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RISK RATIOS AND HEDGING: FLORIDA FEEDER CATTLE

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Hedging livestock historically has been practiced mainly by midwestern and Great Plains producers because they are the dominant force within the U.S. cattle industry. Likewise, futures contract definitions and delivery points have been tailored to the needs of these producers. Recent growth in the feeder cattle industry in the Southeast, and particularly in Florida, suggests that greater hedging use may be applicable to southeastern producers. Interest in expanding the usefulness of the feeder cattle contracts to these growth regions is indicated by the recently established delivery point in Montgomery [2].

The Florida feeder cattle industry differs from that of the Midwest in that Florida cattle generally are marketed at lighter weights and a larger portion grade less than Choice. The environment and type of pasture also distinguish Florida feeder cattle production from that of the Midwest [1]. Though still small in relation to the western producers, Florida's feeder industry has grown rapidly in the past decade [5,8]. Comparing the mean price for Choice steers from Florida with the prices at the three major feeder markets (i.e., Amarillo, Omaha, Oklahoma) indicates that Florida's feeders are usually discounted approximately 10 to 12 percent. Obviously, part of this differential reflects the added cost that must be incurred to transport Florida cattle to midwestern feedlots.

Price variability is a major indicator of the risk level producers face and, as such, gives a good indication of the need for alternative pricing mechanisms such as hedging. The relative variation in Florida's selling price for Choice steers of deliverable weight against the futures contract has exceeded that of midwestern markets by approximately 13 percent. Furthermore, price variability for lighter weight steers substantially exceeds the variability for the heavier weight steers. This increase in price variability rises in a direct linear relationship with a decrease in the weight of the Florida steers marketed. These statistics suggest that hedging may be an alternative in addressing the price risk problem evident in the Florida feeder cattle market. However, trading in a contract somewhat removed from the economic conditions of the regional market may add a new element of risk which, in turn, is ultimately determined by the price performance of the local markets in relation to the futures.

The price risk associated with hedging can generally be examined in terms of two broad aspects. First, the prices in the local markets must be associated sufficiently with the futures markets to allow effective hedging. Much of this association depends on whether local prices reflect regional and local supplies or the current national market conditions for feeders. Second, contract specifications in contrast to overall weight and grade characteristics of regional supplies may reduce the delivery option for many Florida producers. Though deliveries are generally low for most futures markets, the option is usually considered essential to the trading mechanism, especially for the less liquid markets. A dilemma arises in weighing the respecification of a contract to meet regional needs against the almost assured reduction in market liquidity. It is for this primary reason that the usefulness of the currently defined feeder contract to the Florida feeder cattle producer is analyzed.

The following discussion is limited to the first aspect of price risk—i.e., can the current contracts be used to reduce price risk in comparison with trading only in the cash markets? If not, there is little use in pursuing the second issue of delivery problems. The discussion is limited in that deliveries are not considered. Also, the tradeoffs between risk and expected income [7] are not addressed. The following sections include the traditional approach to measuring price risk and an application of the risk model to the Florida feeder cattle industry. Only short hedgers are considered because primary interest is with the producers and not feeder cattle buyers.

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RISK MEASUREMENT

Producer's income for cash and futures trading is easily expressed mathematically as [4,7]:

$$(1)\quad \pi = x\{ (P_{t+k} - P_t) + h(F_t - F_{t+k}) - CP - hCF\},$$

where x = supplies of feeder cattle, P_t = cash price of feeder calves during the initial positions in period t, P_{t+k} = price of feeder cattle when sold k periods later, F_t = current futures price, F_{t+k} = futures price k periods later, CP = cash transformation cost, CF = futures transaction cost, and h = percent of x that is hedged. Both costs are assumed fixed per unit over the k periods. The supply of cattle can be expressed in numbers of head or in pounds of marketable feeder cattle. If it is expressed in pounds, the calf price P_t would have to be adjusted to reflect the units of x, whereas on a per head basis this adjustment is not necessary. Subsequent models show that the unit measurement of x is not critical to the risk analysis. Likewise, equation 1 could be expressed in terms of the traditional concepts of basis. An initial basis, however, has little meaning for the nonstorable good because of the difference between the units reflected by P_t versus P_{t+k}. Also, leaving the model expressed in terms of both cash and futures prices facilitates interpretion of the price risk resulting from differences in both the spot and futures markets. Subsequent calculations show the merits of expressing income as in equation 1.[1] The variability of income follows as a function of the distribution properties of both cash and futures prices. If the initial prices are assumed known in period t, the problem further simplifies to knowing the distributional properties for the closing prices in period t+k as shown in equation 2.

$$(2)\quad \sigma_\pi^2 = x^2(\sigma_P^2 + h^2\sigma_F^2 - 2h\varrho\sigma_P\sigma_F)$$

letting σ_P^2 = variance of P_{t+k}, σ_F^2 = variance of F_{t+k}, and ϱ = correlation between P_{t+k} and F_{t+k}. These variance are not assumed conditional on the initial prices. However, that assumption is explored in the empirical analyses.

When h = 0, $\sigma_\pi^2 = x^2\sigma_P^2$, giving the income variance in the absence of hedging. When $0 < h \leqslant 1.0$ the relative reductions (or increases) in risk in contrast to when h = 0 become the initial indicator of the usefulness of futures and can be easily expressed as a risk ratio (i.e., RR $= \sigma^2_{\pi(h>0)}/\sigma^2_{\pi(h=0)}$). Defining λ as the relative variation between the cash and futures markets ($\lambda = \sigma_F/\sigma_P$), the risk ratio follows where

$$(3)\quad RR = 1 + h\lambda(h\lambda - 2\varrho).$$

Given a fixed level of hedging h, the degree of risk in relation to no hedging depends on both the relative price variations (λ) and price association (ϱ). Both of these statistics can change with the price series studied and, in particular, may lead to different conclusions when grades and weights of steers, location of markets, hedging time, etc. are analyzed. Given that RR $\gtreqless$ 1.0 depending on h, λ, and ϱ and that λ and ϱ are fixed for a set of market characteristics, the important question is how the risk ratio changes with the level of hedging.

From equation 3 it always follows that hedging will reduce the income risk (RR < 1.0) as long as $h < 2(\varrho/\lambda)$.[2] Because hedging cannot exceed 100 percent, it also follows that any level of hedging will be effective if $\varrho > .5\lambda$. Hence the association between the two markets becomes an especially important factor in evaluating the hedging effectiveness.

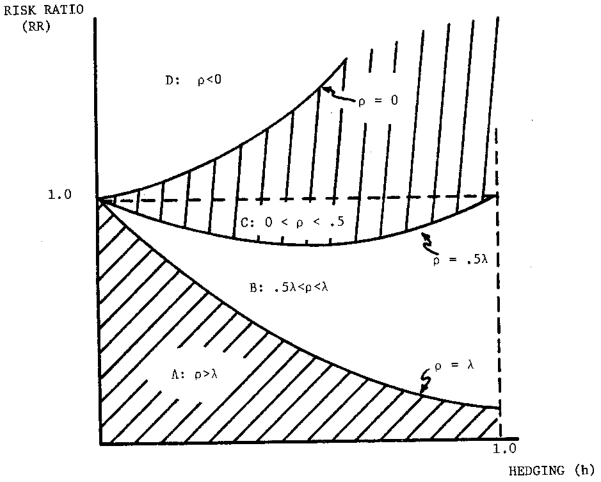
The relative risk changes with increases in hedging are calculated in equation 4.

$$(4)\quad \frac{\partial RR}{\partial h} = 2\lambda(h\lambda - \varrho) \gtreqless 0 \text{ and } \frac{\partial^2 RR}{\partial h^2} = 2\lambda^2 > 0$$

As long as the hedging level is increased up to the point where $h < (\varrho/\lambda)$, the relative risk will continue to decline with hedging. The minimum risk occurs at the point where $h = \varrho/\lambda$, assuming $\varrho > 0$. Finally, the marginal gains from risk reduction must always decline in this model because $\partial^2 RR/\partial h^2 > 0$.

The relationships between the relative risk and levels of hedging are illustrated in Figure 1. Note that the minimum risk hedge may not

FIGURE 1. RISK RATIOS OVER HEDGING LEVELS



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[1] Though risk is best expressed as in equation 1, knowledge of the closing basis is essential to development of hedging programs. A basis model has been devised by the authors but is beyond the scope of this article.

[2] In the discussion, ϱ and λ are used primarily because they are independent of scale and can be easily interpreted. Note that $(\varrho/\lambda) = \sigma_{PF}/\sigma_F^2$ and, hence, the discussion could also be presented with reference to σ_{PF} and σ_F^2.

always be at the 100 percent level and hedging could, in fact, lead to added risk at the maximum level of h. Such a situation could arise when the price association between the two markets is weak in relation to their price variation (see area C in Figure 1). If the local markets are so far removed from those conditions influencing the futures market that $\varrho < 0$, hedging obviously adds to the price risk as shown by area D. When the risk ratios for different sets of marketing characteristics giving different ϱ and λ's are compared, it is entirely possible that RR in area B exceeds RR in area A for the different values of ϱ and λ.

The relationship in Figure 1 and the underlying values for ϱ and λ are used in the next section to determine exactly where Florida's feeder cattle industry lies with respect to reducing RR. Both ϱ and λ change as various grades, weights, time periods, and initial price levels are analyzed. The four designated areas in Figure 1 provide a useful reference for the subsequent discussion.

POTENTIAL HEDGING EFFECTIVENESS

The potential effectiveness of using the feeder cattle futures contract to hedge is first determined by relating ϱ and λ for different feeder cattle weights and grades. Table 1 shows that the association between Florida's feeder cattle prices and the nearby closing futures prices is sufficient to ensure that hedging reduces the price risk in relation to no hedging. All hedging levels will lie within either area A or area B of Figure 1.

The A values in Table 1 further show that for many of the characteristics, the minimum risk occurs when complete hedging takes place. The heavier Choice steers are in area B which indicates that the minimum risk level will be at some point less than 100 percent hedging. These RR relationships hold in general over the feeder cattle marketing year as shown by the time periods in Table 1.

TABLE 1. POTENTIAL FOR HEDGING EFFECTIVENESS OF FLORIDA FEEDER CATTLE (SEE FIGURE 1)

	Selling weights (lbs)			
	300 - 400	400 - 500	500 - 600	600 - 700
STEERS				
(A) CHOICE	A[a]	A	A	B
(B) GOOD	A	A	B	B
HEIFERS				
(A) CHOICE	A	A	A	-
(B) GOOD	A	A	B	-
TIME PERIODS[b]				
JAN - MAR	A	A	B	B
APR - JUN	A	A	A	B
JUL - OCT	A	A	B	B
NOV - DEC	A	A	A	B

[a] The letters correspond to positions in Figure 1 and relate to the changes in the risk ratio as hedging increases. Both ϱ and λ where calculated from weekly price data from Jan. 1972 to June 1978. The cash prices were recorded as the closing average for the week and the futures prices were for the Monday closing [2,3].

[b] Calculated for Choice steers only.

RISK RATIOS

Though Table 1 establishes that Florida feeder cattle producers can expect hedging to reduce their price risk, it does not show the absolute risk ratios. These ratios may differ by location, weights, grades, sex, and time.

Figure 2a includes the risk ratios for Florida and Omaha Choice steers of 600-700 pounds. Florida's absolute risk level is higher than that of the midwestern markets. However, the patterns of risk reduction are nearly identical for both markets. For example, if $h = .5$, Omaha's risk ratio declines to .27 and Florida's to .31. Risk is reduced by more than 90 percent with the maximum hedge and the minimum risk level in both markets occurs when hedging is near the 80 percent level. Comparison of Florida's risk ratio with that of Amarillo, Oklahoma, and Montgomery further establishes that there is little difference in the capability to reduce risk in relation to the base risk when $h = 0$ for each location.

Variations in feeder cattle weights lead to considerable difference in the patterns of risk reduction for Florida producers as illustrated in Figure 2b. The spread between the lighter and heavier feeders indicates that futures trading is a less effective tool in marketing the lighter weight steers. If $h = .50$, risk is reduced by 70 percent for the deliverable weights but by approximately 44 percent for the lighter weights. The reduction in hedging effectiveness is especially important because the absolute price risk tends to be nearly 50 percent greater for the lighter weights than for those weights deliverable against the futures contract. Hedging is obviously complicated by the fact that these lighter weights are not deliverable against the futures contract.

The futures contract calls for Choice grade steers, yet nearly 58 percent of Florida's feeders are sold as Good. Data for the deliverable weights (600-700 lbs) show that the risk ratio could be reduced by hedging both grades. Hedging is shown to be slightly more effective for the Choice steers as is evident in Figure 2c, but the grade effect on the risk ratio is negligible for the lighter weights. Even though Choice steers sell for a higher price, there is only a small difference in the price variability between Choice and Good feeders. The absolute risk levels for both grade feeders should

FIGURE 2A. RISK RATIOS FOR FLORIDA AND OMAHA CHOICE FEEDER STEERS

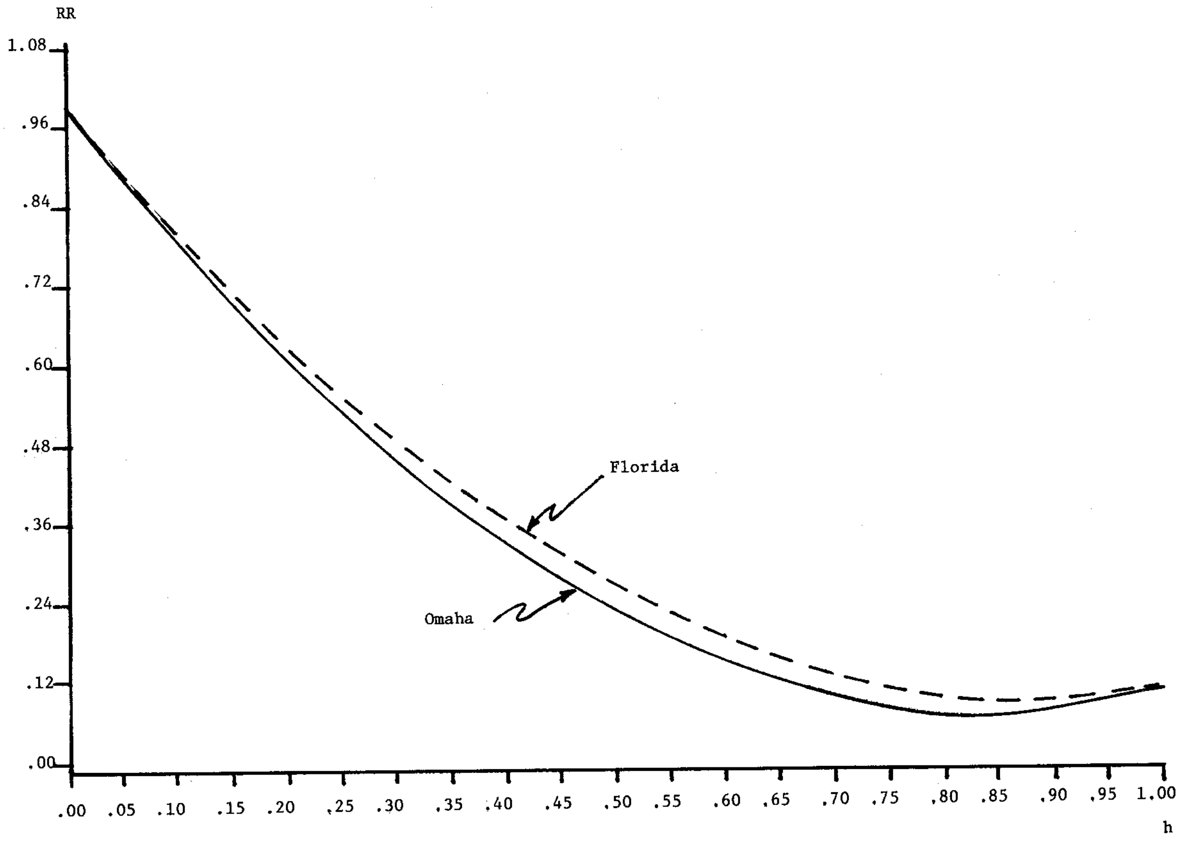


FIGURE 2B. RISK RATIOS FOR FLORIDA AND OMAHA CHOICE FEEDER STEERS BY WEIGHT

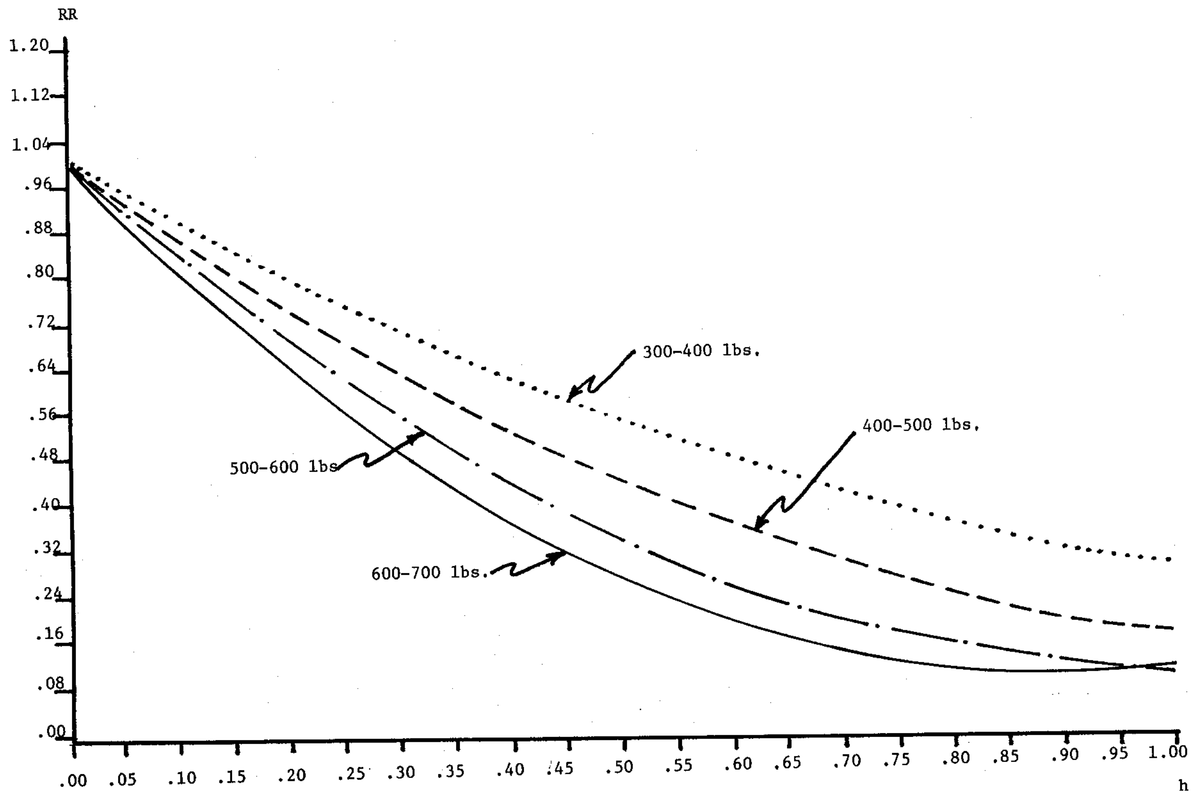


FIGURE 2C. RISK RATIOS FOR FLORIDA AND OMAHA FEEDER STEERS BY GRADE

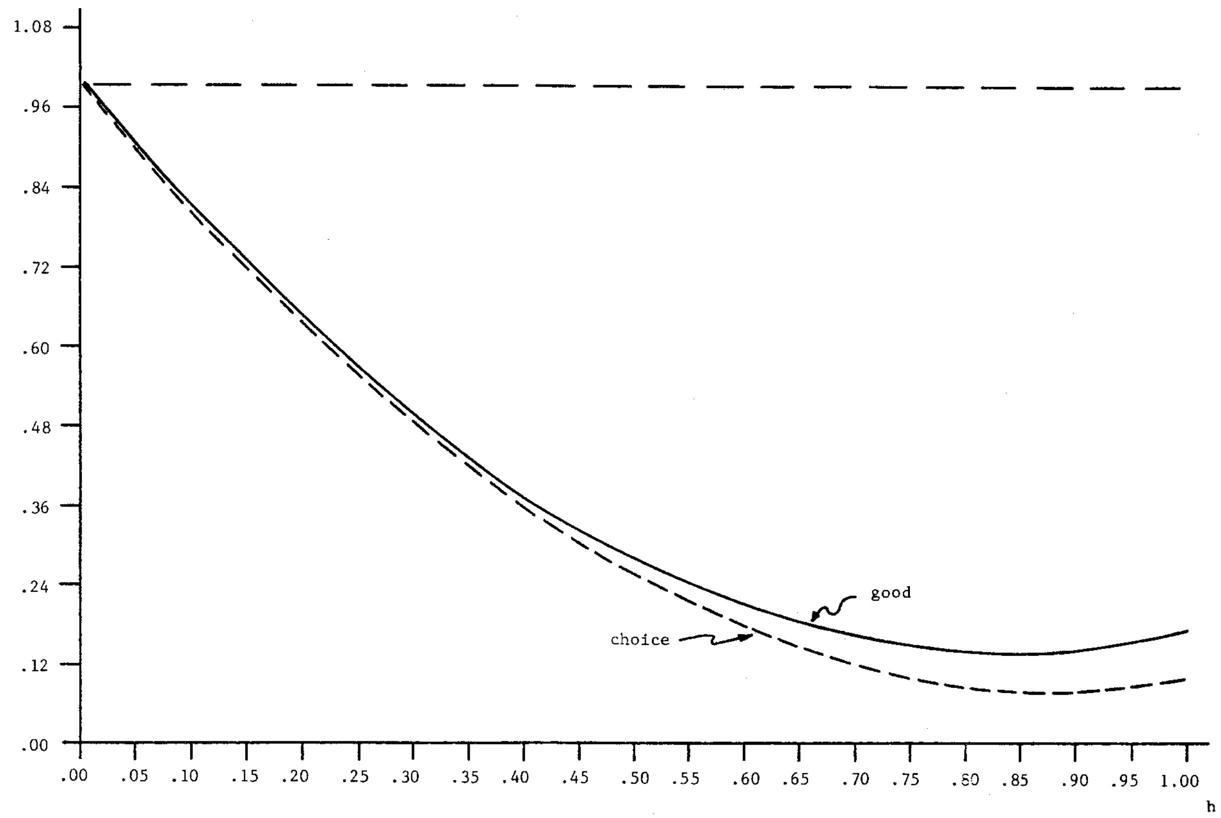
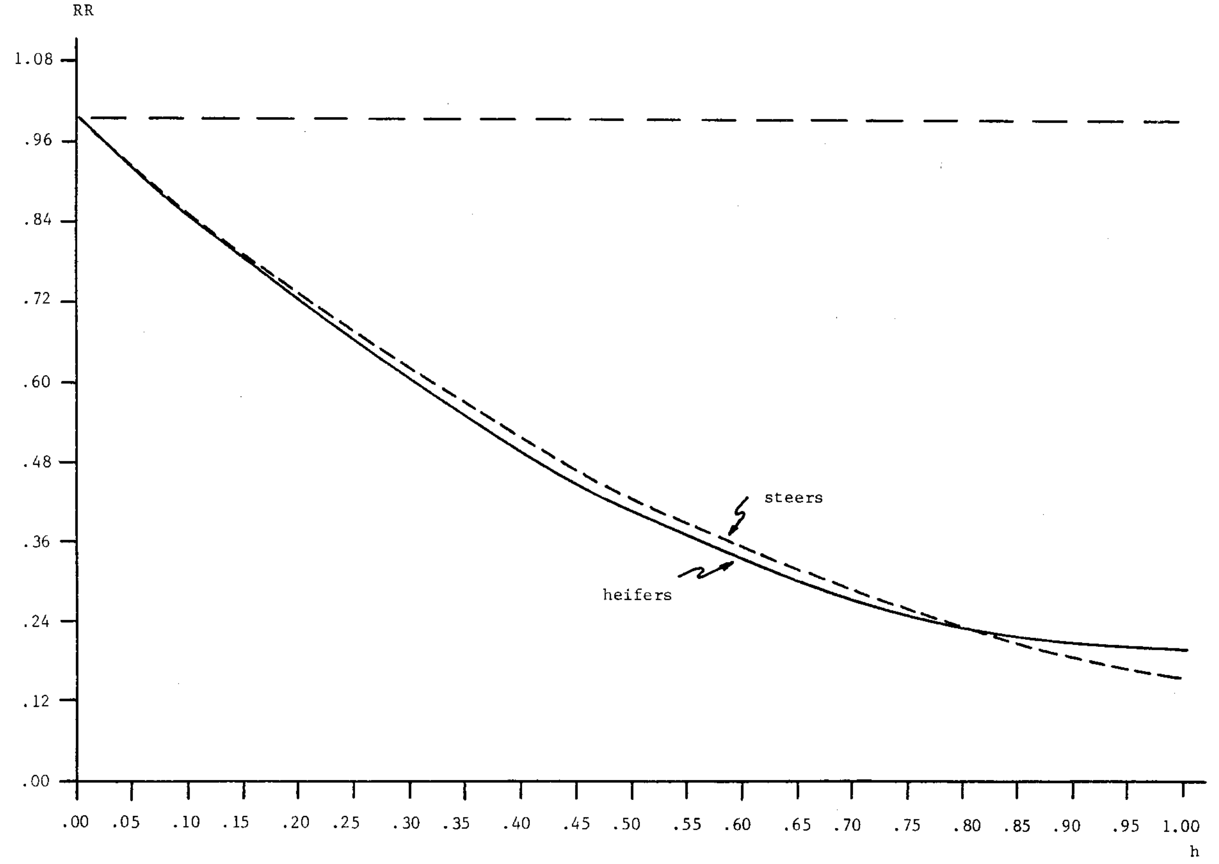


FIGURE 2D. RISK RATIOS FOR FLORIDA AND OMAHA CHOICE FEEDER STEERS BY SEX



not differ greatly given appropriate hedged positions.

Florida's heifers are generally discounted in relation to feeder steers by an average of $4/cwt. However, the relative price variations are nearly identical for the same weights and, as illustrated in Figure 2d, the risk ratios show only minimal differences. As with the grades, the major potential problem is not with differences in the risk ratio but with the inability to deliver heifers against the contract.

Florida's feeder cattle industry can be catagorized according to production and marketing cycles and it is possible that the distribution properties of both cash and futures prices change seasonally. This seasonality could in turn influence the effectiveness of hedging. The risk ratios for the four seasons of production and marketing are plotted in Figure 2e. The closeness of these RR curves suggests that the effectiveness of hedging does not have strong seasonal trends for 600-700 pound steers. In contrast, for the lighter weight steers, positions in April, May, and June show the lowest effectiveness (i.e., RR higher). The differences for all weights tend to be the greatest when hedging is near the 100 percent level.

CONDITIONAL PRICE RISK

In the preceding analysis, the absolute price risk and the risk ratios are considered to be independent of the initial prices in the months hedges are placed. The distribution properties of closing prices may differ depending on the price levels of prior periods. If lighter weight feeder cattle prices were high at the outset of the hedging program, closing prices and their variance may differ from those of periods when initial prices were lower [4]. In Figure 3 these

FIGURE 3. ADJUSTMENT IN RISK ACCORDING TO INITIAL PRICES AND HEDGING LEVEL

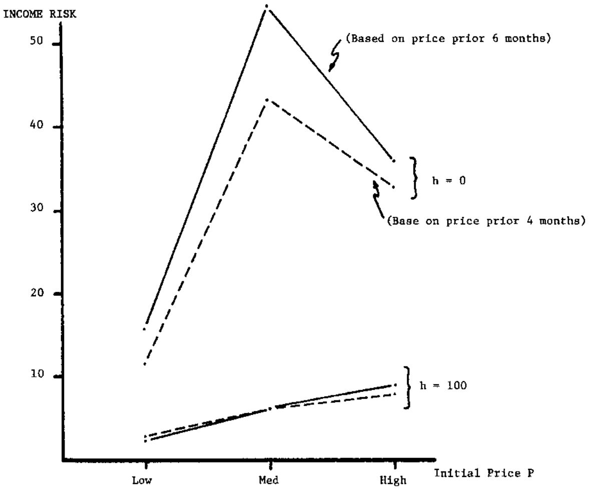
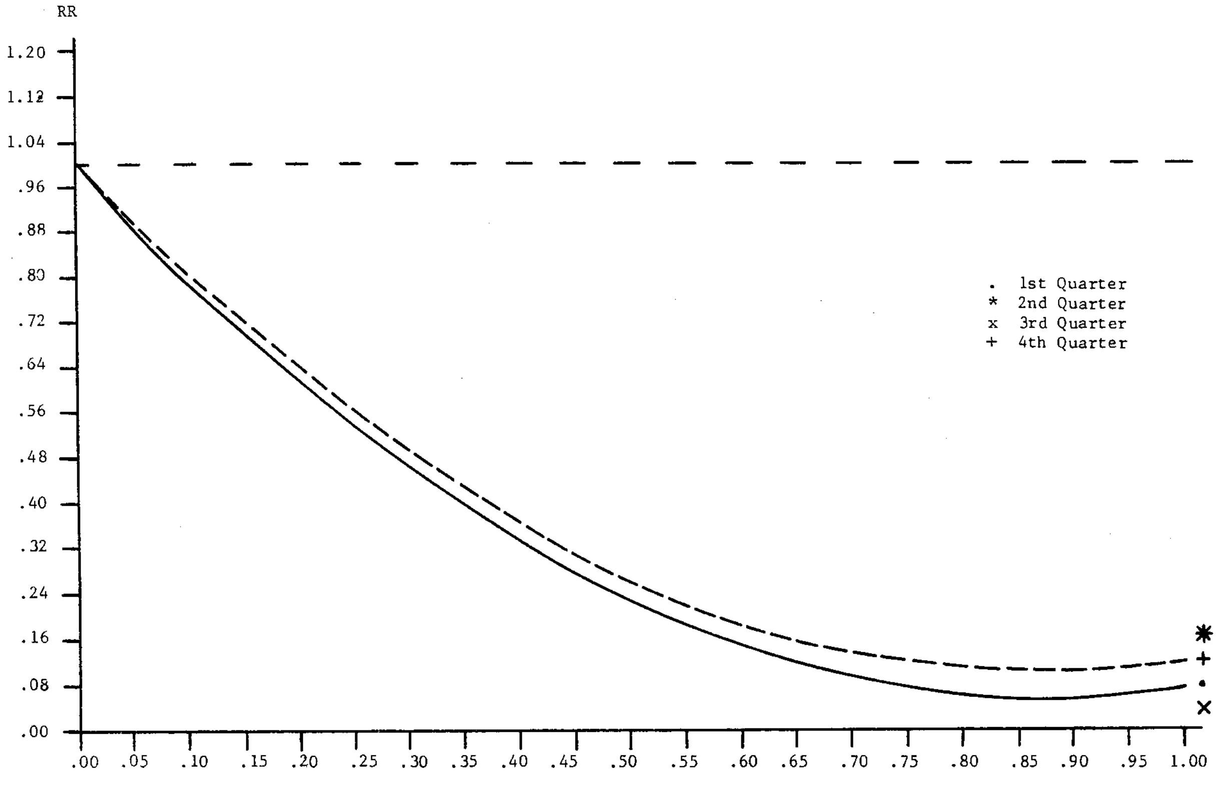


FIGURE 2E. RISK RATIOS FOR FLORIDA AND OMAHA CHOICE FEEDER STEERS BY MARKETING PERIODS



conditional initial price effects are considered. The distributional properties of the closing prices are calculated given prices in the previous four and six months. The high and low initial price levels are defined as above and below P ± σ_P, respectively. Figure 3 shows the acactual values of σ_π^2(see equation 2) per unit of x.

The closing price variation does differ according to whether the initial prices are high or low. The greatest price risk occurs when the initial prices are within the limits of $\bar{P} \pm \sigma_P$, and the least risk occurs with the lower initial prices. Also, the risk level is somewhat less when conditioned on the prices in the previous four months rather than six months.

Hedging programs greatly reduce this price risk, as is established with the lower values of RR in Figure 2. The 100 percent hedging example in Figure 3 shows that the risk level, given the range of initial prices noted, is much more stable than that without hedging. This stability arises from the adjustments in the risk ratio calculated for each price level. Also, there is now little difference in the absolute risk when prices in the previous four or six months are considered.

The relationships in Figure 3 emphasize not only the merits of hedging for reducing risk but also the fact that concern for income variability given initial market conditions can be greatly reduced under the hedging option. Likewise, concern about the impact of placing hedges four months rather than six months prior to closing has little substance in evaluating the risk levels because the σ_π's are nearly identical for both initial hedging periods.

CONCLUSIONS

The risk ratios for hedging Florida feeder cattle show that the CME futures contract can be a useful marketing tool even though the grades and weights may deviate somewhat from the contract specifications. The analyses address income risk without calculating the tradeoff between risk and expected returns. Measurement of the tradeoff is the logical extension of the results of in this analysis [6, 7]. Also, identification of basis patterns is essential to developing the hedging plan.

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