MEAN–VARIANCE ANALYSIS OF ALTERNATIVE HEDGING STRATEGIES*

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Much of the research in commodity hedging has concentrated upon the development of theoretical models describing the optimum position in cash and futures markets [8, 10, 16]. Other studies have shown that the difference between current spot price and futures price represents the market price for storage, processing services, or both [9, 17]. The revenue stabilizing potential of futures markets for commodities with continuous as opposed to noncontinuous inventories has also received attention [9]. However, very little work or literature is publicly available on how different hedging strategies actually would have performed for a particular commodity over time.

The objective of this study was to evaluate the performance of alternative hedging strategies for cattle feeding operations. Estimates of the mean and the variance of net returns for selected strategies are developed. Clearly, the mean net return is a relevant criterion in selecting from alternative strategies. If income variability is important to the financial institutions which extend credit to the feeder, variability of net returns should also be of interest to the cattle feeding industry. Consequently, both the mean and variance of net returns are used as evaluative criteria. The results indicate several strategies compare favorably, with regard to both criteria, to an unhedged operation.[1]

PROCEDURE

The analysis is applicable to cattle feeding operations in the High Plains of Texas, Oklahoma, New Mexico and Kansas. Weekly price and cost data were gathered for the period 1965-1970. Published studies provided cost information for a number of representative feedlot situations with respect to rate of gain, lot size, and capacity utilization [2, 15]. For a given rate of gain, lot size, and utilization rate a representative feeding situation was constructed. It was assumed that the animal is placed on feed at a weight of approximately 650 pounds, kept on feed for 20 weeks, and sold. The rate of gain was assumed constant over the feeding period.[2] In order to obtain a large number of observations, a new feeding period was started each week.

THE MODEL

The following notation of variables was employed:

M_t =Amarillo milo price in week t [14]

OKP_t =Oklahoma City 650-lb. Choice steer price [12]

CLO_t =Clovis 1,000-lb. Choice steer price [13]

FP_t =Futures price at Monday's close [1]

$CAPUT^{ij}$ =Variable representing weekly cost of gain as a function of lot size i and utilization rate j [2]

$GAIN^k$ =Variable representing change in weekly cost of gain for changes in milo prices as a function of rate of gain k [2]

LOC =Location component of the Chicago-Clovis basis

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[1] The analysis does not identify a single "best" strategy. The preference patterns with regard to level versus variability of returns are not known for different entrepreneurs. Also, what is "best" may depend on operating circumstances. The young and growing feeding operation relying heavily on borrowed capital may, for example, opt for a strategy which gives maximum protection against the large loss--even at the cost of decreased mean returns.

[2] It is realized that this does some injustice to the actual growth curve, but comparison and testing with actual growth curves as developed by Wagner indicated no significant difference in total cost for the entire feeding period [15].

TIME = Time component of the Chicago-Clovis basis

EWT^k = Weight of finished animal for rate of gain k

$PJCLO_t$ = Projected Clovis price.

The net revenue function for lot size i, utilization rate j, and feeding rate k is then defined as:

$$(1) \qquad NR_t = (EWT^k)CLO_t - 6.5(OKP_{t-19}) - 20(CAPUT^{ij}) - \sum_{t=t-19}^{t} \frac{(M_t - 1.85)\, GAIN^k}{.05}.$$

The last expression on the right side of the equation represents changes in the cost of gain as a function of weekly changes in milo prices [2].

ALTERNATIVE HEDGING–FEEDING STRATEGIES

I. Unhedged Feeding Operation

This is the basic cattle feeding activity. The equation describing the net revenue per head is defined in (1).

II. Completely Hedged Operation

Equation (1) is also used to define the net revenue of the feeding part of the completely hedged operation. This strategy assumes that every animal is fully hedged in the week in which it is placed in the lot and that the hedge is lifted in the week when the animal is sold. A charge equal to the commission cost of the contract on a per head basis ($1.04) was subtracted.[3] The expression for the net returns due to the futures activity is:

$$(2) \qquad HNET_t = (FP_{t-19} - FP_t)\, EWT^k - 1.04.$$

Net returns to the strategy is then the sum of the net returns derived from hedging and from feeding, or

$$(3) \qquad NRH_t = NR_t + HNET_t.$$

III. Seasonal Hedging Operation

In recent years cattle prices have historically moved upward in the spring and downward in the fall. Strategy III hedged all cattle coming out in the months September-December inclusive. There was no hedging during the rest of the year. The returns position is therefore defined by a combination of the procedures explained under I and II above.

IV. Hedge if Expected Lock-In is Less than the Mean Net Return

The expected lock-in margin was calculated as the appropriate Chicago futures price[4] adjusted to Clovis for differences in location and time minus the estimated cost of producing a finished animal. Letting μ_R represent the mean net return of the unhedged operation a futures position was established if

$$(4) \qquad ELI_{t-19} < \mu_R$$

where: $ELI_{t-19} = FP_{t-19}$ - BASIS - COSTS,

and BASIS = LOC + TIME.

The average difference between Chicago and Clovis weekly cash prices, for the weeks just prior to closing of the futures contract, during the period 1965-1970 was used to compute LOC for each of the futures contracts. The average difference between the price of the futures contract which had been sold and the Chicago cash price, during the weeks just prior to closing of the futures contract, was used as a measure of the lack of convergence between the futures and cash prices for any particular contract–the TIME component of the basis.[5] Feeding costs were estimated by extending current grain costs into the future. Strategy IV might appeal to a feeder who would like to gamble on possible price increases if considerable potential for a larger than average return existed but would prefer to hedge if smaller than average returns appeared probable.

V. Hedge if Expected Lock-In is Greater Than or Equal to the Mean Net Return

For strategy V the decision rule is to hedge if $ELI_t \geq \mu_R$. The rationale for this rule may be explained in the following manner:

(1) If the expected lock-in return is greater than the average return then attempt to guarantee that return by hedging.

(2) If the expected lock-in return is lower than the average return, then gamble that product prices will increase and do not hedge.

VI. Hedge if Expected Net Revenue is Less than the Mean Net Return and Expected Lock-In is Greater than Zero

[3] No charge was made to cover the interest cost of the margin deposit. It is realized that if an established position went against the feeder, considerable capital could be required to maintain the margin requirement.

[4] The futures contract sold in time period t-19 was the contract which either matured in week t, or in the next "contract maturity week" after week t.

[5] The difficulty with this approach is that the variation and range of the calculated basis is large and using the mean values as the adjustment factor does not give a highly accurate estimate of the Clovis-adjusted Chicago price.

In equation form, the decision rule for this strategy specifies a hedge if

(5) $ENR < \mu_R$, and $ELI_{t-19} > 0$,

where $ENR = (PJCLO_t)(EWT^k) - COSTS$.

In order to calculate expected net revenue the current Clovis price was extrapolated into the future using a seasonal price index.[6] Current grain costs were used in estimating feeding costs. Expected lock-in was calculated as defined in strategy IV.

If the income from feeding cattle as reflected in ENR is not particularly favorable and there is an expectation of obtaining a positive revenue by hedging, then a short position is taken. Such a strategy allows the feeder to gamble for large returns when the combination of cattle prices, feeder prices, and grain prices appears favorable. No hedge is placed under such a favorable outlook.

VII. Seasonal Hedging Operation With Correction for Price Change

Strategy VII is a modified version of strategy III which was designed to protect cattle feeders from unfavorable price movements in the fall. Under strategy III, no protection was afforded the feeder against unfavorable price movements during the remainder of the year. Strategy VII allows the feeder to correct his unhedged position in the spring if typical price patterns are altered. It provides for the hedging of all cattle coming out in the September-December months with additional hedging during the remainder of the year if a price decrease greater than $1.00 per cwt. over a four-week interval occurs. Therefore, cattle coming out in the months of January-August are hedged only if prices decrease by more than the $1.00 over a four-week interval.[7]

THE RESULTS

Table 1 presents estimates of the mean and variance in net returns for each of the strategies. Estimates in Table 1 illustrate a 20,000 head lot operating at full capacity. Average daily gain is held constant at 2.8 lbs. per day. The results are also presented graphically in Figure 1.

Table 1
MEAN AND VARIANCE OF NET RETURNS PER HEAD
FOR SELECTED HEDGING STRATEGIES

Strategy	Mean μ_R	Variance σ^2_R
	($ per head)	($ per head)
I	10.16	454.71
II	3.73	135.64
III	10.96	407.97
IV	4.45	324.68
V	10.32	301.95
VI	9.17	322.23
VII	11.63	438.85

Number of Observations = 295

[6] Seasonal indices are easily obtained for most price series. The analysis provides a measure of the usefulness of an index as an elementary price forecaster. The value of the index was obtained from [5].

[7] The trip mechanism of greater than a one-dollar change over a four-week interval was chosen after some preliminary investigation showed that this criterion would avoid most temporary aberrations while identifying the major contraseasonal fluctuations.

FIGURE 1

RELATIONSHIP BETWEEN MEAN AND VARIANCE IN NET RETURNS FOR SELECTED HEDGING STRATEGIES

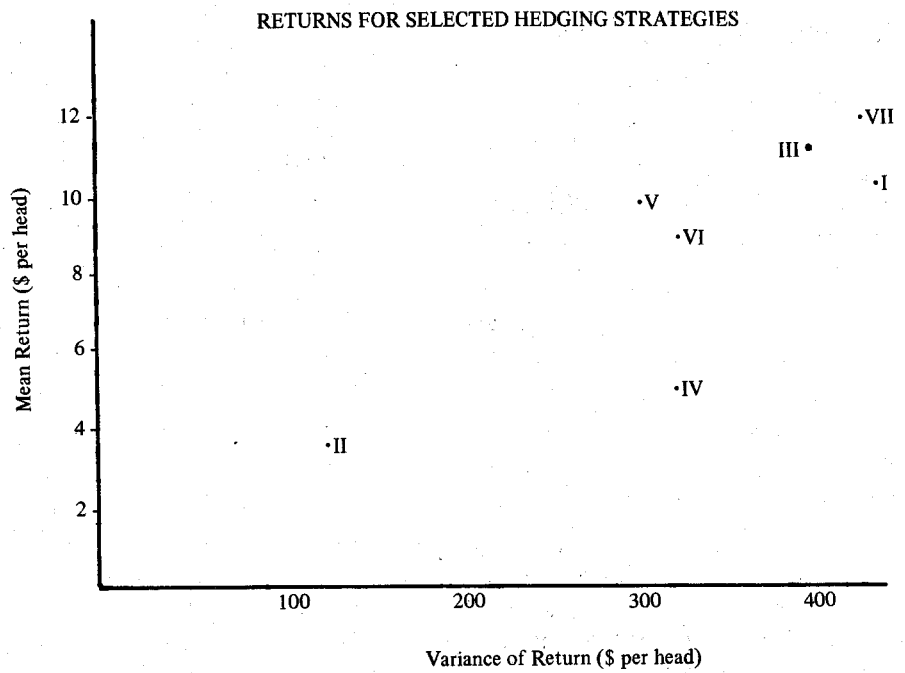

Table 2
MEAN AND VARIANCE OF NET RETURNS FOR LOTS OF 5, 10, AND 20 THOUSAND HEAD: SELECTED HEDGING STRATEGIES

	μ_R			σ^2_R		
Strategy	5,000	10,000	20,000	5,000	10,000	20,000
I	4.16	7.95	10.16	449.16	452.13	454.71
II	-2.27	1.52	3.72	135.07	134.89	135.64
III	4.96	8.75	10.96	401.79	405.15	407.96
IV	-1.91	2.10	4.45	324.09	324.68	324.68
V	3.91	7.98	10.32	302.83	301.95	301.95
VI	4.18	7.13	9.17	367.26	330.83	332.23
VII	5.26	9.29	11.63	438.48	438.68	438.85

In Table II, μ_R and σ^2_R are presented for lot sizes of 5,000, 10,000, and 20,000 head. Full capacity utilization and a rate of gain of 2.8 lbs. per day are still assumed.

In comparing the performance of strategies I and II, the completely hedged operation (strategy II) resulted in a large decrease in the variability of net returns but at the expense of a large decrease in μ_R. To a large degree the reduction in mean net returns was due to a generally upward tendency in cattle prices over the last three years of the study period. If the price patterns of recent years continue, the fully hedged operation will be characterized by a substantial trade-off in mean net returns for a lower

variability of net returns.

Strategies III, V and VII compare favorably with the unhedged feeding strategy. Of the three, strategy V is the only one which is superior in a statistical sense. The variance for V is significantly smaller (at the .01 level) with no concurrent significant decrease in the mean level of net returns. However, both III and VII are characterized by smaller variances and larger mean returns–both desirable properties–as compared to the unhedged feeding strategy.

Strategy VI used both expected net revenue and expected lock-in and resulted in a reduction in the variance and mean relative to strategy I. The principle difficulty with VI is that the projecting of current live price into the future with a seasonal index, while usually correct as to directions of the future change, consistently underestimated the magnitude of change. In the fall, the magnitude of the price change in the following spring would often be underestimated and futures contracts were sold when they should not have been on an ex post basis. In the summer, the magnitude of the drop in price for the coming fall would be underestimated, meaning expected net revenue would be overestimated, and the position would not be hedged. However, the index-price adjusting procedure did often get the direction of price movements correct, contains considerable information, and does have some value as a rule of thumb adjustment.

CONCLUSIONS

Previous studies have shown that both the mean and variance are important selection criteria when risky alternatives are involved [7]. The mean and variance of net income were selected as criteria for evaluating alternative hedging strategies for cattle feeding operations. The objective of the study was to give some empirical content to these criteria for several simple but reasonable decision rules. While no particular strategy is recommended, the analysis does indicate which of the strategies are efficient.

In comparison to a completely unhedged operation the strategy of hedging all cattle results in a significant reduction in σ_R^2 but at the cost of a large and statistically significant reduction in μ_R. Decision rules incorporating additional information and feedback also resulted in large decreases in variability, while actually increasing the mean net return. The seasonal hedge with a corrective mechanism, strategy VII, gave the best mean returns by taking advantage of the seasonal movements and avoiding being caught in a "bad" position. However, the variance was higher than for any of the strategies employing hedging and was not statistically smaller than the variance of the unhedged feeding strategy.

The rule using expected lock-in greater than the mean return as a criterion, strategy V, performed quite well. Even though establishing an accurate expected lock-in margin proved difficult because of considerable variation in the basis, this strategy accomplished a significant decrease in variance of net returns compared to the unhedged feeding strategy with a small increase in mean net returns.

The strategy employing expected net revenue, strategy VI, is not without problems but does appear to contain information that can be used to advantage. The difficulty with this strategy was that current prices projected into the future on the basis of a seasonal index generally failed to account for the magnitude of price change that often took place.

In general, it appears strategies involving hedging can be used successfully by the manager of cattle feeding operations. Results of this analysis suggest strategies are available which not only decrease the variability of net returns (which is expected) but also increase the mean net returns (which is not usually expected). Further work, especially involving incorporation of more refined short-run price projection techniques, would appear to be very promising.

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