Estimated Hedging Risk with Cash Settlement Feeder Cattle Futures

Emmett Elam

Beginning with the September 1986 contract, feeder cattle futures have been settled based on cash settlement rather than physical delivery. The effect that cash settlement will have on hedging risk for feeder cattle was estimated using Arkansas prices for 1977–86, but the results should be representative of other markets. For 600–700-pound steers and heifers, hedging risk is estimated to be lower for hedges placed in the new cash settlement contract. For steers and heifers weighing less than 600 pounds, hedging risk is estimated to be lower for the cash settlement contract for fall hedges, whereas hedging risk is estimated to increase for spring hedges.

Key words: feeder cattle, futures contract, hedge ratio, hedging risk.

Feeder cattle futures began trading as a physical delivery contract on the Chicago Mercantile Exchange (CME) in November 1971. Total open interest in feeder cattle futures reached a peak of 27,000 contracts in March 1979, with an average daily trading volume of 5,000–6,000 contracts (CME *Yearbook*). Since then, open interest has generally ranged from 9,000–11,000 contracts with an average daily volume of 1,000–3,000 contracts.

Cash settlement of feeder cattle futures was implemented beginning with the September 1986 contract. A weighted average price of 600–800-pound steers which should grade 60%–80% choice at slaughter weight is calculated by Cattle-Fax, the economic research unit of the National Cattlemen's Association, and used as the final settlement price.[1] All contracts remaining open at contract expiration are settled in cash based on this final settlement price rather than by physical delivery of steers.

Even though the delivery feeder cattle contract is considered a success, it is commonly felt that commercial usage of the market has never reached its potential. Open interest of 10,000 contracts reflects hedges for 750,000 to 1 million head of feeder cattle if every contract is held by a hedger. Because some contracts are held strictly by speculators, the number of cattle hedged is even less. From 1981–85, the average U.S. feeder cattle supply was 45 million head (USDA), which compared to 750,000 to 1 million head indicates that potential exists for increased commercial usage of feeder cattle futures.

The lack of commercial usage has been attributed to problems with the physical delivery contract (CME Dec. 1985, p. 4). First, uncertainty and disputes are associated with the grading of feeder cattle during delivery. Second, the futures contract discounts for non-par grades, weights, and locations are often out of line with cash market differentials. Third, basis risk has been notoriously large, even for par grade-and-weight steers at delivery locations (Kilcollin, attachment 2A). Settling feeder cattle futures by cash settlement will eliminate the need to grade feeder cattle for delivery and establish discounts for non-par units. Also, cash settlement should reduce basis risk because it will force the futures price to equal the final cash settlement price. Research conducted by Cattle-Fax and the CME indicates that basis risk is reduced for 600–800-pound steers in twenty-seven states with a cash settlement contract (Kilcollin). This reduction in basis risk was a prime consideration in adopting a cash settlement contract.

The objective of this research was to extend

Emmett Elam is an associate professor, Department of Agricultural Economics, Texas Tech University.

The author would like to thank two anonymous referees for their helpful comments.

[1] See Cattle-Fax and Kilcollin for details of the procedure used to determine the weighted average price.

the results of Cattle-Fax and the CME to lighter weight feeder cattle and heifers. This required developing an equation to measure hedging risk based on a sample of cash and futures prices. The equation was used to estimate the change in hedging risk with a cash settlement contract using Arkansas prices for 1977–86. Because Arkansas prices are highly correlated with cash prices from other markets, the results for Arkansas should be representative of other feeder cattle markets.[2] Also, the results for Arkansas are important because a large number of feeder cattle are marketed in Arkansas. From 1982–86, receipts of feeder cattle at Arkansas auctions averaged 729,000 head per year (Agricultural Marketing Service (AMS), USDA, LS-182 forms), which is equal to 63% of the average yearly receipts at the eight major feeder cattle markets reported by the USDA AMS (*Livestock, Meat and Wool Market News*).[3]

An outline of the paper is as follows. In the first section, hedging risk is discussed and an equation is derived for measuring hedging risk based on a sample of cash and futures prices. In the second section, the data used to compare hedging risk for the physical delivery contract and the new cash settlement contract are discussed, and the empirical results are presented. In the last section, the conclusions are provided.

Hedging Risk

The success of a hedge depends on the extent to which cash and futures prices move together. If perfect correlation exists between cash and futures prices, no risk is involved in hedging. In practice, cash and futures prices do not always move together, and consequently risk is involved in a hedge.

The risk associated with a hedge is derived as follows.[4] First, the relationship between cash and futures prices must be specified:

$$(1) \qquad C_t = b_0 + b_1 F_t^t + e_t,$$

where C_t is the per unit cash price at time t; F_t^t is the per unit price at time t for the futures contract maturing at time t; e_t represents the variation in the cash price that is not accounted for by a linear function of the futures price; and b_0 and b_1 are fixed parameters.

The parameters in equation (1) can be estimated using ordinary least-squares regression:

$$(2) \qquad \hat{C}_t = \hat{b}_0 + \hat{b}_1 F_t^t,$$

where $\hat{C}_t$ is the predicted cash price at time t; and $\hat{b}_0$ and $\hat{b}_1$ are estimated values of the parameters. The estimated slope parameter ($\hat{b}_1$) indicates the number of units of futures required to offset one unit of the cash commodity. A production (or short) hedge would involve the sale of of $\hat{b}_1$ units of futures per unit of anticipated production; and a long hedge of an anticipated requirement—e.g., feeder cattle for a cattle feeding program—would involve the purchase of $\hat{b}_1$ units of futures per unit of the requirement.

The target price for a hedge is the price the hedger expects to achieve from hedging. Assume that the hedger is interested in placing a hedge that will be lifted at time $t + j$, and currently it is time t. The target price is calculated by substituting the current futures price for the contract maturing at time $t + j$ into the estimated regression and solving for the predicted price:

$$(3) \qquad T_t^{t+j} = \hat{b}_0 + \hat{b}_1 F_t^{t+j},$$

where T_t^{t+j} is the per unit target price for time $t + j$ as calculated at time t and F_t^{t+j} is the per unit price at time t for the futures contract that matures at time $t + j$.[5]

The net price for a hedge is

$$(4) \qquad N_{t+j} = C_{t+j} + \hat{b}_1(F_t^{t+j} - F_{t+j}^{t+j}),$$

where N_{t+j} is the per unit net price of the cash commodity at time $t + j$ and C_{t+j} is the actual per unit price of the cash commodity at time $t + j$. The net price is the sum of the cash price at the time the hedge is lifted plus the return on the futures position. The net price represents the actual price achieved from hedging.

Risk is involved in hedging because the net and target prices are not always equal. The difference between net and target prices can be

[2] For 600–800-pound steers, Cattle-Fax and Kilcollin report that the estimated change in hedging risk with a cash settlement contract is similar for different feeder cattle markets.

[3] Eight markets include Kansas City, National Stock Yards, Oklahoma City, Omaha, Sioux City, Sioux Falls, South St. Joseph, and South St. Paul. Effective 8 March 1986, National Stock Yards and Omaha are replaced by Amarillo and Dodge City.

[4] This section extends the results in Miller by developing a measure for hedging risk based on a sample of cash and futures prices rather than using a simulation analysis.

[5] Hedging costs are not included because they are relatively small and approximately the same for both the delivery and cash settlement contracts.

obtained by subtracting equation (3) from equation (4) and substituting for C_{t+j} from equation (1):

$$(5) \quad N_{t+j} - T_t^{t+j} = (b_0 - \hat{b}_0) + (b_1 - \hat{b}_1)F_{t+j}^{t+j} + e_{t+j}.$$

One measure of the risk associated with a hedge is the variance of the difference between net and target prices, which can be derived from equation (5):

$$(6) \quad \text{var}(N_{t+j} - T_t^{t+j}) = E[(b_0 - \hat{b}_0)]^2 + E[(b_1 - \hat{b}_1)^2(F_{t+j}^{t+j})^2] + 2E[(b_0 - \hat{b}_0)\cdot(b_1 - \hat{b}_1)F_{t+j}^{t+j}] + E[(e_{t+j})^2] + 2E[(b_0 - \hat{b}_0)e_{t+j}] + 2E[(b_1 - \hat{b}_1)F_{t+j}^{t+j}e_{t+j}],$$

where $E(\cdot)$ is the expectation of the term(s) in parentheses based on what is known at time t. A problem with equation (6) is that it depends on the futures price at time $t + j$ when the hedge is lifted (F_{t+j}^{t+j}), and this is not known at time t when the hedge is placed. Now, F_{t+j}^{t+j} can be removed from equation (6) using the relation

$$(7) \quad F_{t+j}^{t+j} = F_t^{t+j} + v_{t+j},$$

where v_{t+j} is a random error term with $E(v_{t+j}) = 0$.[6] The result is

$$(8) \quad \text{var}(N_{t+j} - T_t^{t+j}) = E(b_0 - \hat{b}_0)^2 + E\{(b_1 - \hat{b}_1)^2[(F_t^{t+j})^2 + 2F_t^{t+j}v_{t+j} + (v_{t+j})^2]\} + 2E[(b_0 - \hat{b}_0)(b_1 - \hat{b}_1)(F_t^{t+j} + v_{t+j})] + E[(e_{t+j})^2] + 2E[(b_0 - \hat{b}_0)e_{t+j}] + 2E[(b_1 - \hat{b}_1)(F_t^{t+j} + v_{t+j})e_{t+j}].$$

Equation (8) can be further simplified to obtain an expression for hedging risk, which can be calculated using data that are available at time t when the hedge is placed:

$$(9) \quad \text{var}(N_{t+j} - T_t^{t+j}) = \text{var}(\hat{b}_0) + (F_t^{t+j})^2\text{var}(\hat{b}_1) + 2F_t^{t+j}\text{cov}(\hat{b}_0, \hat{b}_1) + \sigma_e^2 + \text{var}(\hat{b}_1)\sigma_v^2,$$

where $\text{var}(\hat{b}_0) = E(b_0 - \hat{b}_0)^2$; $\text{var}(\hat{b}_1) = E(b_1 - \hat{b}_1)^2$; $\text{cov}(\hat{b}_0, \hat{b}_1) = E[(b_0 - \hat{b}_0)(b_1 - \hat{b}_1)]$; $\sigma_e^2 = E[(e_{t+j})^2]$ is the variance of the error term in equation (1); and $\sigma_v^2 = E[(v_{t+j})^2]$ is the variance of the j-period changes in futures prices from equation (7). In deriving equation (9), it was assumed that

$$(10) \quad \begin{aligned} E[(b_0 - \hat{b}_0)e_{t+j}] &= 0 \\ E[(b_1 - \hat{b}_1)e_{t+j}] &= 0 \\ E[(b_0 - \hat{b}_0)(b_1 - \hat{b}_1)v_{t+j}] &= 0 \\ E[(b_1 - \hat{b}_1)^2 v_{t+j}] &= 0 \\ E[(b_1 - \hat{b}_1)e_{t+j}v_{t+j}] &= 0. \end{aligned}$$

These expressions are zero because e_{t+j} is independent of $(e_t, e_{t-1}, \ldots)$ which influence $\hat{b}_0$ and $\hat{b}_1$ and because changes in futures prices (v_{t+j}) are independent of known information $(e_t, e_{t-1}, \ldots)$ as a result of discounting by futures markets. The assumptions of least-squares regression—$\hat{b}_0$ and $\hat{b}_1$ are unbiased and $E(e_{t+j}) = 0$—are also used in showing that the expressions are zero.

The variance of the difference between net and target prices in equation (9) is the result of:

(*a*) Errors in estimating the parameters in equation (1) which are responsible for the variance and covariance terms in equation (9). As the errors in estimating b_0 and b_1 increase, the variances of $\hat{b}_0$ and $\hat{b}_1$ increase and hedging risk increases.

(*b*) Uncertainty in the relationship between cash and futures prices at time $t + j$ when the hedge is lifted. This uncertainty is represented by e_{t+j} in equation (5). As σ_e^2 increases, the target price becomes less reliable as an indicator of the net price and, *ceteris paribus*, hedging risk increases.

(*c*) Variability in futures prices between time t when the hedge is placed and time $t + j$ when the hedge is lifted. The variability in futures prices (σ_v^2) contributes to hedging risk because F_{t+j}^{t+j} is approximated by F_t^{t+j} in deriving equation (9). To the extent that F_t^{t+j} is not equal to F_{t+j}^{t+j}, hedging risk is increased beyond what it

---

[6] Equation (7) implies that the futures price at time t is an unbiased estimate of the futures price at time $t + j$. The following procedure was used to test for bias in feeder cattle futures prices. First, monthly returns are calculated for the nearby futures contract. That is, in mid-January 1977, the March 1977 contract is purchased and sold in mid-February 1977, and the monthly return calculated. In mid-February 1977, the March 1977 contract is purchased and sold in mid-March 1977, and the monthly return calculated. And so on until mid-March 1986 when the April 1986 contract is purchased and sold in mid-April 1986, and the final monthly return is calculated. The mean of the 112 monthly futures returns is \$.07 per hundredweight with a standard error of the mean of .35. If the true return is zero, the probability is .84 of the sample mean return deviating at least \$.07 from zero. Consequently, there is no evidence of bias for the nearby feeder cattle futures contracts.

The same procedure was used to test for bias for futures contracts closest to, but not less than, three months from maturity and the contracts closest to, but not less than, six months from maturity. The average monthly futures returns are \$.08 and \$.15 per hundredweight, respectively, with t-values of .24 and .53. Neither t-value rejects the null hypothesis of zero bias.

would be if F_{t+j}^{t+j} were known when the hedge was placed.

By substituting the least-squares estimators for var($\hat{b}_0$), var($\hat{b}_1$) and cov($\hat{b}_0$, $\hat{b}_1$) (Pindyck and Rubinfeld, pp. 53–54) into equation (9), the formula for the variance of the difference between net and target prices can be written as

$$(11)\quad \text{var}(N_{t+j} - T_t^{t+j}) = \sigma_e^2\left[1 + \frac{1}{n} + \frac{(F_t^{t+j} - \bar{F})^2 + \sigma_v^2}{\Sigma(F_{t+j}^{t+j} - \bar{F})^2}\right],$$

where $\bar{F}$ is the mean of F_{t+j}^{t+j} and the summation (Σ) is over the n observations used to estimate equation (2). Hedging risk from equation (11) is directly related to the size of σ_e^2, σ_v^2 and $(F_t^{t+j} - \bar{F})^2$ and inversely related to the sample size (n) used to estimate equation (1).

The risk associated with feeder cattle hedges placed in delivery and cash settlement futures contracts can be estimated using equation (11). The price data used to estimate hedging risk are discussed in the following section along with the results.

Estimated Hedging Risk with Delivery and Cash Settlement Contracts

Hedging risk was estimated for feeder cattle using Arkansas Auction prices for medium frame, no. 1 steers and heifers weighing 300–400, 400–500, 500–600, 600–700 pounds (AMS USDA, LS-214 forms). The average weekly price for the week including the fifteenth day of the month was used. Daily CME feeder cattle futures prices were averaged for the same week and used for physical delivery futures prices. The cash settlement futures price was approximated by the weighted average price reported by Cattle-Fax for 600–800-pound steers for the week that included the fifteenth day of the month. The Cattle-Fax price was used as a proxy for cash settlement futures prices that were not available before 1986. The Cattle-Fax price should be approximately equal to the cash settlement futures price because cash settlement futures are settled using the Cattle-Fax price.[7] A historical series for the cash settlement price was made available by Cattle-Fax and is reported in "Cash Settlement for Feeder Cattle Futures" published by the CME.

Hedging risk was estimated using the standard deviation of the difference between net and target prices evaluated at the mean nearby futures price ($\bar{F}$):

$$(12)\quad std(N_{t+j} - T_t^{t+j}) = \left[1 + \frac{1}{n} + \frac{\hat{\sigma}_v^2}{\Sigma(F_{t+j}^{t+j} - \bar{F})^2}\right]^{1/2}\hat{\sigma}_e,$$

where *std* stands for standard deviation; $\hat{\sigma}_v^2$ is the sample estimate of the variance of j-period changes in futures prices; $\Sigma(F_{t+j}^{t+j} - \bar{F})^2$ is the sum of squared deviations of nearby futures prices (F_{t+j}^{t+j}) about $\bar{F}$; n is the number of observations on cash and futures prices used to estimate the parameters in equation (2); and $\hat{\sigma}_e$ is the standard deviation of the residuals from the regression of cash on nearby futures prices [equation (2)]. The standard deviation of the difference between net and target prices is preferable to the variance from equation (11) because it measures hedging risk in the original units of measure—dollars per hundredweight.

Sample estimates for σ_v^2 and σ_e are needed to calculate $std(N_{t+j} - T_t^{t+j})$ using equation (12). The variance in futures prices (σ_v^2) was estimated using delivery futures prices for 1977 through April 1986. Delivery futures were used because cash settlement futures only began trading in January 1986. The variance of changes in cash settlement futures prices should be approximately the same as the variance of changes in delivery futures prices because delivery and cash settlement futures prices are influenced by the same demand-supply factors.

An estimate of σ_e was obtained from the regression results for equation (1). Regressions were run for both delivery and cash settlement futures using cash (C_t) and nearby futures prices (F_t^t) for 1977 through April 1986. For the delivery contract, equation (1) was estimated using Arkansas auction prices for C_t and delivery futures prices for F_t^t. For the cash settlement contract, equation (1) was estimated using Arkansas auction prices for C_t and the price reported by Cattle-Fax for 600–800-pound cash steers for F_t^t. As stated above, the Cattle-Fax price was used as a proxy for cash settlement futures prices that were not available before

[7] Results for the September, October, and November 1986 contracts and the January and March 1987 contracts support the use of Cattle-Fax prices as proxies for cash settlement futures prices. The average of the five differences between Cattle-Fax prices and cash settlement futures prices for the day cash settlement futures are settled is −$.12 per hundredweight. The hypothesis that Cattle-Fax prices are equal to cash settlement futures prices cannot be rejected at the .05 level of significance.

Table 1. Hedge Ratios and Hedging Risk for Arkansas Steers Hedged in Delivery Versus Cash Settlement Feeder Cattle Futures Contracts, 1977–April 1986

Weight Categories and Contract	Hedge Ratio[a]		Hedging Risk[b]		Change in Hedging Risk with Cash Settlement Contracts[c]
	Delivery	Cash Settlement	Delivery	Cash Settlement	
(lbs.)			($/cwt)		(%)
300–400:					
January	1.33	1.38	6.31	6.13	−2.9
March	1.35	1.45	4.24	5.16	21.5
April	1.53	1.60	5.06	6.84	35.2
May	1.54	1.57	3.61	4.73	31.0
August	1.27	1.41	6.48	5.98	−7.8
September	1.21	1.27	4.92	4.67	−5.1
October	1.24	1.29	2.91	2.42	−16.5
November	1.21	1.25	5.22	4.02	−22.9
400–500:					
January	1.22	1.26	4.55	4.27	−6.0
March	1.22	1.31	3.42	4.17	21.9
April	1.33	1.40	3.91	5.03	28.5
May	1.30	1.33	2.34	3.15	34.6
August	1.11	1.23	5.28	4.95	−6.3
September	1.11	1.17	4.13	3.68	−10.9
October	1.06	1.11	3.07	2.58	−16.1
November	1.04	1.05	3.28	2.69	−18.1
500–600:					
January	1.08	1.12	2.67	2.35	−11.7
March	1.05	1.15	2.98	2.13	−28.5
April	1.17	1.24	2.71	3.71	36.9
May	1.23	1.26	1.47	1.85	25.7
August	1.00	1.11	3.22	2.77	−14.1
September	0.98	1.02	2.34	1.87	−20.0
October	1.04	1.08	2.16	1.60	−26.0
November	0.94	0.95	2.37	1.92	−18.8
600–700:					
January	0.99	1.05	1.18	1.22	2.7
March	0.92	1.01	2.09	0.76	−63.6
April	0.94	0.90	1.79	1.42	−20.7
May	1.04	1.02	0.96	0.91	−5.4
August	0.97	1.08	2.67	2.32	−13.2
September	0.87	0.96	1.59	0.54	−66.1
October	0.98	1.04	1.82	1.07	−41.3
November	0.80	0.90	1.94	1.08	−44.5

[a] Pounds of feeder cattle futures required to hedge one pound of Arkansas feeder steers. Hedge ratios are the estimated $\hat{b}_1$'s from equation (2). For the 300–400, 400–500, and 500–600-pound weight categories, ten observations were used to estimate the hedge ratios for March and April and nine observations for the other months. For the 600–700-pound weight category, only six to nine observations were used in estimation because prices were not reported for 600–700-pound steers and heifers for twenty-four months during 1979 through early 1981.

[b] Standard deviation of the difference between net and target prices calculated using equation (12).

[c] Column 5 divided by column 4 minus 1.0.

1986. The standard deviation of the residuals from the two regressions were used as estimates of σ_e for delivery and cash settlement futures.

The hedge ratios [$\hat{b}_1$'s from equation (2)] and hedging risk [$std(N_{t+j} - T_t^{t+j})$ from equation (12)] for feeder cattle hedged in the physical delivery contract and the new cash settlement contract are presented in tables 1 and 2. The results are for hedges held for three months. Results for other length hedging periods are not reported because they are essentially the same as for three-month hedges. In fact, the hedge ratios from equation (2) are exactly the same for any length hedging period. Hedging risk varies somewhat for different hedge periods because $\hat{\sigma}_v^2$ depends on the length of time a hedge is held. However, $\hat{\sigma}_v^2$ in equation (12)

Table 2. Hedging Ratios and Risk for Arkansas Heifers Hedged in Delivery Versus Cash Settlement Feeder Cattle Futures Contracts, 1977-April 1986

Weight Categories and Contract	Hedge Ratio[a]		Hedging Risk[b]		Change in Hedging Risk with Cash Settlement Contract[c]
	Delivery	Cash Settlement	Delivery	Cash Settlement	
(lbs.)			($/cwt)		(%)
300–400:					
January	1.20	1.25	5.71	5.37	−6.0
March	1.14	1.23	4.55	4.76	4.5
April	1.41	1.48	6.80	7.92	16.5
May	1.23	1.25	4.18	5.21	24.4
August	1.13	1.25	6.05	5.93	−2.0
September	1.12	1.17	5.52	5.36	−2.9
October	1.06	1.10	3.71	3.45	−7.0
November	1.11	1.12	3.89	3.48	−10.4
400–500:					
January	0.96	0.99	3.75	3.56	−4.9
March	1.06	1.14	2.98	3.32	11.6
April	1.09	1.16	3.65	3.85	5.6
May	1.09	1.11	2.94	3.66	24.6
August	1.01	1.12	4.26	4.31	1.3
September	1.06	1.11	3.86	3.65	−5.5
October	0.93	0.97	2.34	2.04	−12.5
November	0.97	0.99	3.24	2.73	−15.9
500–600:					
January	0.98	1.01	2.39	2.11	−11.6
March	0.94	1.02	1.70	1.71	0.5
April	0.98	1.05	2.51	2.67	6.4
May	1.02	1.05	2.07	2.26	9.0
August	0.92	1.02	2.86	2.65	−7.5
September	0.95	0.99	3.53	3.15	−10.8
October	0.93	0.96	1.62	1.34	−17.0
November	0.87	0.88	2.07	1.56	−25.0
600–700:					
January	0.92	0.97	2.26	2.09	−7.4
March	0.94	0.92	1.72	1.31	−24.0
April	0.90	0.88	2.62	1.62	−38.3
May	0.93	0.91	1.19	1.10	−7.9
August	0.84	0.93	2.04	1.95	−4.6
September	0.74	0.83	1.78	1.36	−23.4
October	0.88	0.94	1.77	1.00	−43.8
November	0.85	0.94	1.81	1.34	−26.0

[a] Pounds of feeder cattle futures required to hedge one pound of Arkansas feeder heifers. Hedge ratios are the estimated $\hat{b}_1$'s from equation (2). For the 300–400, 400–500, and 500–600-pound weight categories, ten observations were used to estimate the hedge ratios for March and April and nine observations for the other months. For the 600–700-pound weight category, only six to nine observations were used in estimation because prices were not reported for 600–700-pound steers and heifers for twenty-four months during 1979 through early 1981.
[b] Standard deviation of the difference between net and target prices calculated using equation (12).
[c] Column 5 divided by column 4 minus 1.0.

is divided by $\Sigma(F_{t+t}^{t+j} - \bar{F})^2$ which is a much larger term[8]; and therefore when different values of $\hat{\sigma}_v^2$ are substituted in equation (12) for different length hedging periods, the estimates of hedging risk change very little. This means that the results in tables 1 and 2 for three-month hedges can be used as estimates of hedging risk (and especially relative hedging risk in column six) for other hedging periods.

The hedge ratios in columns two and three of tables 1 and 2 differ by sex, weight category, and futures contract. The hedge ratios are generally smaller for heifers than steers. As weight increases, the hedge ratios generally decrease.

[8] Note that $\Sigma(F_{t+j}^{t+j} - \bar{F})^2$ is the sum of n squared deviations in F_{t+j}^{t+j} about $\bar{F}$, whereas $\hat{\sigma}_v^2$ is the average squared j-period change in futures prices.

The hedge ratios vary by contract, tending to be the largest for March, April, and May hedges and smallest for September, October, and November hedges. Overall, across sex, weight category, and contract, the hedge ratios are slightly larger for the cash settlement contract.

The 44,000-pound CME feeder cattle futures contract will hedge different numbers of feeder cattle depending on the sex and weight of the animals being hedged and the month when the hedge will be lifted. For example, a cow-calf producer hedging 350-pound steers for the April market would need to sell 1.60 pounds of cash settlement futures per pound of anticipated production. This means that one April CME futures contract would represent a hedge for approximately 79 steers. By contrast, hedging 350-pound steers for the November market would require the sale of 1.25 pounds of cash settlement futures per pound of anticipated production. The November CME futures contract would hedge roughly 101 steers, or 22 more steers than the April contract.

Hedging risk in columns four and five of tables 1 and 2 varies by sex, weight category, and contract month. For the same weight category and contract month, hedging risk is generally lower for heifers than steers, which is surprising because both the delivery and cash settlement contracts reflect steer prices. Hedging risk decreases as weight increases, generally ranging from \$3–\$6 per hundredweight for 300–400-pound animals and from \$1–\$2 per hundredweight for 600–700-pound animals. Overall, hedging risk tends to be highest in April and August and lowest in October.

The estimated change in hedging risk with a cash settlement contract compared to a delivery contract is shown in the last column of tables 1 and 2. Hedging risk is consistently lower in September, October, and November with a cash settlement contract, and the reduction in hedging risk increases with weight. For example, for October hedging risk is estimated to be 16.5% lower for 300–400-pound steers hedged in a cash settlement contract compared to 41.3% lower for 600–700-pound steers. Hedging risk is lower for a cash settlement contract for 600–700-pound heifers for all months and for 600–700-pound steers for all months except January. The largest reduction in hedging risk with a cash settlement contract is 66.1% for 600–700-pound steers hedged in the September contract.

By contrast, for March, April, and May hedges for feeder cattle weighing less than 600 pounds, hedging risk is estimated to generally increase 20%–35% for steers and 5%–25% for heifers with the cash settlement contract compared to the delivery contract. This most likely means that cow-calf operators (who generally market cattle at less than 600 pounds) will hedge fewer March, April, and May feeder cattle now that cash settlement futures have started trading. Other means, such as forward contracts, may be used more often to fix the price of feeder cattle marketed during this period.

Conclusions

The objective of this research was to determine whether hedging risk for feeder cattle will be lower with the new cash settlement contract compared to the delivery contract. This required developing an equation to measure hedging risk based on a sample of cash and futures prices. The equation was used to estimate the change in hedging risk using Arkansas cash prices, but the results should be valid for other feeder cattle markets because feeder cattle prices are highly correlated across markets. However, the results can indicate only what might happen because they are estimates based on prices for 1977–86 when only delivery futures were trading. Also, they are valid only if the relationship between prices remains the same after cash settlement is introduced.

Remembering these caveats, hedging risk is estimated to be lower with the new cash settlement contract compared to the physical delivery contract for 600–700-pound steers and heifers. Because the majority of feeder cattle hedges are placed by cattle feeders who are hedging animals weighing more than 600 pounds, the reduction in hedging risk with cash settlement should result in increased commercial usage of the feeder cattle futures market. For steers and heifers weighing less than 600 pounds, hedging risk is estimated to be lower for the new cash settlement contract for fall hedges, whereas hedging risk is estimated to increase for spring hedges placed in the cash settlement contract. As a consequence, it is likely that more lighter weight feeder cattle will be hedged in the fall and less will be hedged in the spring. The estimated increase in hedging risk for lighter weight feeder cattle for the spring months is a drawback to cash settlement for feeder cattle futures.

[*Received July 1986; final revision received March 1988.*]

References

"An Executive Summary of a Proposal to Provide a Cash-Based Settlement Price for the Feeder Cattle Contract." Englewood CO: Cattle-Fax, Jan. 1985.

Chicago Mercantile Exchange. "Cash Settlement for Feeder Cattle Futures." Dec. 1985.

———. *Yearbook,* 1972–73 through 1983.

Kilcollin, Thomas Eric. Letter to Jean A. Webb, Commodity Futures Trading Commission, from Kilcollin, senior vice president, Chicago Mercantile Exchange, Jan. 1985.

Miller, Stephen E. "Simple and Multiple Cross-Hedging of Millfeeds." *J. Futures Mkts.* 5(1985):21–28.

Pindyck, Robert S., and Daniel L. Rubinfeld. *Econometric Models and Economic Forecasts,* 2nd ed. New York: McGraw-Hill Book Co., 1981.

U.S. Department of Agriculture, Agricultural Marketing Service. *Livestock, Meat and Wool Market News.* Washington DC, various issues.

U.S. Department of Agriculture, Economic Research Service. *Livestock and Poultry Outlook and Situation.* Washington DC, various issues.

Wall Street Journal, various issues, 1984–86.