A Decision Model to Assess Cattle Feeding Price Risk

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Practitioners Abstract

Traditional break-even/fed cattle price projections do not provide adequate risk information to feeders, investors, lenders, and other stakeholders interested in cattle feeding decisions. The objectives of this study were two-fold: 1) develop a spreadsheet model that could estimate the net income distribution surrounding a cattle placement decision based on historical errors of futures based price forecasts, and 2) determine whether information generated from the model can be used to improve placement and marketing decisions. To accomplish objective 1, model was developed that could estimate the income distribution around a pen of cattle under a cash speculating and short hedge pricing strategy. Distribution estimates were based on 7 alternative forecast horizons and were derived from historical forecast errors. To accomplish objective 2, decision rules were developed that allow the feeder to specify the maximum probability he/she is willing to risk losing a specified level of income. These decision rules were compared to random and naïve decision rules by simulating the outcomes over 168 discrete six months feeding periods between 1987 and 2000. Risk averse decision rules were successful in signaling highly unprofitable feeding periods, but also filtered out highly profitable feeding periods.

Keywords: forecast error, marketing decisions

Introduction

Fed cattle price is the primary source of risk for cattle feeders. Research suggests that as much as to 80% of the variability in cattle feeding profits is explained by the variability in fed cattle prices (Mark et al. 2000, Lawrence et al. 1999, Schroeder et al. 1993). Consequently, marketing management is a critical component of a successful cattle feeding enterprise. To raise marketing management to the levels demanded by the lending industry, feedlot operators need access to outlook information. Cattle feeding projection models focus primarily on comparing point estimate price forecasts to calculated break-even points, but they do not identify the risk profile associated with a specific feeding and price management regime. The feedlot projects an expected profit, but ignores the probability of a specific gain or loss. To make sound management decisions, managers need access to risk outlook in addition to with price forecasts.

Price risk can be managed with the use of futures or options contracts, or by avoiding risky situations. However, in order to manage risk, it must be measured first. Historical returns provide a potential indicator of the risk associated with cattle feeding. Cattle feeding profitability and risk have been researched extensively (Hampel, Schroeder and Kastens 1998; Dodson and Elam 1992). Studies typically have shown that, while average return on investment is relatively favorable, volatility in returns is high (Dodson and Elam 1992). Retrospective in nature, these studies describe the overall risk of cattle feeding but do not necessarily estimate the risk of a specific pen of cattle given prevailing supply and demand outlook information.

Decision support aids are needed to translate observable or historic predictors of risk into practical applications to help producers evaluate the risks associated with their management and marketing decisions. There are two primary objectives of the study. First, we will develop procedures for estimating the probability distribution around a forecast price and projected net income for fed cattle at market time und. Next, we will simulate the economic outcome of decision rules cattle feeders may use at placement time that incorporate the risk profile of a pen of cattle into purchasing decisions and choices regarding futures or options contracts.

Methods

Forecast Methodology

To accomplish the first objective of the study, we developed a model that quantifies fed cattle price risk given the historical reliability of futures based price forecasts. Specifically, this model will identify probabilistic payoff of alternative price management strategies when given cattle placement weight and date, prevailing futures and cash price conditions at placement, and historic basis and animal performance patterns.

The first step in developing the model was establishing a method of forecasting prices. To be useful, forecasting methods must be easily understood and must utilize readily available information. Futures prices meet these criteria and, consequently, are the natural choice for the beginning point of the price forecast. In addition to widespread availability, deferred futures prices are generally as accurate as forecasts from other private, academic, and government sources (Just and Rausser 1981; Kastens, Schroeder, and Plain 1996).

Price forecasts were derived from futures prices adjusted with a 5-year moving average basis observed during the projected marketing month. Equation 1 provides a formal mathematical specification of the price forecast. $E[CP_t]$ represents the expected cash price on the first business day of month t. Fut_{t-h} represents the closing futures price for the corresponding deferred contract month on the first business day of the month h months prior to t. The second term on the right hand side of equation 1 represents the 5 year moving average basis, defined as the cash price minus the nearby closing futures price observed on the first business day of the month. Kastens, Jones, and Schroeder (1998) examined the accuracy of five alternative forecasting methods and found this approach outperformed the other methods of forecasting fed steer prices for forecast horizons less than 7.5 months.

Equation 1) $E[CP_t] = Fut_{t-h} + \frac{1}{5}\sum_{t=T-4}^{T}(CP_t - Fut_t)$

Forecast errors were estimated by comparing the forecasted prices to actual cash prices observed on the first business day of the month. A database of forecast errors was compiled for each marketing month of the year at 7 alternative forecast horizons. The database was developed from futures and cash price observations on live cattle futures prices and Iowa Minnesota Direct trade prices from 1988 to 2000. The forecast horizon alternatives (30-day discrete increments ranging from 90 to 270 days) were selected to represent a range of feeding periods common in the Midwest. The mathematical specification of forecast error is defined in equation 2.

Equation 2) Forecast Error = Actual Price – Forecasted Price

Estimating an income distribution around a futures and options pricing strategies requires an estimate of basis forecast accuracy. Forecasts used in the model were simply the 5-year moving average basis observed during the projected marketing month. Forecast errors were determined by comparing forecast to the actual basis observed on the first business day of the month. A database of basis forecast errors was established to correspond to the price forecast error database. Table 2 shows the standard deviation of basis forecast errors based on month of the year.

The net income observations were calculated by comparing probabilistic fed cattle price projections to deterministic break-even costs. Break-even costs are determined primarily by feed and feeder cattle prices. These values are generally known at the time the placement decision is made. Production risk is a source of variability for break-even prices. However, studies have shown that production risk is minor compared with price risk. Consequently, production risk was not considered in this study.

Using Historical Forecast Errors to Estimate Risk

Price and basis forecast errors were modeled with a normal distribution, with the forecast specified as the mean and the standard deviation of historical forecast errors specified as the standard deviation. Using distribution parameters, the probability of specified net price or income ranges can then be estimated by evaluating the area between their respective intervals of the normal distribution function.

This approach to describing and measuring risk is comparable to the Value-at-Risk model (Boelhje and Lins, 1998; Manfredo and Leuthold 1999). The Value-at-Risk model quantifies the distribution around the expected end-of-period value of an asset portfolio. Manfredo and Leuthold (2001) applied Value-at-Risk to cattle feeding. Their model considered the risk exposure of an asset portfolio consisting of several pens of cattle purchased and marketed weekly in a continuous year round flow. This approach is consistent with large feeders common to the Southern Plains. Conversely, our model considers the risk distribution surrounding an individual group of cattle. This approach is applicable to the relatively small farmer-feeders common to the Corn Belt region that feed cattle seasonally. This model is also applicable to cow-calf producers considering retained ownership.

Evaluating the Economic Outcome

Granger and Pesaran (2000) argue that evaluating the economic consequences of forecast based marketing decisions is the most important but least utilized tool of evaluating price forecasts. To have any management value, the information generated by outlook model must facilitate better management decisions. The motivation behind developing the risk model was to provide information that leads to improved management decisions. To determine the effectiveness of the model in improving management decisions, decision rules derived from information provided by the model were applied to historical price data and the outcomes were evaluated. This study evaluates the marketing decisions and economic outcomes of the alternative decision rules for 168 discrete 6 month feeding periods. The first feeding period began July 1986 and ended January 1987. A potential feeding period began each successive month, with the final feeding period June 2000 through December 2000. Specific cash price, futures price, and basis observations used to trigger a management decision and evaluate the outcome were identical to those described in Lawrence and Smith (2001).

The decision rules were programmed to choose between three alternative management strategies for each feeding period: 1) speculate in the cash market, 2) protect the current price outlook with a short hedge, and 3) withdraw from the market altogether. These alternatives are applicable to feeders, investors, cow/calf producers considering retained ownership, or other stakeholders that selectively participate in cattle feeding. In the interest of brevity, the decision maker will hereafter be referred to as investor. The decision rule was set up to specify a risk preference based on a minimum critical income and a probability of achieving that income. The model was programmed to select the marketing strategy based on the following order of preference: cash market ? short hedge ? withdraw from the market. Since relative expected income values mirror this order of preference, the objective of this decision rule states implicitly to maximize expected income subject to risk constraints. The mathematical specification is as follows:

Equation 3) $\text{Max } E(\pi)$; s.t. $p(\pi < \pi_{crit}) < y$

The decision rules were programmed into the model as follows:

If $[p(\pi_{cash} < \pi_{crit}) < y]$, then cash, If $[p(\pi_{cash} < \pi_{crit})$? $y]$, but $[p(\pi_{hedge} < \pi_{crit}) < y]$, then hedge, otherwise, withdraw from the market

The symbols π_{cash} and π_{hedge} represent net income per head realized by pricing the cattle in the cash market and with a short hedge, respectively. The symbol π_{crit} represents the critical level of income required. Each individual investor will typically derive the value for this variable by examining the strength of his/her balance sheet. The variable y is a probability representing the investor's risk tolerance. The value indicates the maximum probability the investor is willing to risk realizing an income level lower than the stated critical income. For example, valuing π_{crit} = $-10/head and y=10% suggests an investor is willing/able to bear a 10% probability that the income will be less than $-10/head. An identical, but more intuitive explanation is that the investor requires a 90% probability that income will be greater than $-10 per head.

The performance of each decision rule was measured with the following set of outcome variables:

1) the frequency each marketing strategy alternative was selected;
2) the frequency at which the marketing strategy with most and least favorable outcomes were selected;
3) net income generated; and
4) how well each decision rule conformed to its risk objective (i.e. the frequency net income fell below critical income).

The outcomes of the model-based decision rules were compared to naive decision rules that can be established without the information generated by the model. Using experimental design terminology, these strategies serve as the control variables for which the outcomes of the model based decision rules (treatment) are compared. The non-model based decision rules are as follows;

1) randomly selected marketing strategy,
2) exclusive hedge strategy,
3) exclusive cash marketing strategy, and
4) comparing the expected hedge price to the estimated break-even price.

A random outcome is the traditional standard with which experimental design treatments are typically compared. To derive random outcomes; cash speculating, short hedge, or market withdrawal for each feeding period was selected by a random number generator, with each marketing strategy equally likely to occur. The process was repeated 1,000 times. All outcome variables consistently converged to a value that changed less than 1% after each subsequent iteration.

Non-model decision rules 2-4 represent other plausible decision rules requiring minimal market outlook information. The outcomes for these decision rules were evaluated by Lawrence and Smith (2001). Similar to randomly selecting the marketing strategy, the outcomes of all cash or all hedging marketing programs represent a standard to which the outcome of more refined decision rule can be compared. Comparing the expected hedge price with the estimated break-even price represents a step toward more information-enhanced management. Lawrence and Smith (2001) established decision rules using the following set of if/then/else statements:

1. If the expected hedge price using futures is greater than the estimated break-even costs of production, hedge; otherwise, cash.
2. If the expected hedge price using futures is greater than the estimated break-even cost of production minus $1; hedge, otherwise, cash.
3. If the expected hedge price using futures is greater than the estimated break-even cost of production minus $2; hedge; otherwise cash.

These decision rules are rooted in the conventional marketing wisdom suggesting commodities should not be hedged at loss. Consequently, as expected profitability increases, the probability of selecting a conservative marketing strategy (hedge) increases, a relationship directly opposite to the model based decision rules described in equation 3. Direct net income comparisons between these decision rules and the decision rules presented in equation 3 should be interpreted cautiously because Lawrence and Smith did not allow for the possibility of withdrawing from the market.

The models were run assuming the variability around the price, and basis forecast errors were constant throughout the period of the study. The price and basis forecast errors used in the study were calculated from data generated during the same time period as that of the decision rule simulation. Consequently, the results should be considered “in sample.”

Results

Forecast Accuracy

Table 1 shows the mean, standard deviation, and root mean squared errors for both cash price and basis forecasts from a 6-month forecast horizon. The reliability of cash price forecasts varies by season. June appears to be the most reliable forecast with a forecast error standard deviation and root mean squared error (RMSE) of $3.61 and $3.52 per cwt, respectively. September through January cash prices are the least accurate months in which to forecast. The November forecast had the highest forecast error standard deviation and RMSE of $6.49 and $6.26 per cwt, respectively. The mean absolute percent forecast error (MAPE) ranged from 4.26% in the March cash price forecast to 7.61% in the November forecast. This range was consistent with the MAPE of 5.82% generated by this forecasting method for slaughter steers in Western Kansas (Kastens, Jones, and Schroeder 1998).

The mean forecast error reveals the amount of bias present in the forecast. An unbiased forecast would generate a mean forecast error near zero. If futures markets are efficient, futures based price forecasts should be unbiased. Some studies have found a greater possibility of inefficiency in livestock futures than grain futures. In Particular, Kastens and Schroeder (1995) found evidence of bias in livestock futures. However, in the Kastens, Jones, and Schroeder (1998) study, fed steer price forecasts using basis adjusted futures prices performed better than more sophisticated models that corrected for bias in deferred futures prices. According to the data in Table 1, the mean errors ranged from $-0.07 per cwt in the August forecast to $2.08 per cwt in the December forecast. Statistically, none of these values are significantly different from zero (α=0.10), suggesting a high probability that the forecasts are unbiased.

Figure 1 shows the relationship between forecast error and forecast horizon. The values on the y-axis represent the average standard deviations of alternative forecast horizons considered by the model. Each bar on the graph represents an average of 12 forecasts (one for each month of the year). Consistent with expectations, forecast errors widened as the length of the forecast horizon increased. The standard deviation of errors ranged from $4.43 per cwt in the 3-month forecast to $5.50 per cwt in the 9 month forecast.

The seasonal variability in basis forecast accuracy is similar to that of cash price forecast accuracy. Basis appears to be most predictable during the February-April period, with a standard deviation of forecast errors ranging from $1.61 to $1.66 per cwt and RMSE ranging from $1.59 to $1.71 per cwt. A readily apparent seasonal pattern does not emerge for the remaining months. November and June basis patterns appear to be least predictable, with standard deviation of basis forecast errors at $3.55 and $3.45 per cwt, respectively.

Net Price and Income Distribution

By using the historical price forecast information from Table 1 and the properties of a normal probability distribution, probabilities can be assigned to alternative economic outcomes. To demonstrate, an example based a pen of steers placed in mid May 2001 at 750 lbs and marketed in mid November 2001 at 1,250 lbs is presented in Figures 1 and 2. Figure 1 shows the estimated distribution around the net price generated by the alternative marketing strategies considered in the study. The December futures contract closed on May 14 at $73.62. With a $+0.32 average basis observed in November during the past 5 years, the forecasted cash price was $74.61. With a forecast error standard deviation of $6.49/cwt (from Table 1), the model suggests a 68% probability that the realized price would lie in the interval from $68.45 to $81.45. Considering historical basis forecast error, the model suggests a 68% probability that the net hedge price would lie between the $71.06 and $78.16 interval.

Figure 2 shows the distribution around net income per head assuming a projected break-even price of $71.37. Expected net income values were $45 per head under a cash marketing strategy and $40 under the short hedge strategy. The 68% income interval ranged from $-35 to $125 per head in the cash marketing strategy and $-4 to $84 per head under a short hedge marketing strategy. Under a cash marketing strategy, the estimated probability of breaking even was 70.9%. The estimated probability of losing more than $10, $20, and $30 per head was 24.7%, 20.9%, and 17.5%, respectively. Under a short hedge scenario, the estimated probability of realizing a break-even price was 84.4%. The estimated probability of losing more than $10, $20, and $30 per head was 10.8%, 7.2% and 4.6%, respectively.

On November 12, 2001, cash prices averaged $62.37, a $0.62 premium over the closing futures price. At these price and basis levels, net income realized under a cash market strategy was $-112 per head, while net income realized on a short hedge placed on May 14 was $44 per head. The price forecast error was $12.59 per cwt or 16.8%. If forecast errors indeed follow a normal distribution, the model suggests the frequency of the futures market forecast error that extreme was 1 every 36 years. At the time the placement decision was made, the likelihood of the cattle placed achieving a net income of $-112 per head by speculating in the cash market was estimated to be about 2.8%. The profitability outcome of the hedge was much closer to what the model suggested, near the mid-point of the distribution.

Non-Model Based Decision Rules

Table 2 shows the results from the simulation of the decision rules. The “Most Favorable Strategy” represents the best possible outcome. Under this scenario, the investor had perfect foresight to select the most favorable marketing strategy for each feeding period considered in the study. During the period of the study, remaining in the cash market would have been favorable 53% of the time, a short hedge was favorable 23% of the time, and staying out of the market would have been favorable 24% of the time. Average income for the most favorable scenario was $45 per head overall. Average income for feeding periods actually selected to feed cattle was $59 per head. The most favorable outcome during the study period was $228 per head for cattle placed December 1986 and marketed June 1987. The “Least Favorable Strategy” represents the opposite extreme. Average income for the least favorable scenario was $-27 per head overall, and $-47 per head for feeding periods actually selected to feed cattle. The worst outcome for an individual feeding period was a net income of $-154 per head occurring for the March - September 1991 feeding period.

The “cash only” management strategy provided the highest average income, generating an average income of $20 per head. Speculating in the cash market was the best strategy 53% of the time and the worst strategy 28% of the time. This strategy also exposed the investor to the greatest risk. The income standard deviation, $69 per head, was ranked highest of all the management strategies, suggesting a high degree of variability. Thirty five percent of the feeding periods incurred a loss. Nearly one quarter of the feeding periods lost more than $30 per head.

Table 2 suggests the “hedge only” strategy was inferior to the cash only strategy. Average net income was reduced dramatically to $4 per head, half of the average income generated by a random decision rule. A short hedge provided the most favorable outcome 23% of the time and the least favorable outcome 29% of the time. Risk reduction realized under the hedge only strategy was moderate and the frequency of losses under this strategy was greater than that of the the cash only strategy, 46% to 35%. The hedge only strategy began providing risk protection at losses of $20 per head.

Random simulation results are also presented in Table 2. Consistent with probability theory, randomly selecting the marketing decision evenly distributed the frequency of selecting the three marketing alternatives. Likewise, the most favorable, middle, and least favorable strategies were selected an equal number of times. The income variables represent averages over the 1,000 iterations. The average low income feeding period was $-141, while the overall average and average high income feeding period were $8 and $197, respectively. The standard deviation of income was $49 per head, 29% less than the cash only marketing strategy. Twenty seven percent of the feeding periods generated negative income. Twenty four percent, 18%, and 14% of the feeding periods lost more than $10, $20, and $30 per head, respectively.

Model-Based Decision Rules

The economic outcome of applying decision rule 2 is presented in Table 4. The first two columns specify the level of risk aversion. Column one represents a level of income ($/head) a producer is willing to place at risk and column two represents the maximum probability of losing this net income the producer is willing to tolerate. Zero income value indicates the feeding margin. The second column represents the maximum probability a feeder is willing to risk losing the associated critical income. For example, the row with zero and one in the first two columns represents the producer willing to tolerate a 5% probability of achieving a negative net income. An alternative explanation is that this producer requires a 95% probability of breaking even before participating in a cattle feeding venture.

Consistent with *a priori* expectations, cash speculating and hedging activity are highly correlated with risk tolerance. When the decision rule was applied to a risk preference scenario requiring a 95% probability of breaking even, the model could not identify any cash market speculating opportunities that satisfied the risk requirement. Furthermore, the model identified an acceptable hedging opportunity 22 times out of the 168 (13%) potential feeding periods. An investor with this level of risk tolerance would have remained out market 87% of the time. As the risk tolerance level increases, cash market speculating increases while remaining out of the market decreases. Hedging increased as risk tolerance levels increased from 5% to 20%, and declined at to zero as risk tolerance approaches 50%. The critical net income level affect the marketing decisions, but less dramatically than the risk tolerance level. For example, when the tolerance level is held constant at 5% the model identified 0, 1, and 6 cash market speculating opportunities at the $-10, $-20, and $-30 levels of critical income, respectively.

Highly risk averse decision rules severely restricted the model's ability to select the profit maximizing marketing strategy. Using the decision rule described in equation 3, investors with just a 5% tolerance for losing their specified level of critical income selected the optimal price management strategy just 21% to 22% of the time, substantially lower than the frequency at which the random decision rule chose the best strategy. Because the objective function is constrained by risk preference, a more meaningful variable may be the frequency the decision rule selected the strategy with the worst possible outcome. The frequency at which the least favorable pricing mechanism was selected does not appear to be highly correlated to level of risk aversion. For example, at the zero level of critical net income, the 5% and 10% risk tolerance decision rules selected the least optimal pricing mechanism 22.0% and 20.8% percent of the time, respectively, while the both the 20% and 40% risk tolerance decision rules selected the least optimal outcome 17.9% of the time.

Table 3 presents average income under two alternative methods of computation. The first method, labeled selected average, considers only the income generated from actual trades (does not include the zero income generated by sitting out of the market). The second method, labeled overall average, represents the average income over the entire 168 feeding periods whether or not the investor was in the market. Overall averages clearly demonstrate a risk/return trade-off. Average income under very low levels of risk tolerance (<8% to 12%) was inferior to income generated by randomly selecting the pricing strategy. Risk tolerance levels of 10%-20%, depending in the level of critical income, were necessary before average income under the model-based decision rules approached average income under the cash only model. Conversely, there does not appear to be a strong correlation between the selected mean and risk tolerance.

Although risk averse decision rules were not successful in choosing the best management strategy, they were successful in signaling highly unprofitable feeding periods and avoiding the worst outcome marketing strategy relative to the non-model based decision rules. The least profitable trades incurred under the non-market decision rules were $-154 for exclusive cash strategy and $-141 for the hedge only and randomly selected strategy. By comparison, 5% tolerance levels resulted in minimum income feeding periods of $-11, $-19, $-34, and $-34 for the $0, $-10, $-20, and $-30 levels of critical income, respectively. Minimum income levels at the 50% risk tolerance levels approached that of the cash only marketing and random marketing decision rules. The risk model would have signaled the investor to stay out of the market during these unprofitable feeding periods. The last column of Table 3 presents the frequency at which actual income was less than critical income stated in the decision rule. For example, the decision rule for a producer willing to accept a 5% probability of a net income less than zero selected a strategy that resulted in net income less than zero just one time. In all risk preference combinations evaluated in the study, the decision rule met the risk tolerance requirement. Consequently, the model based decision rules performed well in avoiding feeding periods that resulted in losses greater than the tolerable levels specified in the risk preference statement.

Discussion and Conclusions

This model converts complex forecasting and risk measurement techniques into a practical management tool for cattle feeders and other producers. The intent of this effort is to help feedlot operators, investors, lenders, and other stakeholders quantify the risks associated with their management decisions. When refined, the model will be made available to the public as a spreadsheet for feedlots to use when planning feeder cattle purchases.

A notable result is the relative infrequency the model selected the futures market as the management strategy and the frequency at which the model selected no cattle feeding. One possible interpretation is the model may help explain the low hedging rates among producers. However, feedlots do not remain empty as frequently as the model suggests. As a note of caution, the decision rules were set up to allow a marketing decision at one point during the month, and on one day during the entire feeding period. In reality, feeders enjoy a wider decision window. Feeders, therefore, can make a placement decision and wait for a more favorable pricing opportunity to occur sometime during the feeding period. Another limitation is that the model assumed the marketing decision made on placement day cannot be reversed. Future research will evaluate the sensitivity of the results to these assumptions.

These results suggest decision rules derived from information provided by the risk model are successful at signaling, and thereby avoiding, feeding periods that result in large losses. By applying conservative decision rules, the investor missed out on high return feeding periods, consequently average income was not greatly enhanced. These results are consistent with the philosophy that futures markets are available for price protection rather than price enhancement.

The risk distributions generated by the model apply to cattle sold on the cash market. An increasing proportion of fed cattle are sold on a contract or formula based pricing system. These arrangements have a dramatic impact on risk exposure and potential payoff. For example, cattle sold on price grids are offered to premiums or discounts based on quality or yield grades. Premiums/discount values are dependent on the choice-select price spread. Modeling the risk exposure of these arrangements would require information about the stochastic nature of these variables. Future studies could explore these issues.

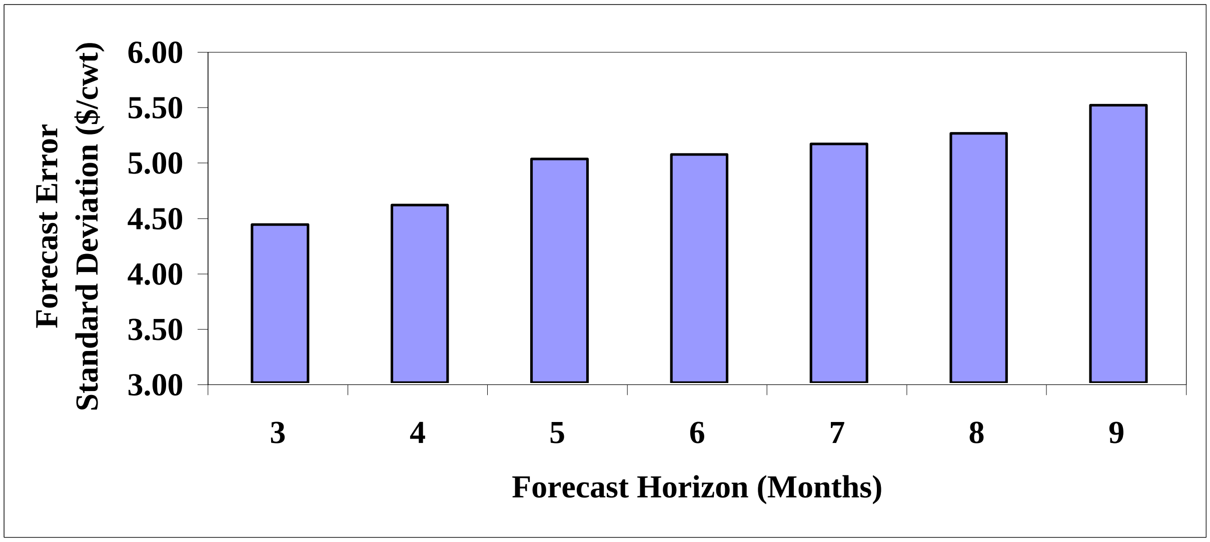

Figure 1. Forecast error standard deviations for alternative forecast horizons.

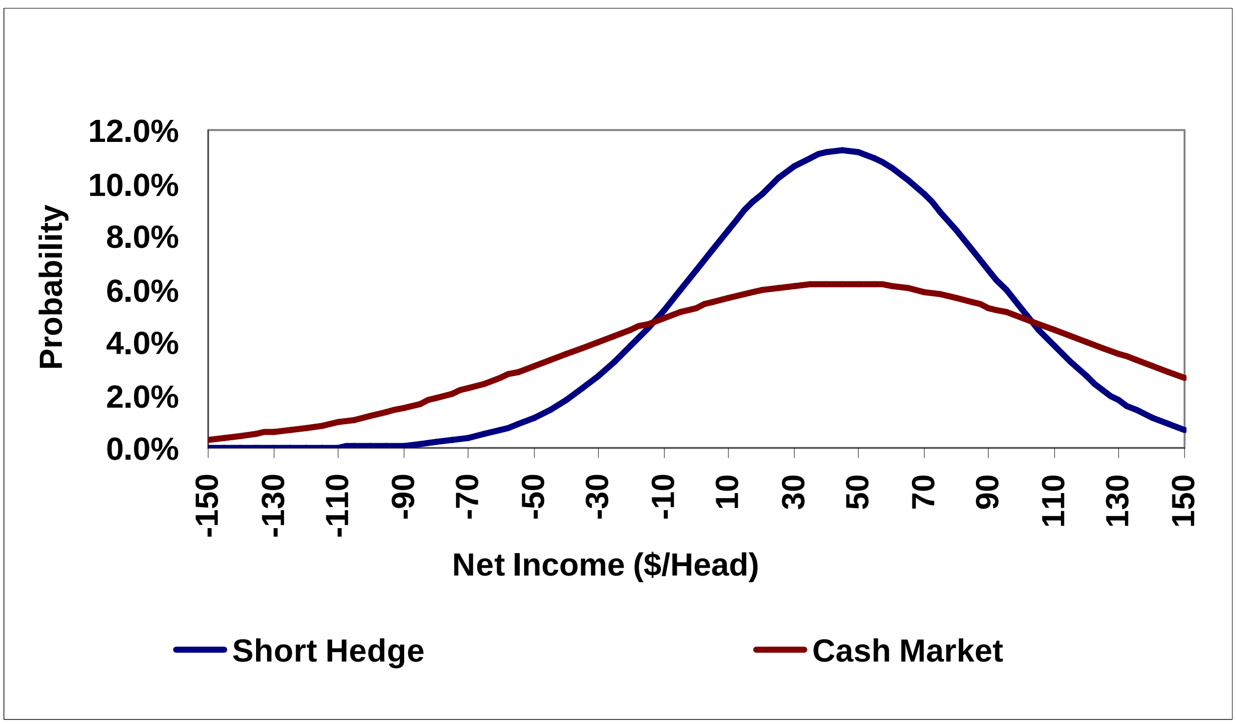

Figure 2. Distribution on net income under a short hedge and cash marketing strategies.

Table 1. Mean, standard deviation, and root mean squared error (RMSE) for cash price and basis forecasts at a 6-month forecast horizon.

	Cash Price Forecast Error			Basis Forecast Error		
Marketing Month	Mean	Standard Deviation	RMSE	Mean	Standard Deviation	RMSE
	--Dollars per cwt--------------------------------					
January	1.64	5.55	4.75	0.55	2.41	2.44
February	1.20	4.50	4.33	-0.11	1.66	1.59
March	0.92	4.32	4.32	-1.52	1.66	2.22
April	1.02	4.53	4.65	-0.73	1.61	1.71
May	0.95	5.00	5.02	0.37	3.45	3.34
June	0.36	3.61	3.52	1.14	3.11	3.20
July	0.65	4.73	4.75	1.00	2.61	2.70
August	-0.07	4.81	4.62	0.44	2.16	2.12
September	0.07	5.60	5.36	-0.74	2.41	2.43
October	0.86	5.91	6.85	-0.41	3.22	3.12
November	0.75	6.49	6.26	-0.65	3.55	3.47
December	2.08	5.74	5.87	0.50	2.29	2.26

Table 2. Economic outcome non-model based decision rules.

Strategies	Cash	Hedge	None	Best Decision	Worst Decision	Selected Mean[1]	Overall Mean[2]	Max	Min	SDev	π < $0	π< $-10	π< $-20	π < $-30
	---------------Frequency (%)----------------					------------Income ($/Head)-------------					-------------Frequency (%)---------			
Most Favorable	53.0	23.2	23.8	100	0.0	59	45	228	0	45	0	0	0	0
Least Favorable	28.0	29.2	42.9	0.0	100	-47	-27	0	-154	37	100	50	38	31
Cash Only	100	0.0	0.0	53.0	28.0	20	20	228	-154	69	35	33	29	24
Hedge Only	0.0	100	0.0	23.2	29.2	4	4	147	-141	47	46	39	27	19
Random	33.3	33.3	33.3	33.3	33.3	12	8	197	-141	49	27	24	18	14
E[HP] > BE[3]	44.6	55.4	N/A	26.8	73.2	15	15	168	-154	53	33	30	21	17
E[HP] >BE-$1[4]	32.7	67.3	N/A	20.2	79.8	13	13	168	-154	49	37	32	22	17
E[HP] >BE-$2[5]	19.6	80.4	N/A	12.5	87.5	10	10	148	-154	47	42	35	22	16

1. Selected Mean represents mean income per feeding period a
2. Overall mean represents the mean income over the entire 168 feeding periods regardless whether feeding actually occurred
3. If expected hedge price (E[HP]) is greater than the estimated break-even price (BE), hedge, otherwise remain in the cash market.
4. If expected hedge price (E[HP]) is greater than the estimated break-even price (BE) minus $1/cwt, hedge, otherwise remain in the cash market.
5. If expected hedge price (E[HP]) is greater than the estimated break-even price (BE) minus $2/cwt, hedge, otherwise remain in the cash market.

Table 3. Economic outcome of model based decision rules.

Risk Preference		Cash	Hedge	None	Best Decision	Worst Decision	Selected Mean	Overall Mean	Max	Min	SDev	$\pi < \pi_{Crit}$
π_{Crit}	Tolerance	---------------Frequency (%)----------------					-------------------Income ($/Head)------------------					(%)
$0	5%	0.0	13.1	87.5	20.8	22.0	39	5	76	-11	16	0.6
$0	10%	0.6	17.9	82.1	23.2	20.8	38	7	108	-19	19	1.8
$0	20%	8.3	22.0	70.2	29.2	17.9	41	13	228	-34	32	5.4
$0	40%	36.9	7.1	56.5	39.9	17.9	42	18	228	-117	51	10.7
$0	50%	51.2	0.0	49.4	45.2	18.5	42	21	228	-117	53	21.0
$-10	5%	0.0	19.0	81.5	22.6	20.2	35	7	76	-19	18	1.2
$-10	10%	6.5	29.8	64.3	30.4	18.5	33	9	108	-34	22	3.0
$-10	20%	16.1	22.0	62.5	35.7	17.3	42	16	228	-117	40	5.4
$-10	40%	45.2	8.3	47.0	44.0	21.4	37	20	228	-117	52	14.3
$-10	50%	61.3	0.0	39.3	46.4	20.8	34	21	228	-149	58	14.9
$-20	5%	0.6	24.4	75.6	24.4	19.0	33	8	108	-34	20	0.6
$-20	10%	6.5	29.8	64.3	30.4	15.5	42	15	228	-34	35	1.2
$-20	20%	23.2	22.6	54.8	37.5	17.9	38	17	228	-117	46	4.2
$-20	40%	54.8	6.5	39.3	44.0	20.2	33	20	228	-117	56	13.1
$-20	50%	71.4	0.0	29.2	49.4	23.2	31	22	228	-149	61	15.5
$-30	5%	3.6	29.2	67.9	26.8	18.3	36	12	147	-34	28	0.6
$-30	10%	11.9	30.4	58.3	35.1	17.3	37	16	228	-117	38	1.8
$-30	20%	31.5	21.4	47.6	42.9	17.3	39	20	228	-117	50	3.6
$-30	40%	66.1	6.5	28.0	45.2	23.8	26	19	228	-149	61	13.7
$-30	50%	80.4	0.0	20.2	51.8	24.4	27	22	228	-154	64	16.7

References

Boehlje, M.D., and D.A. Lins. Risks and Risk Management in an Industrialized Agriculture. *Agricultural Finance Review*. 58(1998): 1-16.

Dodson, C.B. and E. Elam. "Returns to Custom Cattle Feeding." *Journal of Agribusiness*. Fall 1992: 3-18.

Granger, C.W.J. and M.H. Pesaran. "Economic and Statistical Measures of Forecast Accuracy." *Journal of Forecasting*. 19(2000): 537-560.

Hampel, F.A., T.C. Schroeder, and T.L. Kastens. "Risk and Expected Returns in Cattle Feeding." Proceedings of the NCR-134 Conference on Applied Commodity Forecasting and Risk Management. April 1998. Chicago Illinois.

Just, R.E. and G.C. Rausser. "Commodity Price Forecasting with Large-Scale Econometric Models and the Futures Market." *American Journal of Agricultural Economics*. 63(1981): 197-208.

Kastens, T.L, R. Jones, and T.C. Schroeder. "Futures Based Price Forecasts." *Journal of Agricultural and Resource Economics*. 23(1998): 279-293.

Kastens, T.L. and T.C. Schroeder. "A Trading Simulation Test for Weak-Form Efficiency in Live Cattle Futures." *Journal of Futures Markets*. 15(1995): 649-675.

Lawrence, J.D. and A.H. Smith. "Managing Cattle Price Risk with Futures and Options Contracts." White Paper. Iowa State University. 2001

Lawrence, J.D., Z. Wang, and D. Loy. "Elements of Cattle Feeding Profitability in Midwest Feedlots." *Journal of Agricultural and Applied Economics*. 31,2(August 1999): 349-357.

Manfredo, M.R. and R.M Leuthold. "Market Risk and the Cattle Feeding Margin: An Application of Value-at-Risk." *Agribusiness-An International Journal*. 17(3,2001): 333-353.

Manfredo, M.R. and R.M. Leuthold. "Value-at-Risk Analysis: A Review and the Potential for Agricultural Applications. *Review of Agricultural Economics*. 21(1999): 99-111.

Mark, D.R., T.C. Schroeder, and R.D. Jones. "Identifying Economic Risk in Cattle Feeding." *Journal of Agribusiness*. 18(2000): 331-334.

Schroeder, T.C., M.L. Albright, M.R. Langemeier, and J.Mintert. "Factors Affecting Cattle Feeding Profitability." *Journal of the American Society of Farm Managers and Rural Appraisers*. 57(1993): 48-54.