Hedging Risk For Feeder Cattle With A Traditional Hedge Compared To A Ratio Hedge

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Abstract

This paper compares hedging risk for various weights of feeder cattle hedged with a traditional cross hedge and a ratio cross hedge. A traditional hedge calls for the purchase/sale of one pound of futures for each pound of cash feeder cattle. By contrast, a ratio hedge requires estimation of a hedge ratio to determine the number of pounds of futures needed to hedge one pound of cash feeder cattle. Hedge ratios were found to be larger than 1.0 for light-weight feeder cattle. By using the estimated hedge ratios, it was shown that hedging risk could be reduced 20-50 percent compared to that achieved by using a hedge ratio of 1.0.

Key words: feeder cattle, traditional cross hedge, ratio cross hedge, hedge ratio, hedging risk, basis

Feeder cattle producers have a valuable tool which can allow them to shift price risk to speculators. The feeder cattle futures contract, traded on the Chicago Mercantile Exchange (CME) since 1971, can be used to hedge the purchase or sale of feeder cattle. For example, a cattle backgrounder can sell feeder cattle futures to "lock in" the price of feeder cattle that will be coming from pasture, wheat, etc.[1] Or, a cattle feeder can purchase feeder cattle futures to lock in a price for feeder cattle that will be placed in a feedlot.

Traditionally, feeder cattle have been hedged on a one-to-one basis. That is, one pound of futures is used to hedge one pound of cash cattle (CME 1986, pp. 13-15; Ikerd; Davis, *et al.*). A pound-to-pound hedge is appropriate for steers weighing 600-800 pounds because this is the weight range of steers used to compute the cash settlement index used to settle feeder cattle futures.[2] For heavier- or lighter-weight feeder cattle, a pound-to-pound hedge is not generally the risk minimizing hedge. The problem in hedging either heavier- or lighter-weight feeder cattle, hereafter referred to as off-weight cattle, is that no futures contract exists for these animals. Anderson and Danthine theorize that when dealing with a commodity for which no futures contract exists, a cross hedge may be appropriate. "To cross hedge is to assume a futures position opposite an existing cash position, but in a different commodity" (Leuthold, *et al.*, p. 146). For example, there is no futures market for 400-500 pound steers; however, there is a futures contract for 600-800 pound steers which can be used to cross hedge 400-500 pound steers.

Hedging off-weight feeder cattle presents a problem when the traditional approach to hedging is used. The cash prices of these off-weight steers and heifers move differently from futures prices because the off-weight steers and heifers are not the same animals as the 600-800 pound steers whose prices are reflected in the futures contract. This difference

[1] The term lock in has been put in quotes (at the first use) to indicate that it does not take on its literal meaning to exactly fix the price of a commodity. When one says that a hedge is used to lock in a price, this means that an *approximate* price is determined for the commodity. An exact price cannot be guaranteed by hedging because of basis variation. This is explained in detail in the second section of the paper.

[2] Beginning with the September 1986 contract, feeder cattle futures have been settled by cash settlement, rather than physical delivery of steers. The contract was changed to cash settlement to eliminate disputes associated with grading of feeder cattle for delivery, and to reduce basis risk which was noticeably large even for par grade and weight steers. Studies indicated that the change to cash settlement should reduce basis risk (Kilcollin; Elam; Schroeder and Mintert). According to Paul, the behavior of feeder cattle prices since the adoption of cash settlement (with the September 1986 contract) supports the conclusions of these studies. In cash selltement, all contracts remaining open at contract expiration are settled in cash based on the final settlement price, rather than by physical delivery of steers. The final settlement price is a weighted average of actual cash market prices for 600-800 pound steers that are expected to grade 60-80 percent Choice at slaughter. The final settlement price is known as the U.S. Feeder Steer Price (USFSP), and is calculated by the market information organization Cattle-Fax. The USFSP is derived using auction and direct sales prices from 27 states. The procedure used to calculate the USFSP is explained by the CME (1985).

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in the movement of the cash price for off-weight steers and heifers relative to the futures price brings about the need to estimate a hedge ratio as a means of equating changes in the value of the cash and futures positions. Regression analysis can be used to estimate the relationship between the price of feeder cattle of a particular weight and sex and the futures price. The estimated slope coefficient from the regression is commonly called the hedge ratio, and represents the pounds of futures required to hedge one pound of cash feeder cattle. For feeder cattle weighing less than 600 pounds, the hedge ratio is generally larger than 1.0, which indicates that more than one pound of futures is needed to hedge one pound of cash cattle. This will be explained further in the second section of the paper.

One reason for estimating a hedge ratio is to reduce hedging risk. Although hedging is commonly believed to be a means of reducing price risk, hedging does not literally lock in an exact price (Hieronymus, pp. 148-151). In actual practice, there is a certain amount of risk involved in hedging. This risk comes from the fact that the actual price received from a hedge (or net price) is seldom exactly equal to the locked-in price that was determined at the time the hedge was initiated (hereafter referred to as the target price). A statistical measure of hedging risk is the standard deviation of the difference between the actual net price and target price. The standard deviation is in dollars per hundredweight which provides a common-sense interpretation of the risk measure. It is shown that the standard deviation of the difference between the net and target prices is equal to the standard deviation of the difference between the actual basis and the expected basis. This relates the concept of hedging risk to basis variation. However, in the case where a hedge ratio is used, the basis relationship is slightly different and will be explained in the second section.

This paper compares hedging risk for feeder cattle hedged with a traditional (or pound-to-pound) cross hedge and a ratio cross hedge. Because hedging off-weight feeder cattle is by definition cross hedging, the term cross will be dropped and these hedges will be referred to respectively as a traditional hedge and a ratio hedge. In a traditional hedge, the producer assumes that the hedge ratio is 1.0, and does not examine the possibility that this may not be the best hedge. By contrast, the term ratio hedge is used to reflect the fact that a hedge ratio is estimated. The estimated hedge ratio is used to determine the pounds of futures required to hedge a particular sex and weight of animal. In the situation where the estimated hedge ratio is approximately 1.0, the risk from using a ratio hedge will be approximately equal to that from using a traditional hedge.

The outline of the paper is as follows. The second section develops a definition of hedging risk based on the variation of net about target prices. The third section uses prices from Amarillo, Texas, to estimate hedging risk for a traditional hedge and a cross hedge for feeder steers and heifers weighing 300-800 pounds in 100 pound intervals and feeder steers weighing 800-1000 pounds. The results show that for 600-800 pound steers hedging risk is approximately the same for a ratio hedge and a traditional hedge. But for lighter-weight feeder cattle, hedging risk is reduced 23-40 percent by using a hedge ratio. An *ex ante* simulation analysis performed over a five-year period shows that actual reductions in hedging risk of 28-55 percent were achieved by using a ratio hedge for light-weight feeder cattle. These results indicate that a traditional hedge, which is commonly used to hedge feeder cattle, is not the best hedge for light-weight feeder cattle. The last section summarizes the paper and restates the main conclusions.

HEDGING RISK

Hedging risk can be measured by calculating the variation of the actual net price from a hedge about the target price. This concept of hedging risk has been used in practical applications (Hieronymus, p. 208; CBT 1978) and academic studies of hedging (Miller; Elam *et al.* 1986). It is applicable for a traditional hedge as well as a ratio hedge. Based on this concept of hedging risk, equations are derived that measure hedging risk for a traditional hedge and a ratio hedge.

Traditional Hedge

A traditional hedge is one where the size of the futures position is the same as the size of the cash position. The hedge ratio for a traditional hedge is 1.0. Most textbook examples are traditional hedges. A typical example is a cattle feeder who plans to buy yearling steers weighing 700 pounds to be placed in a feedlot. This requires the purchase of one pound of feeder cattle futures for each pound of 700 pound yearling steers to be purchased.

The net price for a traditional hedge is:

$$(1) \quad N_t = C_t + (F_{t-j} - F_t),$$

where N_t is the net price for a hedge lifted at time t; C_t is the cash price at time t; F_{t-j} is the futures price at time t - j for the futures contract that matures

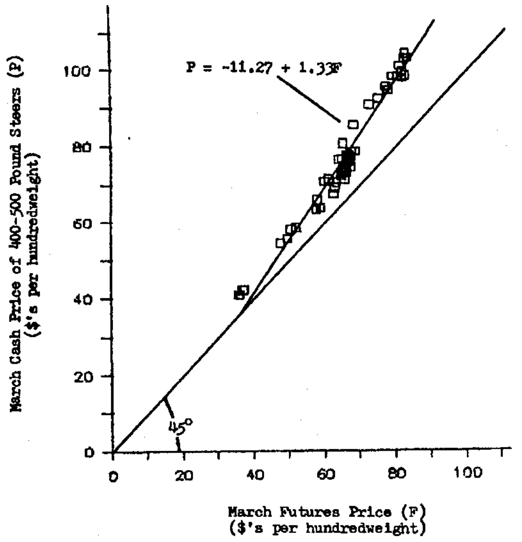

Figure 1. March Cash Price of 400-500 Pound Steers at Amarillo vs. March Feeder Cattle Futures Price, 1977-1988.

nearest to, but not before, time t; and F_t is the futures price at time t for the nearby futures contract.

The target price for a traditional hedge can be represented as:

(2) $T_{t-j} = B^* + F_{t-j}$,

where T_{t-j} is the target price for a hedge to be lifted at time t, and B^* is the basis (cash price-futures price) that is expected to exist at the time the hedge is lifted. The target price is determined at the time the hedge is placed. The target price represents the price the hedger expects to receive from hedging.

The difference between the net and target prices is:

(3) $N_t - T_{t-j} = B_t - B^*$,

where $B_t = C_t - F_t$ is the actual basis at the time the hedge is lifted. This shows that the difference between the net and target prices is equal to the difference between the actual basis and the unexpected basis.

Risk is involved in hedging because the net price is not generally equal to the target price. The standard deviation (s) of the difference between the net and target prices is a measure of hedging risk:

(4) $s(N_t - T_{t-j}) = s(B_t - B^*)$.

The greater the standard deviation of $(N_t - T_{t-j})$, the greater the amount of hedging risk. In the case of a perfect hedge, $B_t = B^*$; and therefore $s(N_t - T_{t-j}) = 0$. This is an unrealistic situation, however, because B_t is seldom equal to B^* (*i.e.*, the basis is not precisely predictable).

In practical applications, the expected basis is typically estimated using the average basis ($\overline{B}$) over a recent time period. The target price for a traditional hedge ist hen

(5) $T_{t-j} = \overline{B} + F_{t-j}$.

The standard deviation of the difference between the net price from eq. (1) and target price from eq. (5) is:

(6) $s(N_t - T_{t-j}) = s(B_t - \overline{B}) = s(B_t)$.

Eq. (6) represents hedging risk as the standard deviation of the basis, which relates hedging risk to the notion of basis variability. As basis variability increases, hedging risk increases and the standard deviation increases.

Ratio Hedge

A traditional hedge is appropriate for feeder steers weighing 600-800 pounds because the estimated hedge ratio is approximately equal to 1.0. But oftentimes a feeder cattle producer or cattle feeder may wish to hedge feeder cattle other than 600-800 pound steers. In this case, a ratio hedge should be used because the prices of feeder cattle of different weight ranges and sex do not move in the same dollar amounts as the price of feeder cattle futures (which reflect the price of 600-800 pound steers). For example, the relationship between the price of 400-500 pound steers at Amarillo during March and the price of March feeder cattle futures at the same time is shown in Figure 1. This relationship is developed from weekly cash and futures prices for each of the weeks in March that the feeder cattle futures contract traded. (The data are discussed at length at the beginning of the next section of the paper.) The slope of the regression line fitted to the two series of prices for the years 1977-1988 is 1.33. This slope indicates that each \$1 change in the price of feeder cattle futures is associated on average with a \$1.33 change in the price of 400-500 pound steers.

If a cattle producer hedges 1 pound of expected production of 400-500 pound steers with 1 pound of feeder cattle futures, he will be partially hedged because of the difference in the variability of 400-500 pound steer prices and futures prices. According to the regression relationship in Figure 1, the change in the cash price of 400-500 pound steers is 1.33

times as great as the change in the futures price. If 1 pound of futures is used to hedge 1 pound of cash 400-500 pound steers, the change in the value of the cash position will be 1.33 times as great as the change in the value of the futures position. Ideally, when hedging, the value of the futures position should change dollar for dollar with the value of the cash position. To make the changes in the values of the cash and futures positions equal when hedging 400-500 pound March steers, a futures position of 1.33 pounds is required for each 1.0 pound of the cash position. The 1.33 is the estimated hedge ratio.

The hedge ratio is determined from a regression of cash (C) on nearby futures (F) prices:[3]

$$(7) \quad C_t = a + bF_{t-j} + e_t,$$

where "a" and "b" are estimated intercept and slope coefficients, and e_t is the estimated random error term. The estimated slope coefficient from the regression is the hedge ratio, which is the number of pounds of futures required to hedge one pound of cash feeder cattle. For example, if a cow-calf producer plans to market calves weighing 400-500 pounds in March, a ratio hedge will require the sale of 1.33 pounds of futures for each 1.0 pound of expected production. This means that the sale of one 44,000 pound feeder cattle futures contract will hedge approximately 74 head of 400-500 pound March steers (44,000/(450x1.33)).

As in traditional hedging, risk in ratio hedging is based on variability of the net price about the target price. However, the definitions of net and target prices are slightly different. The net price for a ratio hedge is represented by the equation:

$$(8) \quad N_t = C_t + b(F_{t-j} - F_t).$$

which is different from that of a traditional hedge (eq. (1) where b = 1) in that the change in the futures price is multiplied by the hedge ratio. The target price for a ratio hedge is represented by the equation:

$$(9) \quad T_{t-j} = a + bF_{t-j},$$

which is different from that of a traditional hedge (eq. (2)) in that "a" represents the *average* generalized basis (discussed below) rather than the basis, and the futures price is multiplied by the hedge ratio.

The difference between the net and target prices for a ratio hedge is

$$(10) \quad N_t - T_{t-j} = (C_t - bF_t) - a.$$

The term in parentheses on the right hand side is the generalized basis for time period t, $G_t = C_t - bF_t$. The generalized basis is the cash price minus "b" multiplied by the futures price, and this is not the same as the basis which is commonly defined as the difference between the cash price and the futures price.[4] The a-value in eq. (10) is the *average* generalized basis (Gbar) which is derived from eq. (7) by averaging over the data sample to obtain:

$$(11) \quad a = \overline{G} = \overline{C} - b\overline{F},$$

where $\overline{C}$ and $\overline{F}$ are the average cash and nearby futures prices, respectively. In deriving eq. (11), note that the average of the error terms from eq. (7) is equal to zero based on least squares regression analysis (*i.e.*, $\overline{e} = 0$).

Using eq. (11) and the fact that $G_t = C_t - bF_t$, eq. (10) can be rewritten as

$$(12) \quad N_t - T_{t-j} = G_t - \overline{G},$$

which expresses the difference between net and target prices as the difference between the generalized basis and the average generalized basis. Eq. (12) uses the generalized basis (rather than the basis as in the case of a traditional hedge) because a ratio hedge has a ratio not equal to 1.0.

As in traditional hedging, the difference between the net price and the target price represents the uncertainty involved in a ratio hedge. The standard deviation (s) of this difference is a measure of ratio hedging risk:

$$(13) \quad s(N_t - T_{t-j}) = s(G_t - \overline{G}) = s(G_t).$$

Eq. (13) differs from the comparable equation for a traditional hedge, eq. (6), in how basis is defined. In traditional hedging, $B_t = C_t - F_t$, whereas in ratio hedging $G_t = C_t - bF_t$.

There are two approaches used to calculate hedging risk for a ratio hedge. The first approach is to calculate the generalized basis for a period of years. The standard deviation of the generalized basis from eq. (13) provides a measure of hedging risk. A

[3] Typically when hedging livestock, the hedge is placed in the contract that will be nearby when the hedge is lifted. This is because the correlation is higher between the cash price and the nearby futures price than between the cash price and the futures price for some other contract. The higher correlation means lower hedging risk.

[4] The basis in ratio hedging is referred to as the generalized basis because it is applicable for any hedge ratio, rather than the particular situation where b = 1.0 (Anderson and Danthine).

second, and easier, approach to calculating risk for a ratio hedge is to estimate a regression of cash on nearby futures prices such as eq. (7). Note that the difference between the net and target prices from eq. (10) is equal to

$$(14)\quad N_t - T_{t-j} = e_t ,$$

where e_t is the error term from the regression of cash on nearby futures prices (eq. (7)). The standard deviation of the regression error terms from eq. (7) provides a measure of hedging risk. In previous studies, researchers have estimated separate regressions for each season to account for seasonality in the relationship between cash and futures prices (Elam; Schroeder and Mintert).[5] The standard deviation of the regression residuals from, say, the March regression will provide a measure of risk for hedges lifted in March. The one figure for hedging risk for March applies to hedges placed at any time (e.g., in January or in March of the previous year).

HEDGING RISK WITH A RATIO HEDGE COMPARED TO A TRADITIONAL HEDGE

Hedging risk was estimated for a traditional hedge and ratio hedge for various weight feeder cattle by calculating the standard deviation of the difference between net and target prices (which for a traditional hedge is the same as calculating the standard deviation of the basis from eq. (6)). The traditional hedge uses a hedge ratio of $b = 1.0$, whereas a ratio hedge uses an estimated hedge ratio which can be different from one. The purpose in estimating a hedge ratio is to reduce hedging risk. Anderson and Danthine develop a general approach to the hedging problem using utility maximization. Their results show that minimizing risk is a special case of utility maximization. Moreover, they show that the use of a hedge ratio calculated from a regression of cash on futures prices (eq. (7)) minimizes hedging risk.[6]

Weekly prices from the Amarillo Livestock Auction were used for cash prices. The Amarillo Livestock Auction trades one day each week (usually Monday or Tuesday). Prices are reported by grade, weight, and sex. The bulk of feeder cattle that trade at Amarillo are Medium Frame No. 1 steers and heifers. The reported weights are in 100 pound intervals from 300-800 pounds for steers and heifers, and in a 200 pound interval for 800-1000 pound steers. Auction prices were obtained for Medium Frame No. 1 steers and heifers for the years 1977-1988 from the CME, which collects the prices from LS-214 forms available from the Agricultural Marketing Service, USDA.

Cash settlement futures prices were collected from the *Wall Street Journal*. The prices were taken for the same day(s) as the Amarillo market traded. Before 1987, the USFSP (see footnote 1) was used as a proxy for cash settlement futures prices. This has been done in other studies where a historical series of feeder cattle futures prices was used (Elam; Schroeder and Mintert). The justification for this is the fact that the cash settlement futures price will approximately equal the USFSP when a contract expires. Also, by using the USFSP to proxy futures prices before 1987, the results are applicable to the current situation where cash settled feeder cattle futures are traded. USFSP's were obtained from the CME and Cattle-Fax.

Hedging risk was estimated for March hedges using Amarillo prices, but the conclusions should hold for other months and other markets. The rationale for a ratio hedge reducing hedging risk stems from the fact that price variability for light-weight cattle is greater than that of futures (or 600-800 pound cattle). This means that the hedge ratio should be greater than 1.0 for light-weight cattle, and thus more than one pound of futures is needed to hedge one pound of cash cattle. The larger futures position is needed to make changes in the value of the less variable futures position equal to that of the more variable cash position. By equating these values, hedging risk is reduced. The above discussion directly relates reductions in hedging risk to the size of the hedge ratio. Because the range in the hedge ratios found in this study for March cattle at Amarillo are typical of those reported for other markets and other months (Elam; Schroeder and Mintert), the conclusions in this paper should be more general than the data set.

The hedge ratios for March hedges for various weight steers and heifers are shown in Table 1. The hedge ratios for 600-700 and 700-800 pound steers are approximately equal to one. This was expected because the cash-settled futures contract reflects the price of 600-800 pound steers. Hedge ratios are

[5]Tests for seasonal differences in hedge ratios and hedging risk were not reported in the articles by Elam and by Schroeder and Mintert. However, the empirical results reported in both articles show marked differences in hedge ratios and hedging risk across seasons.

[6]Ederington uses the criterion of risk minimization to determine the hedge ratio. His approach differs from the one used in this paper in that the hedge ratio is determined from a regression using *changes* in cash and futures prices as regression variables, rather than *levels* of cash and futures prices.

Table 1. Estimated Hedge Ratios for a March Hedge for Amarillo Feeder Cattle, 1977-1988.

Weight (lbs.)	Steers	Heifers
300-400	1.53 (0.06)[a]	1.36 (0.05)
400-500	1.33 (0.04)	1.18 (0.03)
500-600	1.14 (0.02)	1.03 (0.02)
600-700	1.05 (0.02)	0.96 (0.02)
700-800	1.00 (0.02)	0.91 (0.04)
800-1000	0.89 (0.04)	—

Note: The hedge ratio is the b-value from eq. (7) in the text. The hedge ratios were estimated using data for the years 1977-88.

[a]Numbers in parentheses are standard errors of the hedge ratios.

Table 2. Comparison of Hedging Risk for a March Ratio Hedge and a March Traditional Hedge, 1977-1988.

Sex and Weight (lbs.)	Ratio Hedge	Traditional Hedge	Change in Hedging Risk with Ratio Hedge Compared to Traditional Hedge	
	----Dollars per 100 Lbs----			Percent
Steers:				
300-400	4.83	8.11	-3.28	-40.4
400-500	3.04	5.02	-1.98	-39.4
500-600	1.63	2.34	-0.71	-30.3
600-700	1.31	1.41	-0.10	-7.1
700-800	1.35	1.35	0.00	0.0
800-1000	1.60	1.77	-0.17	-9.6
Heifers:				
300-400	4.02	6.01	-1.99	-33.1
400-500	2.66	3.47	-0.81	-23.3
500-600	1.68	1.72	-0.04	-2.3
600-700	1.32	1.42	-0.10	-7.1
700-800	1.51	1.63	-0.12	-7.4

Note: Hedging risk in columns 2 and 3 is measured by the standard deviation of the net price about the target price (derived from eqs. (6) and (14) in the text). Standard deviations were calculated using data for the years 1977-1988.

larger than 1.0 for lighter-weight feeder cattle and smaller than 1.0 for heavier-weight feeder cattle. This reflects the fact that light-weight feeder cattle prices are more variable than futures prices and heavy-weight feeder cattle prices are less variable.

Hedge ratios are smaller for heifers than for steers, for a given weight category (Table 1). However, note that the ratio for a 500-600 pound heifer is approximately the same as that for a 600-700 pound steer. A 500-600 pound heifer is comparable in its growth pattern to a 600-700 pound steer because the finished weight for a heifer is typically 100 pounds less than that of a steer. The relationship between hedge ratios for heifers weighing 100 pounds less than steers holds for all the weight categories reported in Table 1.

Hedging risk was calculated for a ratio hedge and a traditional hedge using the standard deviation of net about target prices as the measure of hedging risk (Table 2). The standard deviation was chosen over the variance because it is in dollars per hundredweight (compared to dollars per hundredweight squared for the variance). The larger the standard deviation, the more risk involved in a hedge. Assuming the distribution of net minus target prices is normal, the standard deviation represents the maximum amount the net price will deviate from the target price 67 percent of the time.

The results in Table 2 show that hedging risk as measured by the standard deviation is lower (or at least as low) with a ratio hedge for all weight categories of steers and heifers. The difference in hedging risk varies, depending on the weight of the cattle being hedged. For steers weighing 700-800 pounds, hedging risk is the same for a ratio hedge and a traditional hedge because the estimated hedge ratio is 1.0. For steers weighing 600-700 pounds, the estimated hedge ratio (1.05) is close to 1.0 and therefore hedging risk is approximately the same for a ratio hedge and a traditional hedge. But, as the weights of steers deviate from 600-800 pounds, hedging risk decreases for a ratio hedge compared to a traditional hedge. For 300-400 pound steers, the standard deviation of net about target prices is \$3.28 per hundredweight (or 40.4 percent) less for a ratio hedge compared to a traditional hedge.

Hedging risk as measured by the standard deviation is lower for all weight categories of heifers with a ratio hedge compared to a traditional hedge (Table 2). The largest difference in hedging risk is \$1.99 per hundredweight for 300-400 pound heifers, which is a 33.1 percent reduction in hedging risk compared to a traditional hedge. The differences in hedging risk are small for heifers weighing more than 500 pounds. The smallest difference in hedging risk is \$0.04 per hundredweight, or 2.3 percent, for 500-600 pound heifers. The small difference is due to the fact that the estimated hedge ratio for 500-600 pound heifers (1.03) is close to the hedge ratio of 1.0 for a traditional hedge.

The figures in Table 2 are estimates of the expected reductions in hedging risk that can be achieved by using an estimated hedge ratio compared to using b

= 1. These estimates were developed using data for the years 1977-1988, and apply to hedges that were to be lifted in March 1989. But the question a practical hedger will ask is whether the estimated reductions can in fact be achieved in practice. To answer this question, we performed an *ex ante* simulation which involved placing and lifting hedges over the five-year period 1985-1989. The simulation was conducted as follows. First, eq. (7) was estimated for a particular sex and weight category (say, 300-400 pound steers) using data for the period 1977-1984. The estimates of "a" and "b" were used to develop the target price for a hedge to be lifted in March 1985. Is was assumed that the hedge was placed at some date before March 1985. The exact date does not need to be specified because hedging risk does not depend on cash or futures prices at the time a hedge is placed (see discussion following eq. (14)). A net price was calculated for the hedge using eq. (8). The difference between the net and target prices was calculated.

The procedure explained above was carried out for each of the years from 1985 to 1989. It was assumed that a hedge was lifted each week during March that the March feeder cattle futures contract traded. Typically, the March futures traded four weeks during March, and thus there were four hedge for each March. The target prices and net prices for these hedges were developed from estimates for "a" and "b" from eq. (7) based on data that were available at the time the hedging decision was being made. This guarantees that the results are truly *ex ante*, and in fact could have been achieved in actual practice. The standard deviations of net minus target prices for these hedges are reported in column 2 of Table 3. For each sex and weight category, 20 observations (*i.e.*, five years times four weekly observations for each March) were used to calculate the standard deviations (except when a cash price was not reported).

A similar procedure was used to calculate hedging risk for a traditional hedge (b = 1.0). Target prices were calculated from eq. (5), with the average basis, $\bar{B}$, being estimated from available historical data. For example, for hedges to be lifted in March 1985, $\bar{B}$ was calculated using basis figures for the years 1977-1984. A new price was calculated using eq. (1). The difference between net and target prices was calculated for hedges lifted each week of March for the five years, 1985-1989. The standard deviation of the difference between net and target prices was calculated using eq. (6). This procedure was followed for each weight category of steers and heifers. The standard deviations of net minus target prices are reported in column 3 of Table 3.

Table 3. *Ex Ante* Comparisons of Hedging Risk for a March Ratio Hedge and a March Traditional Hedge, 1985-89.

Sex and Weight (lbs.)	Ratio Hedge	Traditional Hedge	Change in Hedging Risk with Ratio Hedge Compared to Traditional Hedge	
	—Dollars per 100 Lbs. —			Percent
Steers:				
300-400	3.25	7.19	-3.94	-54.8
400-500	3.65	5.83	-2.18	-37.4
500-600	1.69	2.34	-0.65	-27.8
600-700	1.25	1.28	-0.03	-2.3
700-800	1.09	1.10	-0.01	-0.9
800-1000	1.50	1.51	-0.01	-0.7
Heifers:				
300-400	2.29	4.62	-2.33	-50.4
400-500	2.44	3.61	-1.17	-32.4
500-600	1.32	1.46	-0.14	-9.6
600-700	1.18	1.18	0.00	0.0
700-800	1.25	1.33	-0.08	-6.0

Note: The measure of hedging risk reported in columns 2 and 3 is the standard deviation of the net price about the target price (derived from eqs. (6) and (14) in the text).

The results from the *ex ante* simulation of hedging risk are shown in Table 3. First, note that actual hedging risk is lower (or at least as low) for a ratio hedge for all weight categories of steers and heifers. The reductions in hedging risk reported in Table 3 are those that could have been achieved in actual practice. Second, note that the actual percentage reductions in hedging risk in Table 3 are similar to the estimated reductions reported in Table 2. This shows that the procedure used to estimate hedging risk (explained in the second section of the paper) is valid. The only noticeable difference in the percentage reductions in hedging risk is for the 300-400 pound category of both steers and heifers, where the actual reductions in hedging risk are 15-17 percentage points greater than the expected reductions (Table 2).

SUMMARY AND CONCLUSIONS

Traditionally, feeder cattle have been hedged on a one-to-one basis (that is, one pound of futures is purchased or sold to hedge one pound of cash cattle). A traditional hedge is appropriate for feeder cattle weighing 600-800 pounds, but should not be used to hedge light-weight feeder cattle because the prices of light-weight cattle are more variable than the futures price (which reflects the price of 600-800 pound steers). To compensate for the greater price variability, light-weight feeder cattle should be hedged by buying or selling more than one pound of futures for each pound of cash cattle.

The exact size of the futures position can be estimated from a regression of cash on nearby futures prices. The estimated slope coefficient from this regression is referred to as the hedge ratio. The estimated hedge ratios for 600-800 pound steers and 500-700 pound heifers are approximately 1.0. Thus, a traditional hedge is appropriate for these weight feeder cattle. For lighter-weight feeder cattle, the estimated hedge ratios are larger than 1.0 (ranging from 1.14 to 1.53), and for heavier-weight feeder cattle, the hedge ratios are slightly less than 1.0.

Estimates were made of the reduction in hedging risk that could be achieved by using a ratio hedge (with an estimated hedge ratio) compared to a traditional hedge (with a hedge ratio of 1.0). For steers weighing more than 600 pounds and heifers weighing more than 500 pounds, hedging risk was only slightly less for a ratio hedge. This indicates that a traditional hedge can be used for steers over 600 pounds and heifers over 500 pounds. By contrast, for steers weighing 300-600 pounds and heifers weighing 300-500 pounds, hedging risk was estimated to be 23-40 percent less with a ratio hedge.

A simulation analysis was performed to determine whether the estimated reductions in hedging risk could be achieved in practice. The simulation was performed on an *ex ante* basis using only data that were available at the time a hedging decision was made. The simulation results showed reductions in hedging risk that were equal to, or slightly greater than, the estimated reductions.

The results for light-weight feeder cattle clearly demonstrate the value of using a ratio hedge when the estimated hedge ratio is different from the traditional hedge ratio of 1.0. However, publications that explain hedging typically assume that a pound-for-pound hedge will be used, regardless of the weight of the cattle. Extension and commodity exchange publications are needed to explain how to estimate a hedge ratio and how to use the estimated hedge ratio to reduce hedging risk.

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