FACTORS AFFECTING EFFICIENCY OF FEEDER CATTLE HEDGING IN KENTUCKY

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Recent commodity price volatility and development of new futures contracts has kindled interest in hedging among farmers in many parts of the country. Due to the importance of feeder cattle production in Kentucky and in the South generally, recent development of a feeder cattle contract is of special interest. This paper addresses some potential problems associated with use of feeder cattle futures markets by Kentucky producers. Specifically, it tries to: (1) determine the effect, if any, of location basis variability on *ex post* hedging results in Kentucky markets versus delivery markets at Omaha and Oklahoma City, (2) assess the ability of hedging to reduce revenue variability as compared to cash marketing and (3) determining the presence of bias in feeder cattle futures prices.

All these factors are important in evaluating effectiveness of production hedging. Location basis variability is a factor potentially associated with hedging in areas distant from designated futures contract delivery points. Hedgers in such areas would incur substantial transportation charges if they attempted to discharge their contractual obligations by delivery and, so, would seldom find delivery to be a viable alternative to contract repurchase and sale of the commodity in local cash markets. Therefore, hedging effectiveness in distant areas depends upon the basis relationship between futures market prices and spot prices in local markets. The possibility of arbitrage between spot and futures markets should enforce price convergence at delivery points, but this convergence may not apply in distant cash markets. To the extent that it does not, revenues from hedging will be more variable than at delivery points and correspondingly less effective in forward pricing of the commodity in production. Existence and magnitude of location basis variability is an empirical question. In previous studies of production hedging in southern markets, Bobst found location basis variability a significant factor for fed cattle [1] but not for hogs [2].

Samuelson [9] has suggested that variability of futures prices tends to increase as contracts near maturity. If this principle applies to feeder cattle futures, then it may be possible to reduce the variability of feeder cattle marketing revenue through hedging.

During the study period, 1973-1976, the feeder cattle futures market was characterized by low open interest and trading volume as compared to more established contracts in fed cattle and hogs.[1] Gray [6] has suggested that thin futures markets exhibit a characteristic downward bias, i.e. futures prices consistently underestimate eventual spot prices. If present in feeder cattle futures, such a bias would be an impediment to hedging in that expected hedging revenues would be lower than expected revenues from cash marketings.

FORMULATION OF THE HEDGING MODEL

In order to measure the effects of location basis variability, changing futures price variance and bias, a series of hedges were postulated for selected lengths of hedge and selected markets over time, following

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[1]Maximum monthly trading volume in feeder cattle during the study period was 4,700 contracts as compared to average monthly volumes of 203,000 contracts for fed cattle and 102,000 contracts for hogs. Open interest levels were also lower [4].

procedures used by Bobst [1]. The hedging revenue function was formulated as follows:

$$R_{ijmt} = P_{it} + S_{jm} - L_{mt} \quad (1)$$

where

R_{ijmt} = revenue per hundredweight in market i from a hedge placed j periods prior to the cash marketing data t in the contract maturing in month m

P_{it} = price of feeder steers of deliverable grade and weight in market i in period t

S_{jm} = price at which contract maturing in month m was sold j periods prior to the cash marketing date and

L_{mt} = price at which the contract maturing in month m was repurchased in period t.

Lengths of hedge were determined by production periods. If feeder cattle were placed in a 20-week backgrounding program, hedges would be placed 20 weeks prior to expected sale date in the contract maturing nearest that date. For given hedge lengths and cash marketing dates, S_{jm} and L_{mt} will be identical among markets.

The hedging revenue function is a linear combination of per hundredweight prices oriented on the marketing date. It ignores transactions costs in both cash and futures markets and abstracts from the question of hedging coverage.[2] These factors were assumed to be constant among markets. The effect of ignoring margin costs, which may vary systematically with hedge length, will be discussed later.

While statistical analyses in the study were applied to hedging revenue variance directly, it is useful to examine variance components in order to evaluate an alternative approach to measurement of location basis variability. Hedging revenue variance components are derived from expansion of equation (1). For a series of hedges within a given contract over time, hedging revenue variance is a linear combination of variances and covariances, viz.

$$\begin{aligned} \text{Var}(R_{ijm}) = {} & \text{Var}(P_{it}) + \text{Var}(S_{jm}) + \text{Var}(L_{mt}) \\ & + 2\,[\text{Covar}(P_{it}, S_{jm}) \\ & - \text{Covar}(P_{it}, L_{mt}) \\ & - \text{Covar}(P_{jm}, L_{mt})], \\ & t = 1,2,\ldots T_m \end{aligned} \quad (2)$$

for the mth contract where $\text{Var}(R_{ijm})$ = hedging revenue variance in market i, hedge length. For given hedge lengths, futures price variances and their covariance will be the same in all markets. Differences in revenue variance due to location must arise from cash price variances and covariances of cash and future prices. Differences in cash price variances between distant markets and delivery points would indicate that distant markets were economically separate from those to which futures markets referred. No foundation for hedging in the distant markets would exist.

In delivery markets hedging revenue for producers using the delivery option would be S_{jm}, with variance $\text{Var}(S_{jm})$. Exact convergence between cash and maturing futures contracts would yield the same result for simultaneous contract repurchase and sale of feeder cattle at the (delivery) cash market. In such case, it can be shown through decomposition of covariances that the correlation between delivery market cash prices and maturing contract prices must equal 1 and that, for location basis variability to exist, correlation with distant cash market prices must be less than 1. By association, then, correlation between delivery and distant cash market prices would be less than 1, indicating lags or distortions of the transmission of price change over space, the fundamental reason for location basis variability [7]. Why then should not simple cash market correlations be used to evaluate location basis variability? First exact covergence at delivery points is not guaranteed as Vollink and Raikes found in fed cattle futures [10]. In such case, divergence of the cash market correlation from 1 would be an ambiguous test of location effect. Second, deviations of correlations from 1 will understate effects on hedged revenue variance because of the multiplication of covariance terms, as can be seen from equation (2). For these reasons, straightforward comparisons of hedging revenue variances provide better tests of location basis variability.

Statistical analyses were on pooled within-contract variances. Variances from equation (2) were pooled as follows:

$$\text{Var}(R_{ij}) = \sum_{m}^{M} [\text{Var}(R_{ijm})] / \sum_{m}^{M} T_m - M \quad (3)$$

$$m = 1,2, \ldots M$$

where

$\text{Var}(R_{ij})$ = pooled within-contract variance in market i for hedge length j

M = number of contracts

[2] Hedging coverage refers to the percentage of commodity in production that is hedged.

and other variables as previously defined. Within-contract cash market prices were pooled in similar fashion.

DATA

Price data used in the analysis were weekly cash market quotes and closing prices for feeder cattle futures on a randomly selected weekday (Tuesday). Futures market prices were sampled rather than enumerated to reduce the data processing load. In instances where Tuesday prices for feeder cattle contracts on the Chicago Mercantile Exchange were not available, the next trading day's closing prices were used. The study period was from March 1973 through April 1976 and covered 165 weeks and 23 feeder cattle futures contract maturities. Since weight classifications of cash price quotes were not identical to the contract specification of a 550 to 650 pound deliverable weight range, the cash price series was modified. Midpoints of 500-600 and 600-700 pound price quotations for choice feeder steers were averaged for comparison with the futures market price series.

The hedge length used in this study (32, 24, 20 and 16 weeks) followed a study by Rutledge [8], wherein different backgrounding systems were used to determine the time required to bring an animal to a desired weight.

Feeder cattle futures contracts are not continuous. Due to the seasonal nature of much of the feeder cattle marketings, designated contract months are March through May and August through November for a total of seven contracts per year.

Feeder cattle markets in Kentucky were represented by two price series; one for Louisville, the largest volume market in the state, and the other an average of interior auction markets. Selected futures delivery markets were Omaha, which is a par delivery market, and Oklahoma City, which is also a delivery market but at a $.50 per hundredweight discount. Oklahoma City was included because of opinions expressed by Kentucky dealers that it is a price leader for marketings in the state but that price changes tend to lag those at Oklahoma City. Complete sets of observations were available for Louisville and Oklahoma City, but no quotes were available for Omaha for a period during the summer of 1975 and for Christmas weeks at the interior Kentucky markets.

RESULTS

Results of the analysis of location basis variability are presented in Table 1. Cash price and hedging revenue variances were calculated by pooling within-contract variances for each market. Hedging revenue variances were also standarized to account for missing observations by adjusting variance components from equation (2) so that futures price variances and covariances were identical in all markets. The Bartlett test [5] was used to test for equality of variances of cash prices among markets and among-market equality of hedging revenue variances by hedge length. The tests were run using a five percent level of significance.

TABLE 1. POOLED CASH PRICE AND HEDGING REVENUE STATISTICS BY MARKETS, MARCH 1973—APRIL 1976

Item	Louisville	Oklahoma City	Omaha	Kentucky	F-Ratio Bartlett Test[a]
Cash Price					
Mean	41.52	42.19	44.07	41.44	
Variance	111.51	113.85	105.47	109.62	.41
Observations[b]	165	165	157	162	
Hedging Revenue Statistics					
(32 Weeks)					
Mean	39.42	40.31	41.82	39.40	
Variance	69.22	63.20	68.72	67.24	.05
Observations	59	59	59	59	
(24 Weeks)					
Mean	39.54	40.32	42.38	39.60	
Variance	83.72	73.62	80.46	81.72	.17
Observations[b]	115	115	109	113	
(20 Weeks					
Mean	40.14	40.74	42.88	40.09	
Variance	92.16	85.19	87.61	89.68	.08
Observations[b]	146	146	138	144	
(16 Weeks)					
Mean	40.42	40.98	42.96	40.25	
Variance	102.41	97.81	98.80	101.61	.04
Observations[b]	165	165	157	162	

[a]The critical value of $F_{.05}$ for testing equality of variances between markets within hedge lengths is 2.6.

[b]Observations differed between markets due to missing observations in the cash price series.

No significant differences in cash price variances were found among markets included in the study. This result indicated that the distant markets, represented by Louisville and Kentucky interior sites, were not economically separate from the delivery point markets such as Omaha. These results established conditions necessary for comparing hedging revenue variances for evidence of location basis effects.

No significant differences in hedging revenue variances between markets were found for any length of hedge, as shown by the F-score in the right-hand column of Table 1. These results indicated that location was not a factor affecting variability of Kentucky hedging revenue during the study period. In terms of the variability of hedging outcomes, Kentucky feeder cattle producers would not have been disadvantaged by their distance from delivery

points. Mean revenues were lower than in the delivery markets, but only by the amounts of the cash price differentials.

Since location was not a factor, it was possible to evaluate hedging effectiveness for the markets in general. Cash price and hedging revenues were pooled over markets. As explained before, hedging revenues were again standardized to account for missing observations. An F-test was used to determine whether the pooled cash price variance was significantly greater than hedging revenue variance for each hedge length. These tests were also performed at the five percent level of significance. Pooled variances and associated F-scores are presented in Table 2.

Results indicated that pooled cash price variance was significantly greater than hedging revenue variances for all hedge lengths studied. Hedging could have substantially reduced revenue variance as compared to cash marketings of feeder cattle. It should also be noted that hedge revenue variance and length of hedge were inversely related. Increased efficiency could be obtained with regard to variance by using the longer hedge lengths. This relationship between hedged revenue variance and hedge length is accounted for by reference to the variances of futures selling prices, also presented in Table 2. These were variances of the futures prices at which hedges were placed. Variances increased as hedge lengths decreased, that is, as contracts approached maturity. This was in accordance with Samuelson's principle of increasing futures price variances [9].

The bias statistics presented in Table 2 indicated that downward bias was present in feeder cattle futures during the study period. Bias was calculated as the mean difference between prices at which a hedge of a given length was placed and the prices at which it was repurchased over the study period. Futures prices persistently underestimated eventual cash and maturing contract prices, hence the downward bias. Bias was reflected in the progressive reduction in mean hedging revenue as hedge length increased. Thus, hedges were increasingly costly in terms of reductions in expected revenue as hedge lengths increased. In practice these costs would have been even higher because of added costs of maintaining margins in the face of rising futures prices.

Results of the analysis indicated conflicting criteria so far as evaluation of effective feeder cattle hedging was concerned. On the one hand, the criterion of revenue variance indicated the establishment of long hedges. On the other, expected revenue criterion suggested short hedges or no hedging at all. To develop efficient hedging programs, individual producers would have to determine the trade-off between these two criteria.

TABLE 2. POOLED HEDGING REVENUE AND BIAS STATISTICS BY LENGTH OF HEDGE, MARCH 1973—APRIL 1976

Item	Hedging Revenue	Bias[a]	Hedge Placement Price
(32 Weeks)			
Mean	40.24	5.81	40.39
Variance	67.09		65.18
F-score[b]	1.74		
(24 Weeks)			
Mean	40.44	1.82	40.57
Variance	79.86		76.54
F-score	1.47		
(20 Weeks)			
Mean	40.94	.90	41.36
Variance	88.68		83.84
F-score	1.32		
(16 Weeks)			
Mean	41.07	.31	41.84
Variance	100.16		92.37
F-score	1.17		

Cash Price	Mean	Variance
	42.29	117.05

[a]Bias is equal to the difference between the futures contract price when the hedge was placed and the contract price when the hedge was lifted.

[b]The critical values of $F_{.05}$ for comparison of cash price variance to hedging revenue variance are 1.17, 1.13, 1.12, 1.11 for the 32, 24, 20 and 16-week hedge lengths, respectively.

IMPLICATIONS

Analysis of variances generated by the hedging revenue model indicated that location basis variability did not affect hedging in the Kentucky markets included in this study during the period from March 1973 to April 1976. Hedging revenue was no more variable in these markets than in the delivery markets, although means were lower in accordance with spatial differentials.

Analysis of hedging results by length of hedge were ambiguous so far as the effectiveness of hedging was concerned. Revenue variance was reduced as length of hedge was increased, though it was significantly lower than cash price variance even for the shortest hedge studied (16 weeks). At the same time, bias increased with length of hedge, so that reduction in revenue variance through hedging could have been gained only at the cost of a reduction in expected revenue. Feeder cattle producers in Kentucky and in the delivery markets as well would have had to consult their risk/reward utility functions in order to decide if hedging was an effective device in their marketing programs.

The authors can only speculate what effect current growth in trading volume and open interest in

feeder cattle contracts will have on hedging effectiveness. Clearly it would be improved if the result of increasing liquidity would be to reduce bias while preserving the futures price variance structure.

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