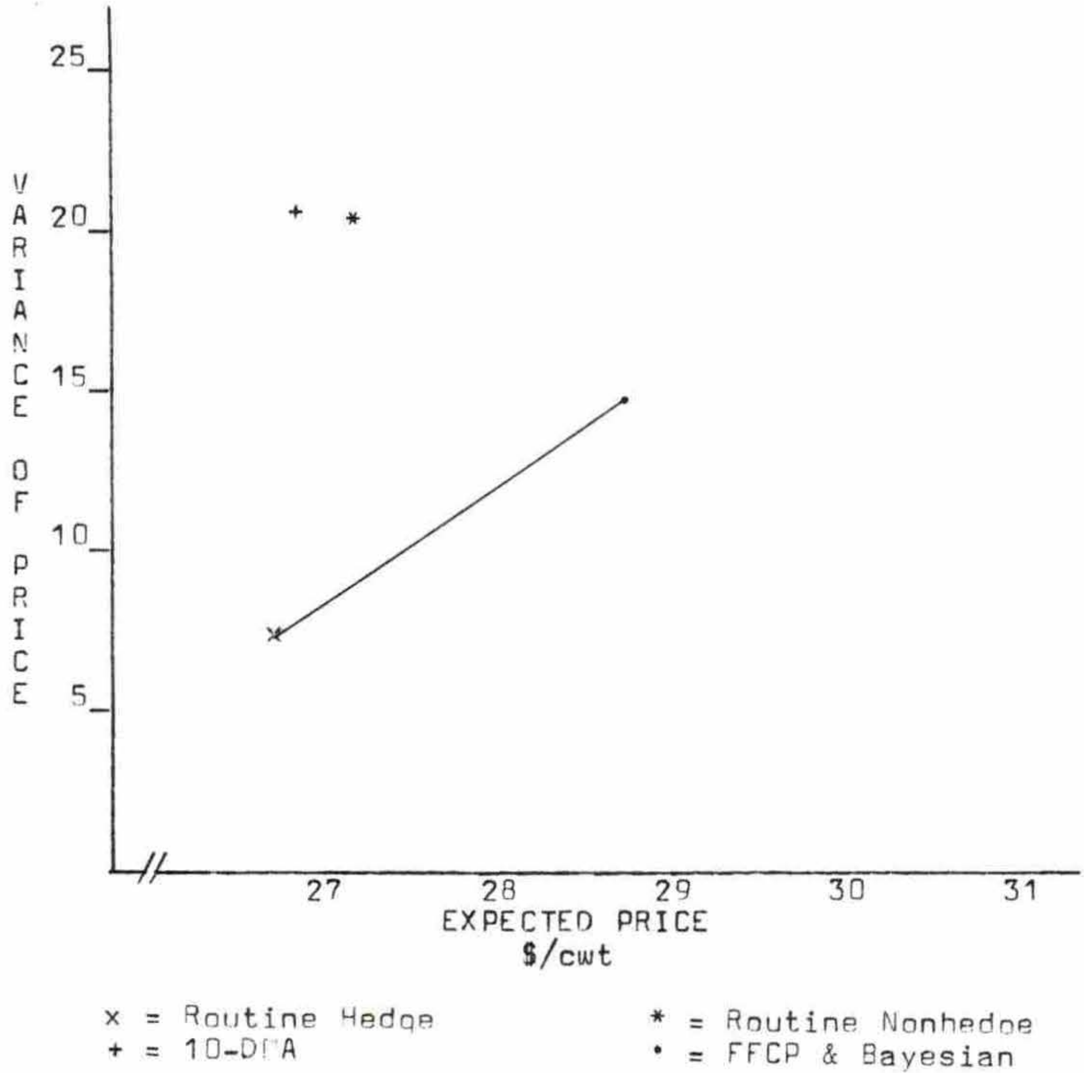

Figure 20. Variance-expected price for the April - December cattle feeding system

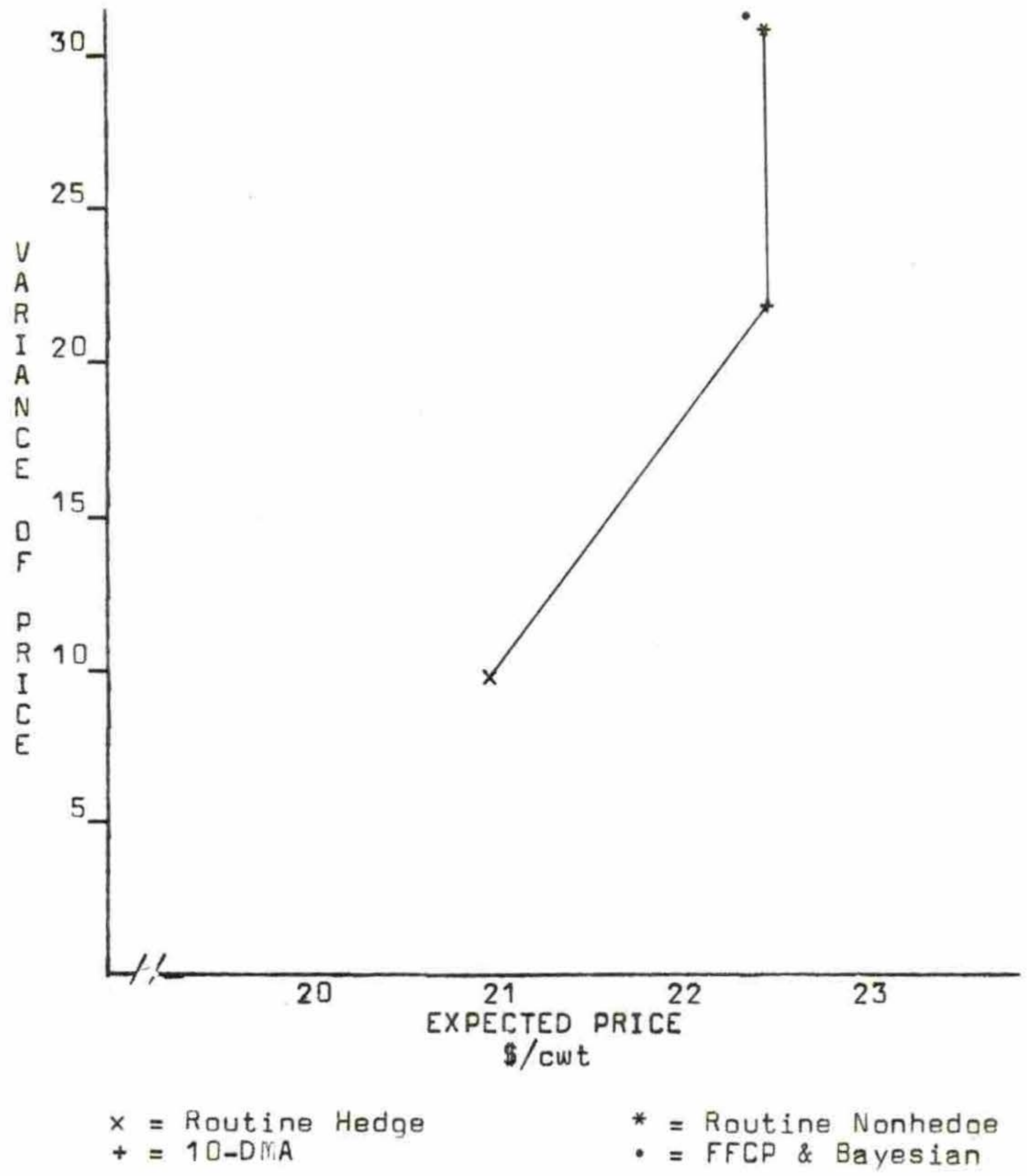

Figure 21. Variance-expected price for the September - December hog feeding system

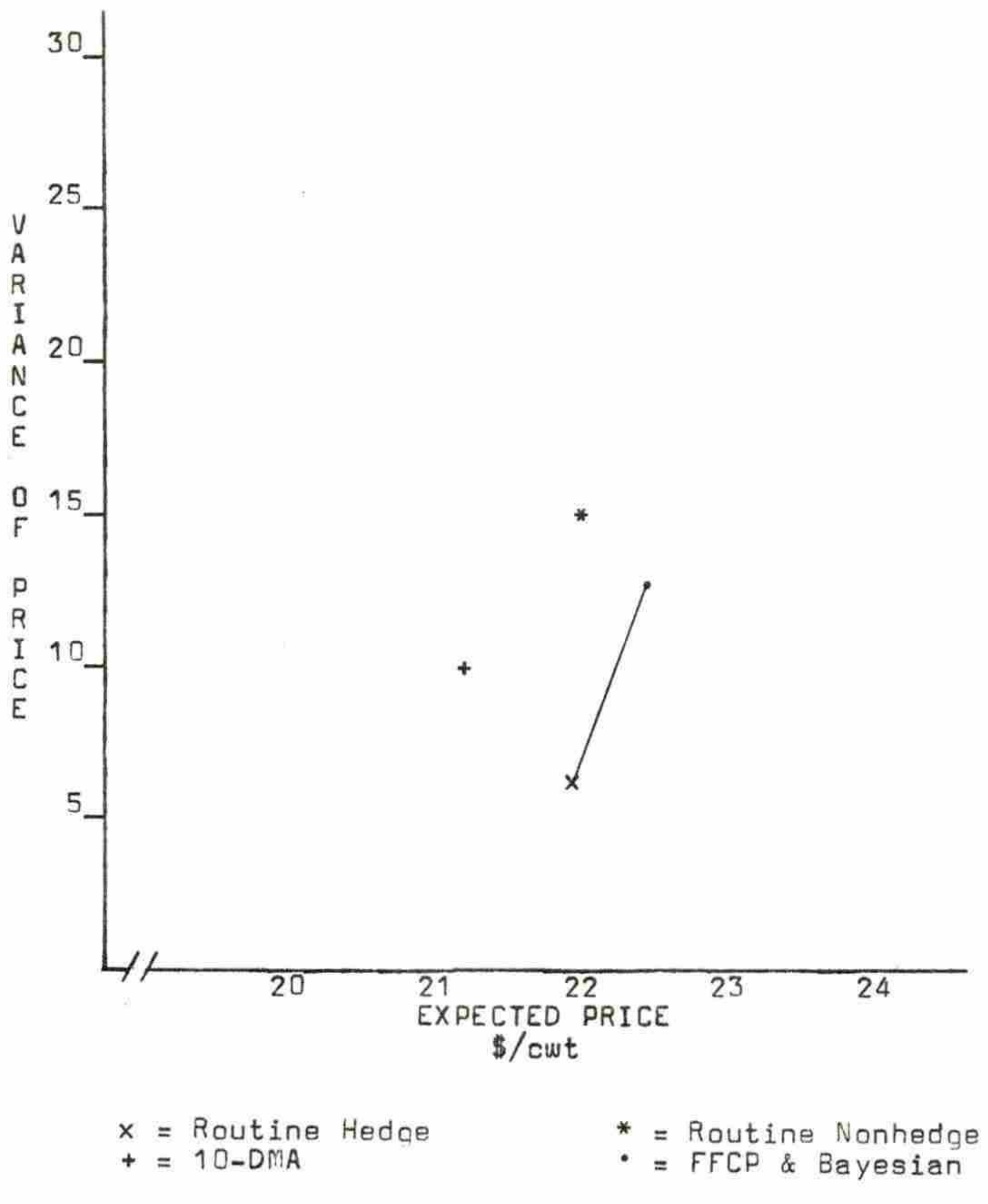

Figure 22. Variance-expected price for the July - October hog feeding system

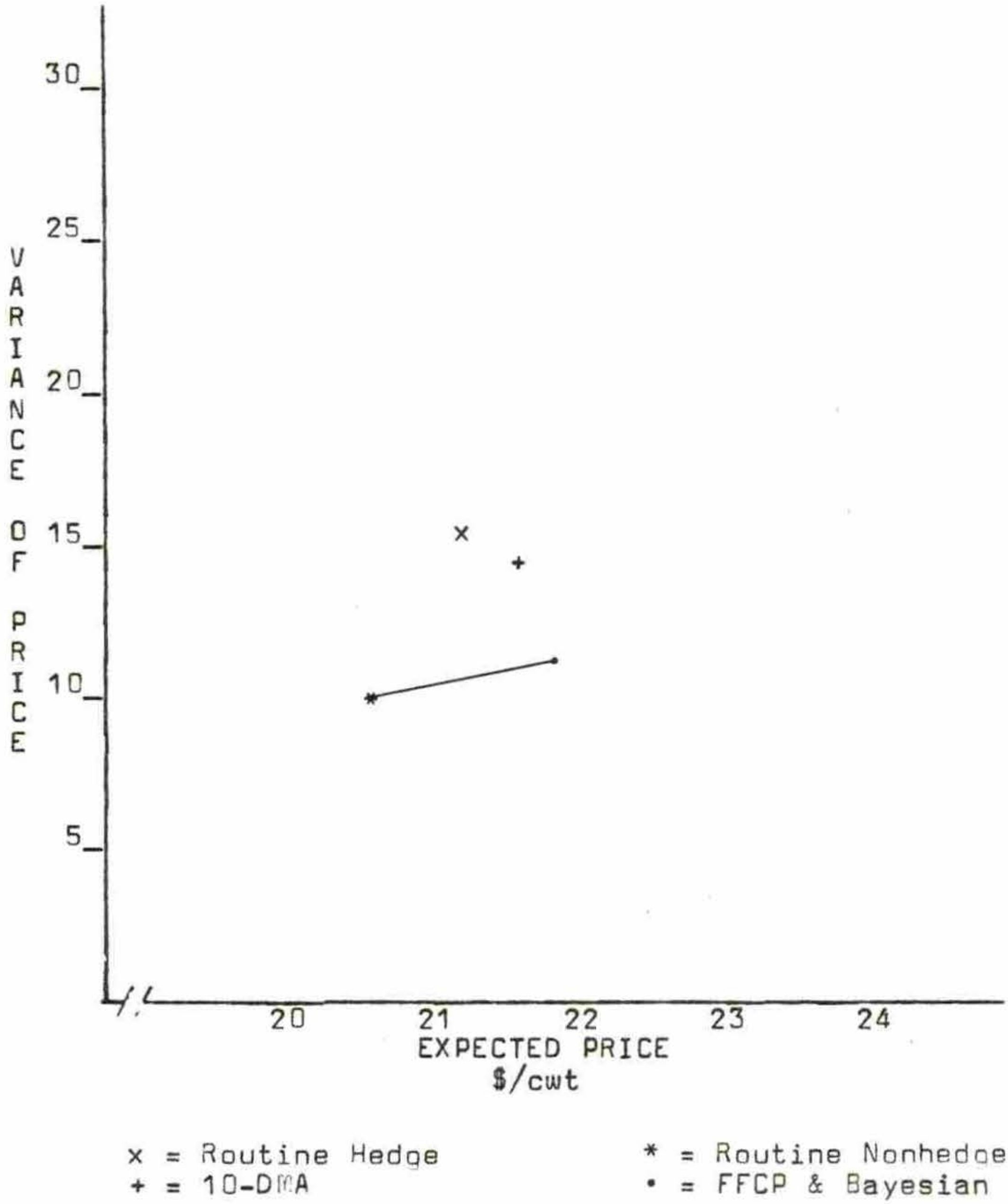

Figure 23. Variance-expected price for the January - April hog feeding system

represents a feeder who has a high marginal rate of substitution between the variance of the expected return and the expected return, while indifference curve BB represents a feeder with a low marginal rate of substitution. The feeder would then choose a strategy at the point where the slopes of the frontier line and the indifference curve are equal, and the curves are tangent. If there is no strategy at that point then a linear combination would be used. Two such points are shown in Figure 18. At point A a linear combination of the 10-DMA strategy and the FFCP or Bayesian strategy would be used, while at point B the feeder would use a combination of the routine hedging strategy and the 10-DMA strategy.

One can see from the above discussion that no one best hedging strategy can be recommended. Rather, he needs to be given a set of alternative strategies from which to choose depending on his own situation.

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APPENDIX

The cash price model used in the analysis was obtained from an as yet unpublished manuscript entitled "A quarterly model of the beef, pork, sheep, broiler, and turkey sectors" (27). The forecasting model gives a forecasted average for the Omaha market price for each "seasonal" quarter. The four seasonal quarters are: 1) December, January, and February, 2) March, April, and May, 3) June, July, and August, and 4) September, October, and November.

Table A1 shows the forecasted cash price for each quarter for both cattle and hogs. The cattle price is for choice steers at Omaha, while the hog price is for number 1-3, 220-240 pound hogs at Chicago prior to July, 1968, number 1-2, 220-240 pound hogs at Chicago from July, 1968 through May, 1970, and number 1-2, 220-240 pound hogs at Peoria after 1970.

Table A1. Forecasted and actual average cash prices for cattle and hogs[a]

Year	Quarter	Cattle: Forecasted Cash Price	Cattle: Actual Cash Price	Hogs: Forecasted Cash Price	Hogs: Actual Cash Price
1965	1	22.89	22.71	16.68	16.82
1965	2	24.77	24.44	19.17	18.90
1965	3	26.56	26.53	24.62	24.60
1965	4	25.59	25.59	24.73	24.15
1966	1	25.44	26.07	28.86	28.49
1966	2	26.33	26.92	24.52	24.02
1966	3	25.26	25.37	25.12	25.77
1966	4	24.58	24.83	22.05	22.22
1967	1	24.18	24.11	20.34	20.47
1967	2	24.03	24.07	19.34	19.97
1967	3	25.98	26.24	21.71	22.45
1967	4	26.00	26.16	18.78	18.89
1968	1	25.75	25.79	18.95	18.98
1968	2	26.41	26.45	19.58	19.43
1968	3	27.16	27.14	20.42	21.70
1968	4	27.14	27.34	19.61	19.86
1969	1	27.99	27.84	20.92	20.84
1969	2	30.56	30.86	21.96	22.70
1969	3	30.99	31.98	26.08	27.16
1969	4	28.93	28.05	26.76	26.88

[a]Source: (27).

Table A1. Continued

Year	Quarter	Cattle: Forecasted Cash Price	Cattle: Actual Cash Price	Hogs: Forecasted Cash Price	Hogs: Actual Cash Price
1970	1	28.19	28.50	28.33	28.79
1970	2	30.38	30.38	25.88	26.03
1970	3	30.73	30.52	24.83	24.76
1970	4	28.83	28.40	20.42	19.05
1971	1	29.41	29.35	19.58	18.00
1971	2	32.65	32.38	18.82	17.86
1971	3	32.90	32.90	20.38	20.15
1971	4	32.89	32.85	21.21	20.14
1972	1	35.55	35.47	24.76	25.07
1972	2	35.25	35.11	25.34	25.05
1972	3	37.18	37.25	28.20	29.09
1972	4	34.82	34.42	30.55	29.28
1973	1	40.07	40.25	33.68	34.57
1973	2	44.29	45.52	36.70	37.66
1973	3	50.00	.00	40.02	.00
1973	4	43.57	.00	40.62	.00
1974	1	48.53	.00	42.08	.00
1974	2	51.06	.00	39.53	.00
1974	3	52.08	.00	40.52	.00
1974	4	45.61	.00	41.91	.00
1975	1	44.45	.00	43.44	.00
1975	2	44.35	.00	42.46	.00
1975	3	44.54	.00	45.89	.00

ACKNOWLEDGEMENTS

First of all I would like to thank the Chicago Mercantile exchange for their support of this research. Secondly, I would like to thank Dr. Ronald Raikes, without whose guidance and understanding this thesis would never have been written. In addition I am grateful to the members of my committee, Dr. Paul Brackelsberg, Dr. J. T. Scott, Dr. Don Kaldor, and Dr. Gene Futrell.

A special thanks goes to Annette Burnham, who put up with my writing and disorganization, to do such a fine job of typing this thesis, with assistance from her husband, Nate, and daughter, Tami.

And to my wife, Rosalie, I extend my greatest appreciation and thanks for her encouragement and understanding which kept me going in graduate school.