DESTABILIZING EFFECTS OF BASIS VARIABILITY ON PRODUCTION HEDGING REVENUES FOR FEEDER CATTLE

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Several studies have shown that production hedging in futures markets can reduce marketing revenue variability. Tomek and Gray showed this to be the case in a non-inventory futures market, namely Maine potatoes, and the effect has been demonstrated for feeder cattle by Brown and Purcell and by O'Bryan, Bobst, and Davis. The methodology of these studies has been to measure hedging performance across contracts. Nowhere has there been any explicit consideration of within-contract variation, the sort of variation that arises from short-run fluctuations in sales dates and corresponding liquidation of futures positions. Within-contract variation was taken into account in this study, and the findings indicate that variability in the basis relationship between cash prices and maturing futures contracts was so large as to cause hedging revenue variances to be significantly larger than corresponding cash price variances. These results are important in that they demonstrate a problem with the feeder cattle futures market and indicate that the results of among-contract hedging analyses need to be interpreted carefully, because they may underestimate the variability that is acutally encountered by hedgers.

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Production Hedging and Basis Variability

Futures markets in nonstorable commodities such as the livestock markets have been hypothesized to be forward pricing institutions in contrast to the carrying-charge markets long established for grains. They allow goods in production (e.g. feeder cattle) to be forward priced, and there has been evidence to indicate that they would also stabilize revenues. This capability of reducing revenue variability arises from an inverse relationship between futures contract price variance and distance from the contract maturity date (Samuelson). Futures price variance increases over the life of a contract until it equals the commodity's spot price variance at or near maturity. As previously stated, this effect has been observed in Maine potatoes (Tomek and Gray) and in feeder cattle by measurements across contracts. However, similar measurements have not been conducted within individual contracts, and it is this within-contract variability that would be of most concern to the occasional or selective hedger.

Selective Hedging

Selective hedging is intuitively a more appealing process than routine or continuous hedging. Feeder cattle are hedged only when the relationship between current futures prices for distant delivery and the outlook for eventual spot prices seems to warrant it. Thus, the selective hedger remains active in the traditional managerial activity of formulating price expectations. In routine hedging, by contrast, the producer adopts a passive role in price expectation formulation,

which is something of a denial of marketing *machismo*. The importance of sources of hedging revenue variation will differ between the two types of hedgers. These sources can be classified as arising from within contracts and from among contracts. Because selective hedging by definition means participation in fewer contracts, long-run results for the selective hedger will be more heavily weighted by whatever within-contract variation there is than the routine hedger. The ultimate in selectivity would be a one-time participant. His outcome would be influenced solely by within-contract sources.

Within-contract hedging revenue variance arises from the fact that contracts are eligible for delivery over a period of several weeks, and, since production periods are not strictly fixed in length, from similar flexibility in choice of cash marketing dates. Thus, hedging revenues are subject to short-run price variability in both cash and futures markets. The expected value of individual contract revenue variance is estimated by pooling within-contract variances across contracts,

$$(1) \qquad E\,V(R) = V(R) = \frac{1}{K} \sum^{K} V(R_k) \;,\; k = 1,2,\ldots,K$$

where K = the number of contracts observed. Ignoring brokerage commissions and margin requirements (which remain constant and so do not affect variance), within-contract revenue variance can be decomposed using the hedging revenue function

$$(2) \qquad R = P + S - F$$

where P, S, and F = cash price, futures contract sales price, and the

contract repurchase price respectively. Using (2) to decompose (1) yields

$$(3) \quad V(R_w) = V(P_w) + V(S_w) + V(F_w) + 2[CV(S_wP_w) - CV(S_wF_w) - CV(P_wF_w)]$$

where the subscript w denotes within-contract variance components.

Equation (3) provides some insight into what constitutes a "perfect" hedge. The issue rests on convergence of spot and futures prices at maturity, which is measured by the covariance term $CV(P_wF_w)$. It can be shown that, if convergence is exact, variance and covariance terms cancel out and hedging revenue variance equals futures price variance at the time contracts were sold,

$$(4) \quad V(R_w) = V(S_w).$$

If $V(S_w)$ is less than $V(P_w)$ revenue will be stabilized by hedging within individual contracts. This result does not depend on the quality of S_w as a forecast of individual prices. If W_w is a good forecast, then the covariances $CV(S_wP_w)$ and $CV(S_wF_w)$ will be relatively large. If not, they will be small. Either way, if P_w and F_w are equal (or have a constant differential) the covariances cancel out. So, S_w can have little value as a forecast and yet provide the means for a useful hedge. Gray has explained this in detail, with graphics, in discussing the Maine potato futures market.

Routine Hedging

The variance-covariance components of measures of hedging revenue variance running across contracts are similar to those for individual

contracts except that a term must be included for among-contract variance, *viz.*

$$(5) \qquad V(R_t) = \frac{(N-K)V(R_w) + (K-1)V(R_a)}{N-1}$$

where N = total observations, K = numbers of contracts, and the subscripts t and a denote total and among contract variances respectively. Among-contract variance is defined as

$$(6) \qquad V(R_a) = \frac{1}{K-1} \sum^{K} (\bar{R}_k - \bar{\bar{R}})^2 , \; k = 1,2,\ldots, K$$

where $\bar{R}_k$ and $\bar{\bar{R}}$ = individual contract and aggregate hedging revenue means respectively. Where single observations per contract are used, $V(R_a)$ is the estimator for $V(R_t)$. In this study total hedging revenue variance contains both within- and among-contract components.

Total hedging revenue variance can be decomposed to

$$(7) \qquad V(R_t) = V(P_t) + V(S_t) + V(F_t) + 2[CV(S_tP_t) - CV(S_tF_t) - CV(P_tF_t)]$$

which is similar to (3), except that each variance and covariance term must be understood to contain a within- and an among-contract component.

Test of Variance Reduction

Equations (3) and (7) provide the means for testing hypotheses concerning the ability of hedging to reduct revenue variance. If hedging in individual contracts can reduce variance, then $V(R_w)$ should be significantly less than $V(P_w)$, the within-contract variance of cash price. Likewise, $V(R_t)$ should be significantly less than $V(P_t)$ if routine hedging

has a stabilizing influence. F-ratios can be used to test the null hypothesis that cash and hedged revenue variances are equal, as was done by Tomek and Gray.

Empirical Analysis

The data base used to test hypotheses concerning variance reduction capabilities included all feeder cattle contracts from March, 1973 through September, 1977, a total of 33 contracts. Cash prices were for choice feeder steers in the 500-600 pound and 600-700 pound weight ranges. These steers would in general be deliverable against the futures contract. Delivery specifications require a 42,000 pound lot of choice steers averaging 550-650 pounds. Markets selected were Omaha and Oklahoma City.[1] Both are authorized delivery points with par delivery at Omaha and at a 50¢ per hundredweight discount at Oklahoma City.

Several lengths of hedge were postulated according to the time requirements of various production systems, but only the results for a 20-week hedge are presented here. In the study period at least, the 20-week hedge appeared to be at the boundary of statistical significance for total hedging revenue variance effects. It follows from the time structure of futures price variances that such a boundary exists. Since variance increases as contracts near maturity, at some point it will become indistinguishable from variance at maturity. In the study period this point fell somewhere between 16 and 20 weeks. Shorter hedges exhibited no significant differences in total variance comparisons while longer hedges exhibited increasingly larger differences.

Hedging revenues were measured weekly using USDA weekly cash price quotations and closing futures prices on a weekday chosen at random (Tuesday). Marketings in a given contract ran from the 21st of the month preceding a delivery month through the 20th of the delivery month, on which date contracts expire. There were 4 and occasionally 5 observations per contract. Running observations over the last 10 days of the preceding months increased degrees of freedom at no cost in measurement precision. Basis variability was the same in these periods as in the delivery months themselves. All hedges were assumed to be liquidated through contract repurchase. There were 140 weekly observations across the 33 contracts at Oklahoma City and 135 at Omaha. Total and within-contract hedging revenue and cash price variances and their associated F-ratios are presented in Table 1.

Results

Table 1 shows that routine 20-week hedges over the study period would have reduced revenue variance significantly compared to cash marketing. These results follow from all previous theoretical and empirical work and are themselves routine. However, they provide a standard of comparison for the individual contract results, also shown in Table 1.

Within-contract hedging revenue variances were significantly greater than corresponding cash price variances. This meant that, during the study period, the expected outcome of any given hedge would have tended to destabilize feeder cattle marketing revenues for that period.

Table 1. Routine Versus Selective Hedging Results for 20-Week Feeder Cattle Hedges in Selected Markets, Choice Steers, March 1973-September 1977

	Omaha		Oklahoma City	
	500-600 lbs.	600-700 lbs.	500-600 lbs.	600-700 lbs.
	----------($/cwt.)^2----------			
A. Routine Hedges				
Total Variances				
Cash	87.76	65.44	102.76	75.23
Hedged Revenues	62.92	49.20	68.38	47.47
F-Ratio	1.40*	1.33*	1.50*	1.58*
Degrees of Freedom	134	134	139	139
B. Selective Hedger				
Within-Contract Variances				
Hedged Revenue	3.22	3.32	3.45	3.52
Cash	2.06	1.61	2.02	1.97
F-Ratio	1.56*	2.08*	1.71*	1.79*
Degrees of Freedom	102	102	107	107

*Indicates significances at the 5% level. Critical values are 1.33 with (134,134) degrees of freedom for total variances and 1.39 with (102,102) degrees of freedom for within-contract variances.

The cause of revenue destabilization was poor basis performance in maturing contracts. In principle, arbitrage forces cash-futures price convergence, at least to a constant differential, so variability is nil. As shown in Table 2, basis measured across contracts approached this ideal. Total variance was small relative to its component variances for all market and weight combinations. Correlations between cash and maturing contract prices ranged from 0.97 to 0.99 as compared to the theoretical level of 1.0. Within-contract convergence was much less exact. Basis variances were large relative to their component price variances, and correlations were low, ranging from 0.67 to 0.73. Vollink and Raikes found similarly poor basis behavior in the fed cattle contract. They ascribed poor basis performance to high perceived risk in delivery and arbitrage, which may well be the case for feeder cattle also.

Concluding Remarks

This research shows a definite destabilizing effect from hedging within individual feeder cattle contracts. It remains to explore the perceptibility of this effect to the producer and the practicability of him doing anything about it. The effect will not be easily perceptible to the producer with one contract's worth of feeder cattle for his outcome will be singular in each contract. In analyzing hedging effectiveness, it will be natural for him to examine the series of outcomes he has experienced. This is a comparison among contracts, which would tend to show a revenue stabilizing effect. It is straightforward methodology, and the results are worth knowing. But it ignores the

Table 2. Components of Basis Variation for Routine and Selective Hedges in Selected Markets, Choice Steers, March 1973-September 1977

	Omaha		Oklahoma City	
	500-600 lbs.	600-700 lbs.	500-600 lbs.	600-700 lbs.
	($/cwt.)^2			
A. Routine Hedges				
Total Basis Variance	4.17	5.17	2.99	2.28
$V(P_t)$	87.76	65.44	102.76	75.23
$V(B_t)$	85.57	85.57	85.57	85.57
$CV(P_t,B_t)$	84.62	72.95	92.69	79.26
$Corr(P_t,B_t)$	.98	.97	.99	.99
B. Selective Hedges Within-Contracts Basis				
Variance	1.75	1.60	1.89	1.64
$V(P_w)$	2.06	1.61	2.02	1.97
$V(B_w)$	3.42	3.42	3.38	3.38
$CV(P_w,B_w)$	1.86	1.71	1.75	1.85
$Corr(P_t,B_t)$	.70	.73	.67	.72

question of what effect minor fluctuations in marketing dates would have had on outcomes. Only a large producer with several contracts and marketings on different dates would directly experience within-contract basis variation. Smaller producers could perceive it only by comparing prices and asking what might have been if they had timed marketings differently.

All producers must be selective hedgers in some sense for none can have the volume and seasonal distribution of output to hedge continuously in the sense of the routine hedges postulated in this paper. The more selective they are the greater within-contract variability will be as a proportion of the total. They may not perceive it for reasons already discussed, but it is there, and it will have a deleterious effect on hedging performance.

Remedial research needs to be undertaken to discover ways and means of reducing basis variability in the cattle futures markets. In theory arbitrage between cash and futures markets is the answer, but it does not seem adequate in practice. Vollink and Raikes have mentioned ways by which delivery and arbitrage risk might be reduced, but the subject has by no means been thoroughly explored.

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FOOTNOTES

[1]The Louisville, Kentucky market was also analyzed. Results were the same as for Omaha and Oklahoma City and so were deleted to save space.