EVALUATION OF A QUANTITATIVE PROCEDURE TO SELECT AMONG ALTERNATIVE MARKETING STRATEGIES TO REDUCE PRICE RISKS OF STOCKER OPERATORS*

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Producers within the cattle industry are faced with three major types of risks: (1) risks of losses in quality; (2) risks of quantity losses; and (3) losses resulting from unfavorable changes in cash prices. Quality and quantity risks are physical risks that can be dealt with through managerial techniques, adoption of new technology, and the use of fire, storm, and theft insurance. The risk associated with unfavorable price changes does not lend itself to an insurance approach. Producers must, therefore, become speculators in the cash market or choose to employ marketing strategies designed to transfer price risks to other market functionaries.

It is the purpose of this paper to report on the evaluation of several marketing strategies permitting Oklahoma stocker operators to reduce the risks associated with unfavorable price changes. A decision-making model is postulated which employs two single-equation price forecasting equations -- one equation to provide a four-month forecast of the average monthly price of 400-500 pound Choice feeder steer calves and another equation to forecast the average monthly price of 600-700 pound Choice feeder steers.

The decision model also employs the Student "t" distribution [1] to reflect the operator's risk profile, where the stocker operator's risk profile is a measure of the amount of money he can lose due to an unfavorable price change and still remain in business. If the stocker operator could not afford to lose any money due to an unfavorable price change his preferred risk level measured by the Student's "t" distribution would approach zero. As the amount of money he can afford to lose increases, his risk level approaches one.

The criterion used to select among the alternative buying and among the alternative selling strategies is based upon the forecast interval computed using a one-tailed probability distribution. The following formula is used to calculate the forecast interval [2]:

$$(1)\quad D = C'\hat{B} \pm t_{\alpha,d.f.} \left\{s^2 \left[1 + C' (X'X)^{-1} C\right]\right\}^{\frac{1}{2}}$$

where

- D = probability interval,
- C' = row vector of the observed independent variables used to predict the average monthly price for month t,
- $\hat{B}$ = column vector of the estimates of the beta coefficients,
- s^2 = estimate of the variance,
- X = a column vector of the observed independent variables over the inference base, and
- t_α = student's "t" statistic at probability level α (one-sided test) and with degrees of freedom d.f.

DECISION STRATEGIES

Two general classes of decisions are considered -- buying decision strategies and selling decision strategies. Within each of these two broad categories three alternatives are evaluated.

Buying Decision Strategies

The stocker operator has the following alternative buying strategies:

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*Oklahoma State Agricultural Experiment Station Journal Article No. 2743.

1. buy feeder steer calves on a cash market,
2. forward contract the purchase of feeder steer calves for a specific price and delivery, and
3. hedge the purchase of feeder steer calves by buying feeder cattle futures contracts.

To select among these buying strategies the stocker operator must evaluate the relation of the forward contract buying price and the adjusted feeder cattle futures contract price to the upper bound of the probability interval. If the purchase price associated with the strategies of forward contracting and futures hedging are below the upper bound, the stocker operator is better off to use one of these strategies rather than run the risk of a Type II statistical error. If the price associated with the latter two strategies is greater than the upper bound, the operator is better off to run the risk of a Type II statistical error.

The decision rules for the buying strategies can be summarized as follows:

1. if the forward contract price is greater than the adjusted futures price but less than the upper bound of the probability interval, use strategy number three;
2. if the forward contract price is less than the adjusted futures price and less than the upper bound of the probability interval, use strategy number two; and
3. if both the forward contract price and the adjusted futures price are greater than the upper bound of the probability interval, use strategy number one.

More succinctly, choose that strategy associated with the lowest price among adjusted futures price, forward contract price and the upper bound of the forecast price.

Selling Decision Strategies

The stocker operator has the following alternative selling strategies:

1. sell feeder steers on a cash market basis,
2. forward contract the sale of feeder steers for a specific price and delivery, and
3. sell feeder cattle futures contracts.

Selection among the selling strategies may be performed using the lower bound of the probability interval in a manner analogous to the method used for the buying strategies. The decision rules for the selling strategies can then be summarized as:

1. if the forward contract price is less than the adjusted futures price but greater than the lower bound of the probability interval, use strategy number three;
2. if the forward contract price is greater than the adjusted futures price and greater than the lower bound of the probability interval, use strategy number two; and,
3. if both the forward contract price and the futures price are less than the lower bound of the probability interval, use strategy number one.

In brief, choose that strategy associated with the highest price among adjusted futures price, forward contract price and the lower bound of the forecast price.

AN APPLICATION OF THE DECISION MODELS

The buying and selling decision models for feeder steer calves and feeder steers are now applied to the situation facing Oklahoma stocker operators between December 1971 and December 1972. The time period selected was conditioned by the availability of data on the feeder cattle futures contract which began trading in December 1971.

Buying Decision Model

The buying decision model is applied to the period from April 1972 through November 1972. During this period the stocker operator selects among the alternative buying strategies for each month. The results obtained from following the decision model are compared with the results that would have been realized from following the alternative strategies.

In order to implement the buying decision model four-month forecasts of the average monthly price of feeder steer calves were made employing the following equation which was estimated from data over the period January 1962 through May 1972:

$$(2)\quad \log \hat{P}_{s,t+4} = \underset{(0.03246)}{0.9421} + \underset{(.001100)}{0.007867}\, P_{ct} + \underset{(0.0009093)}{0.01034}\, P_{s,t-8} + \underset{(0.02003)}{0.02670}\left(\frac{V_{t-1}}{V_{t-8}}\right)$$

$$R^2 = 0.8858 \qquad s^2 = 0.0004146$$

$$E^2 = 6.2878$$

where

$\hat{P}_s$ = four-month forecast of the average monthly price, in dollars per hundredweight, of 400-500 Good and Choice feeder steer calves at Oklahoma City,

P_S = observed average monthly price, in dollars per hundredweight, of 400-500 Good and Choice feeder steer calves at Oklahoma City,

P_C = observed average monthly price, in dollars per hundredweight, of 900-1100 pound Choice slaughter steers at Omaha,

V = monthly inventory of cattle-on-feed in 1000's head according to the Six-State Cattle-on-Feed Report,

s^2 = estimate of the variance,

E^2 = variance of the price forecasting error,[1]

t = time in months,

( ) = estimates of the standard error of the regression coefficients, and

log = logarithm to the base ten.

The forecasts are presented in Table 1 and reflected a strong upward trend from $40.68 in April to $47.97 in November.

The upper bounds of the probability interval for feeder steer calf price forecasts at alternative risk levels are presented in Table 2. The risk levels range from 0.400 to 0.025. As the risk level decreases the upper bound gets larger. For example, in June the upper bound increases from $42.96 at the 0.400 risk level to $46.85 at the 0.025 risk level.

There are no published data on forward contracting prices for feeder steer calves so a proxy was constructed by adjusting the cash market price in month t by the change in the seasonal index between month t and month t + 4. This procedure undoubtedly produces poor estimates of the true forward contracting price except where producers base their forward contracting estimates on such a seasonal model. The calculated figures are, however, useful in illustrating the use of the decision model. The cash market price in month t, the seasonal adjustment coefficients,[2] and the estimated forward contracting price are presented in Table 3.

The feeder cattle futures price and the adjusted feeder cattle futures price for month t + 4 in month t are presented in Table 4. The feeder cattle futures price for month t + 4 is based on the closing price of the futures contract for the last trading day of month t. No feeder cattle futures contracts are traded for the months of June, July, December, January, or February. Therefore, for purposes of analysis, assume the feeder futures contract price for the closest trading month.

The feeder cattle futures price is adjusted for differences in weight classification,[3] location differences, commission charges,[4] and loss of interest on margin funds.[5] An illustration of the procedure used to calculate the adjusted futures price is given in Table 5.

Results for the Buying Decision Model

In all of the months tested either the futures strategy price or the forward contracting strategy price is below the forecasted price for feeder steer calves as revealed in Table 6. The result is that at all risk levels the stocker operator purchases feeder steer

[1] Variance of the price forecasting error is defined as:

$$E^2 = \frac{\sum_{i=1}^{n} (P_i - \hat{P}_i)^2}{n - 1}$$

where:

E^2 = average squared forecasting error,
P_i = observed price of either feeder steer calves or feeder steers,
$\hat{P}_i$ = forecasted price of either feeder steer calves or feeder steers, and
n = number of price forecasts.

[2] Seasonal indexes are based on the period January 1962 through December 1971.

[3] Adjust for price differential between weight groups by

$$\hat{P}_{fR} = 0.8096 + 0.9184\ P$$
$$(0.3404)\ (0.01147)$$
$$R^2 = .9807 \qquad s^2 = 0.4112$$
$$\bar{R}^2 = .9805$$

$$P_{4-5} = -0.8815 + \frac{P_{fR}}{0.9184}$$

where:

P_{fR} = feeder-calf futures prices adjusted for difference in market delivery points; and
P_{4-5} = cash equivalent price ($ per cwt.) of good and choice 400-500 pound stocker calves at Oklahoma City.

[4] Commission charge on a feeder contract (42,000 pounds) is $40.00 which is $0.095 per cwt. For purposes of demonstration the commission charge per cwt. is rounded per $0.10.

[5] Represents a simple rate of interest of six percent per year.

Table 1. FOUR–MONTH FORECAST OF THE AVERAGE MONTHLY PRICE OF 400-500 POUND GOOD AND CHOICE FEEDER STEER CALVES AT OKLAHOMA CITY, APRIL 1972-NOVEMBER 1972

Forecast for Month t + 4	Forecast Price	Actual Price
	($/cwt.)	
April	40.86	40.34
May	41.83	41.18
June	42.43	43.22
July	41.74	45.31
August	43.08	44.86
September	42.91	46.60
October	45.90	46.47
November	47.97	46.99

Table 2. UPPER BOUND OF THE PROBABILITY INTERVAL FOR FEEDER STEER CALF PRICE FORECASTS AT ALTERNATIVE RISK LEVELS, APRIL 1972-NOVEMBER 1972

Risk Level	Month							
	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
	–$/cwt.–							
0.400	41.37	42.34	42.96	41.98	43.62	43.45	46.49	48.61
0.300	41.93	42.93	43.55	42.84	44.21	44.04	47.14	49.27
0.200	42.60	43.61	44.25	43.51	44.92	44.74	47.91	50.12
0.100	43.53	44.59	44.25	44.47	45.92	45.73	49.00	51.24
0.050	44.33	45.42	46.09	45.29	46.77	46.58	49.93	52.74
0.025	45.05	46.16	46.03	47.53	47.53	47.53	47.35	50.11

Table 3. CASH MARKET PRICE, SEASONAL ADJUSTMENT COEFFICIENT AND ESTIMATED FORWARD CONTRACTING PRICE FOR 400-500 POUND GOOD AND CHOICE FEEDER STEER CALVES AT OKLAHOMA CITY, APRIL 1972-NOVEMBER 1972

Month t + 4	Cash Price Month t	Seasonal Adjustment Coefficient	Estimated Forward Contract Price t + 4
		– $/cwt.–	
April	39.37	1.06425	41.90
May	39.01	1.06127	41.40
June	40.10	1.03493	41.50
July	40.07	- 1.00695	39.79
August	40.34	- 1.03916	38.76
September	41.18	- 1.03360	39.80
October	43.22	- 1.07530	39.97
November	45.31	- 1.05695	42.73

Table 4. FEEDER CATTLE FUTURES AND ADJUSTED FEEDER CATTLE FUTURES CONTRACT PRICES, APRIL 1972-NOVEMBER 1972

Month t	Month t + 4	Future Prices	Adjusted Futures Prices
		– $/cwt. –	
December	April	38.24	40.35
January	May	37.50	39.53
February	June	37.75	39.81
March	July	36.42	38.34
April	August	37.10	39.10
May	September	39.00	41.17
June	October	40.15	42.42
July	November	39.80	42.04

Table 5. AN ILLUSTRATION OF THE PROCEDURE USED TO CALCULATE THE ADJUSTED OCTOBER 1972 FEEDER CALF FUTURES CONTRACT PRICE

	$/cwt.
June 30, 1972 October feeder cattle futures closed at	$ 40.15
Deduct for non-par delivery at Oklahoma City	–.50
	$ 39.65
Adjusted price for weight difference	$ 42.29
Add commission	.10
Add interest on margin funds	.03
Adjusted October feeder cattle futures price	$ 42.42

Table 6. PRICE FORECAST, ADJUSTED FUTURES PRICE AND FORWARD CONTRACTING PRICE FOR 400-500 POUND GOOD AND CHOICE FEEDER STEER CALVES, APRIL 1972-NOVEMBER 1972

Decision Month (t + 1)	Action Month (t + 4)	Forecasted Price	Adjusted Futures Price	Forward Contract Price
			– $/cwt. –	
January	April	40.86	40.35	41.90
February	May	41.83	39.53	41.40
March	June	42.43	39.81	41.50
April	July	41.74	38.34	39.79
May	August	43.08	39.10	38.76
June	September	42.91	41.17	39.80
July	October	45.90	42.42	39.97
August	November	47.97	42.04	42.73

calves using either the futures or forward contracting strategies. If the model is followed, the futures market strategy is used to purchase feeder steer calves in April, May, June, July and November. In all other months the forward contracting strategy would be elected.

Over the test period the decision model proved to be an effective tool for transferring the risk associated with unfavorable changes in the price of feeder steer calves. Using the strategies suggested by the decision model enabled an operator to reduce the purchase price of feeder steer calves in each month.

Table 7. COMPARISON OF ALTERNATIVE BUYING STRATEGIES FOR STOCKER CALVES, APRIL 1972-NOVEMBER 1972

Action Month	Cash Market Price	Forward Contracting Price	Profit (+) or Loss (–) over cash	Futures[a] Price	Profit[b] (+) or Loss (–) over cash	Strategy[c] Price	Profit (+) or Loss (–) over cash
				–$/cwt.–			
April	40.34	41.90	–1.56	38.75	+0.37	39.97	+0.37
May	41.18	41.40	–0.22	38.40	+0.77	40.41	+0.77
June	43.22	41.50	+1.72	38.40	+0.52	42.70	+0.52
July	45.31	39.79	+5.52	41.20	+4.67	40.64	+4.67
August	44.86	38.76	+6.10	41.55	+4.32	38.76	+6.10
September	46.60	39.80	+6.80	44.25	+5.12	39.80	+6.80
October	46.47	39.97	+6.50	44.12	+3.84	39.97	+6.50
November	46.99	42.73	+4.26	42.25	+2.32	44.67	+2.32
Average	44.37	40.73	+3.64	41.12	+2.74	40.86	+3.51

[a]The feeder cattle futures price is the closing price on the third Friday of the purchase month.
[b]Futures strategy profit or loss is the profit or loss on futures trade adjusted for commission charges and loss of interest due to margin fund requirements.
[c]Actual purchase price of feeder steer calves by using decision models.

The mixed strategy of the model proved to be superior to a pure futures strategy. On the average, the mixed strategy and the forward contracting strategy were about on a par with respect to reducing the purchase price of feeder steer calves. However, the mixed strategy reduced the purchase price in every month whereas the forward contracting price would have resulted in greater purchasing costs in April and May (Table 7).

Selling Decision Model

The selling decision model is tested over a four-month period to evaluate its performance. During the period the operator selects among the alternative selling strategies. The results obtained from following the decision model are compared with the results that would have been realized from following the alternative strategies.

In order to implement the selling decision model nine-month forecasts of the average monthly price of Choice 600-700 pound feeder steers were made using the following equation which was estimated from data over the period January 1962 through July 1972:

$$(3)\quad \log \hat{P}_{t+9} = \underset{}{0.6859} + \underset{(0.02755)}{0.01091}\, C_t + \underset{(0.000009217)}{0.00008157}\, CML_t + \underset{(0.00001960)}{0.0000645}\, HSL_{t-3}$$

$$R^2 = 0.88 \qquad s^2 = 0.0006839 \qquad E^2 = 3.9981$$

where:

$\hat{P}$ = forecasted price of the average monthly price of Choice 600-700 pound feeder steers at Oklahoma City in dollars per hundredweight,

C = observed average monthly price of Choice 600-700 pound wholesale carcass beef at Chicago in dollars per hundredweight,

CML= monthly commercial cattle slaughter in the 48 states in thousands of head, and

HSL= monthly commercial hog slaughter in the 48 states in millions of pounds.

The forecasted price ranges from a high of $42.45 to a low of $40.64 over the four month period selected for purposes of illustrating the decision model. The forecasts are presented in Table 8.

The lower bounds of the probability interval for feeder steer prices forcasts at several alternative risk levels are presented in Table 9.

The forward contracting price is determined by adjusting the cash market price in month t by the change in the seasonal index between month t and month t + 9. The cash market price in month t, the seasonal adjustment coefficients and the estimated forward contract price are presented in Table 10.

The feeder cattle futures price and the adjusted feeder cattle futures price for month t + 9 are presented in Table 11. The adjusted feeder cattle futures price for month t + 9 is determined by the

Table 8. NINE-MONTH FORECAST OF THE AVERAGE MONTHLY PRICE OF 600-700 POUND CHOICE FEEDER STEERS AT OKLAHOMA CITY, SEPTEMBER 1972-NOVEMBER 1972

Forecast for Month t + 9	Forecast Price $/cwt.	Actual Price
September	40.64	42.33
October	42.45	43.04
November	42.07	43.03
December	41.36	43.94

Table 9. LOWER BOUND OF THE PROBABILITY INTERVAL FOR FEEDER STEER PRICE FORECASTS AT ALTERNATIVE RISK LEVELS, SEPTEMBER 1972-DECEMBER 1972

Risk Level	Month			
	September	October	November	December
		$/cwt.		
.400	38.86	41.77	41.40	40.71
.300	37.96	41.06	40.68	40.02
.200	36.92	40.24	39.87	39.23
.100	35.52	39.13	38.75	38.15
.050	34.40	38.23	37.85	37.28
.025	30.99	35.42	35.06	34.57

Table 10. CASH MARKET PRICE, SEASONAL ADJUSTMENT COEFFICIENTS, AND ESTIMATED FORWARD CONTRACTING PRICE FOR 600-700 POUND FEEDER STEERS AT OKLAHOMA CITY, SEPTEMBER 1972-NOVEMBER 1972

Month t + 9	Cash Price Month t	Seasonal Adjustment Coefficient	Estimated Forward Contract Price
		– $/cwt. –	
September	37.37	0.01943	38.10
October	38.14	–0.01505	37.57
November	38.97	–0.02783	37.89
December	38.33	–0.03885	36.94

Table 11. FEEDER CALF FUTURES PRICES AND ADJUSTED FEEDER CATTLE FUTURES PRICES, SEPTEMBER 1972-NOVEMBER 1972

Month t	Month t + 9	Futures Price	Adjusted Futures Price
		– $/cwt. –	
December	September	34.50	33.84
January	October	35.05	34.49
February	November	35.25	34.59
March	December	35.25	34.59

Table 12. CASH MARKET PRICE, FORWARD CONTRACTING PRICE AND FUTURES PRICE CONTRASTED, SEPTEMBER 1972-DECEMBER 1972

Month	Cash Market Price	Forward Contracting Price	Profit (+) or Loss (–) Over Cash	Futures Price	Profit (+) or Loss (–) Over Cash	Strategy[a] Price	Profit (+) or Loss (–) Over Cash
				– $/cwt. –			
Sept.	42.33	38.10	–4.23	44.25	–8.49	42.33	0
Oct.	43.05	37.57	–5.48	44.12	–8.66	43.05	0
Nov.	43.03	37.89	–5.14	42.25	–8.44	43.03	0
Dec.	43.94	36.84	–7.10	42.25	–9.35	43.94	0

[a]Assuming operator's risk profile is greater than 0.30.

same procedure used in the buying decision model. For the selling decision model the feeder cattle futures price is adjusted for location differences, commission charges and loss of interest on margin funds.

Results for the Selling Decision Model

If the operator's risk level is greater than 0.30, he is advised to sell feeder steers on the cash market in each of the four months. If the risk level is less than 0.30 but greater than 0.05, he is advised to sell the feeders using the forward contracting strategy in September and the cash strategy in the remaining three months. If the risk level is less than or equal to 0.05 but greater than 0.025, he is advised to sell feeder calves using the forward contracting strategy in all four months.

Table 12 contrasts the forward contracting and futures strategies with the cash market strategy.

In each of the months examined the profit for the forward contracting and futures strategies is negative. If the operator follows the futures strategy, the average reduction in the selling price is $8.73 per hundredweight; if the forward contracting strategy is followed, the average reduction in selling is $5.49 per hundredweight.

Over the test period a reduction in the level of risk reduces the average selling price of feeder calves. Between the .30 and .05 risk levels the average reduction in selling price of feeder cattle compared with the strategies for a risk level greater than or equal to 0.30 is $1.06. Between the 0.05 and 0.025 risk levels the average reduction in the selling price of feeder calves is $2.34.

Over the short test period a reduction in risk of unfavorable price changes results in reduction in the selling price which can be viewed as the premium paid by the operator for the price insurance.

CONCLUSIONS

This study has demonstrated the possibility that price forecasting techniques and measures of the stocker operator's risk profile can be effectively combined in a decision model to reduce the risk associated with unfavorable price changes. Over the test period the buying decision model proved to be effective in an uptrending market. During this period the buying decision model recommended that stocker operators employ selected buying strategies to lock-in the purchase price of feeder steer calves. Although the buying decision model was not tested over a downtrending market, it is expected that the decision model would recommend that the stocker operator purchase feeder steer calves on the cash market. By incorporating the price forecasting technique into the decision model the stocker operator should be able to anticipate major changes in the direction of feeder calf prices.

The selling decision model also proved to be an effective means of transferring the risk associated with unfavorable price changes. During the uptrending market the selling decision model recommended that stocker operators, who had high risk levels, sell feeder steers using the cash market strategy. As the stocker operator's risk level decreased the selling decision model recommended that stocker operators transfer the price risk by employing strategies other than the cash market selling strategy. In the case of an uptrending market this would result in a reduction in the selling price of feeder steers, but this reduction can be viewed as the cost of transferring the price risk.

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