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The Risk Premium in Live Cattle Futures

by

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THE RISK PREMIUM IN LIVE CATTLE FUTURES

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Between 11-12 million head of cattle are on feed in the U.S. at a given point in time (USDA, ERS). The investors who own these cattle (i.e., cattle feeders) are subject to financial risk from a decline in fed cattle prices. To reduce financial risk, they can sell live cattle futures contracts traded at the Chicago Mercantile Exchange to speculators, who take a buy position opposite the hedgers because they believe cattle futures prices will increase on average. The expected increase in the futures price is termed the risk premium (RP), which is a payment to speculators for assuming price risk. Numerous studies have attempted to estimate the RP in futures markets (references cited in second section).

The RP is important to both speculators and hedgers. To the speculator, the RP is the return earned for assuming price risk. In a broad context, the speculator compares the expected return and risk in cattle futures to that from other assets (e.g., stocks, bonds, real estate, other commodities, etc.). A speculator will choose to invest in cattle futures only if the RP compensates for the level of risk. To the hedger, the RP is the "insurance premium" paid to eliminate price risk in favor of basis risk (which is usually less). By reducing risk, a cattle feeder can more easily obtain loans at favorable interest rates.

The objectives of this research are: (1) to estimate the RP in live cattle futures; (2) to determine whether the RP is "reasonable" for the given level of risk in cattle futures; and (3) to relate the cost of hedging (RP, etc.) to the return earned from feeding cattle.

The research results are organized as follows. In the second section we review previous studies on the RP in futures. In the third section, we report estimates of the RP in live cattle futures. The RPs are compared to returns from other assets. In the fourth section, asset pricing models are used to measure risk in cattle futures and to estimate the return required to attract investor money to cattle futures. In the fifth section, we calculate the cost to hedge fed cattle and examine the effect of hedging cost on average cattle feeding returns. The last section includes a summary and the conclusions.

PREVIOUS STUDIES

According to Keynes, the distant futures price is a downward biased measure of the expected future price of a commodity. This bias represents the risk premium (RP) that hedgers, predominantly short, pay to long speculators to protect themselves from the risk of adverse price fluctuations (Raynauld and Tessier). The live cattle futures market is extensively used for short hedging; therefore, theoretically one would expect this market to be biased downward, which would mean reduced returns for cattle feeders from hedging

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(Hayenga et al.). The reduced returns would equal the RP a cattle feeder pays for shifting price risk by selling futures to a long speculator who assumes the price risk.

Through the years, many studies have been conducted to test or measure the existence of a RP. However, empirical evidence of the existence of a RP is still inconclusive. According to Raynauld and Tessier, tests which rely on various hedging models generally warrant the existence of a RP, while studies based on the capital asset pricing model (CAPM) do not support the existence of a RP. Because the RP is based on the expected price (which is not readily known), it is difficult to calculate. Nevertheless, Brennan estimated the RP by subtracting the marginal carrying cost from the expected spot prices (estimated by an autoregressive model). Raynauld and Tessier argue that the results from Brennan's study are ambiguous because the forecasting error is hidden in the estimated RP.

Dusak shows that the RP can be measured by taking the percentage change in spot prices (net of storage) over a given interval minus the riskless rate; or alternatively, one can approximate the RP as the percentage change in the futures prices over the same interval. In her study, Dusak adopted the latter approach and examined the question of a RP using the CAPM. Her results indicate that futures investors in wheat, corn, and soybean futures did not bear systematic risk. Consistent with the low risk, she found no evidence of a RP in these markets. Baxter, et al. replicated Dusak's study using a market portfolio including commodities and stocks (Dusak used only stocks) and found essentially zero systematic risk. In contrast to the above studies, Chang used a nonparametric statistical procedure and found evidence of a downward bias in wheat, corn, and soybean futures.

In studies of the live cattle futures market, varying conclusions have been reached on the level of risk and size of the RP. Using the CAPM, Carter, et al. found moderate systematic risk in live cattle futures (with average $\beta=.35$), while Elam and Vaught found low systematic risk ($\beta=-.08$ to $+.23$). Estimates of the size of the RP vary, depending on the study period and research methodology. Kolb and Gay failed to reject the null hypothesis of a zero RP. In contrast, Leuthold found a significant downward bias in live cattle futures. Kolb tested for a RP in 29 markets over the period 1958-88 and found evidence of a RP in live cattle futures (1 of 4 markets with a significant RP).

Hartzmark used a different approach in his study of the RP. According to Keynes' normal backwardation theory, hedgers pay a RP to speculators for assuming price risk; and this RP should be evidenced by positive profits earned by speculators. Hartzmark examined the daily trading records of large futures traders for nine futures markets over the period 1977-81 to determine whether speculators made positive profits as the theory implies. He found in the live cattle futures markets that speculators earned positive returns while hedgers lost money. This is consistent with theory and thus provides evidence for a RP in cattle futures. In general, Hartzmark did not find that speculators earned positive returns across the nine futures markets.

Gray measured the RP in the corn futures market over an extended period of time (1921 to 1959) by employing a measurement technique that had not been used before. The technique consisted of holding a buy position in the nearby corn futures contract, and switching out of this future into the next contract on first delivery day. For example, a position in the March contract was held until March 1st, when it was switched to the May contract; and so on. Gray took great care to initiate and terminate his simulated trading technique at approximately the same price level, so that any profits were clearly attributable to futures price bias and not to rising prices. From his study, Gray concluded there was no adequate evidence of a RP in the corn futures market.

RISK PREMIUM

Generally, risk premium (RP) refers to an average reward to investors for willingness to assume a price risk in a risk-averse financial world. In the futures markets, RP is the difference between the expected futures price at time t (EP_t) and the current futures price for the same contract at time t-j (P_{t-j}), i.e., $RP_t = EP_t - P_{t-j}$. In this study, the RP was estimated by averaging the percentage differences between end of month futures prices. This is the standard procedure used in previous studies (e.g., Gray; Kolb).

To calculate the RP, live cattle futures returns were divided into six groups (1-2, 3-4, 5-6, 7-8, 9-10, and 11-12 months) based on time to maturity of the futures contracts. For example, in the month of January, the nearby futures contract is February and the next contract is April, then, June, August, October, and December. The return on the February contract was put in group one, which included futures maturing in 1-2 months; the return on the April contract was put in group two, which included futures maturing in 3-4 months; and so on. For the month of February, the nearby futures contract is April, then June, August, October, December, and February for the following year. The return on the April contract was put in group one, the return on the June contract was put in group two, and so on. The returns for the other ten months of the year were grouped in the fashion just explained. By grouping the contracts based on time to contract maturity, we could determine whether RPs varied due to time to maturity.

The RP was estimated using data for the period 1965-92, which covers (to date) the entire trading history of live cattle futures on the Chicago Mercantile Exchange. To determine if there was any pattern of changes in the RP over time, the study period was divided into sub-periods (1965-74, 1975-84, 1985-92). We also adopted Gray's idea of initiating and terminating the calculation of the RP at the same price level. For example, for contracts 1-2 months from maturity, we initiated our program in April 1979 when the nearby (June) futures price was $71.35 per 100 lbs. and terminated it in May 1992 when the nearby (June) futures price was $71.92. The period 1979-92 is the longest period that conformed to Gray's equal price idea.

The estimated RPs are shown in Table 1. Note that the RPs are highest for contracts 1-2 months from maturity and decrease as time to maturity increases. For the entire sample period 1965-92, the estimated RP=.73% per month for nearby contracts, and .34% per month for the contracts 11-12 months from maturity. The RPs for contracts up to 8 months from maturity are significantly greater than zero at the .05 level (for a one-tail test).

A graph of the RP starting in 1967 is shown in Figure 1a. The estimated RP is the average monthly percentage change for the nearby (1-2 month) futures contracts from February 1965 to a particular point in time shown on the horizontal axis. For example, the estimated RP at December 1978 is .8%; this value represents the average monthly percentage change in nearby cattle futures prices over the period February 1965 through December 1978. The RP graph (Figure 1a) shows that the estimated RP increases as the price level increases (Figure 1b); and vice versa. This relationship supports Gray's idea that RP is influenced by increases in the price level. Gray contends that RP can best be measured for periods which begin and end at approximately the same price level. The results for nearby contracts in Table 1 show that RP=.73% per month during the entire sample period 1965-92; whereas RP=.45% per month during the period 1979-92, with approximately equal beginning and ending prices. The results in Table 1 clearly show that rising price levels result in an increase in the RP estimate; but the values also show that RP is sizable (although not statistically significant) even during periods of balanced price levels (roughly equal up-and-down movements).

The RPs for live cattle futures (for 1-2 month contracts) are compared to excess returns from stocks and bonds (Table 2). The excess returns for stocks and T-bonds are the actual returns minus the T-bill rate. In the case of commodity futures, because there is no capital investment, the actual return is not reduced by the T-bill return. The results in Table 2 show that the return for cattle futures is higher than the excess returns for stocks and bonds during 1965-92. The standard deviation for live cattle futures is only slightly higher than for stocks. (For futures 3 months (or more) to maturity, the standard deviations for cattle futures are generally lower than for stocks.) The return for cattle futures from 1965-92 is higher than for the Dow Jones index of 12 commodity futures markets. For the last half of the study period (1979-92), the excess return on stocks is highest, followed by live cattle futures in second place. The return on stocks during 1979-92 was abnormally high, over 60% above the 65-year historical mean return for the S&P 500 stock index (Ibbotson Associates).

ESTIMATED RISK LEVEL AND REQUIRED RETURN

The estimated risk premiums reported in the previous section represent the return paid to speculators for assuming price risk. Whether these risk premiums are "reasonable" depends on the amount of risk in a cattle futures investment. According to financial theory, there are two types of risk, systematic risk and unsystematic risk (Copeland and Weston, pp. 198-199). Systematic risk is due to overall economic forces which cause prices of most assets to rise or fall together; whereas unsystematic risk is due to specific firm on industry effects, which impact only the specific firm or industry.

Financial theory indicates that the return on an asset is determined by the amount of systematic risk, which depends on the covariation of an asset's return and overall economic activity.[2] Assets whose returns vary greatly with

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[2]According to asset pricing theory, the level of unsystematic risk should not affect asset returns because it can be minimized by investing in a broad portfolio of assets. Pricing theory assumes that investors hold a diversified portfolio of assets, and thus are not affected by unsystematic risk.

economic conditions are high risk assets with high rates of return. By contrast, assets whose returns vary little with overall economic conditions are low risk assets with correspondingly low rates of return. Agricultural assets are generally considered low-risk assets because their returns are not closely related to the overall economy.

In this section, we will use financial asset pricing models (1) to measure the level of risk in a live cattle futures investment, and (2) to estimate the expected return from buying cattle futures. The two asset pricing models used are the capital asset pricing model (CAPM) and arbitrage pricing theory (APT).

<u>Capital Asset Pricing Model (CAPM)</u>

The amount of systematic risk in an investment can be determined from a theoretical asset pricing model such as the CAPM. The CAPM defines risk as the covariation of an asset's return with the market's return. This covariation is estimated using the market model:

(1) $R_t = \alpha + \beta\ (R_{mt}-R_{ft}) + e_t$

where R=return on an asset; R_m=return on the market portfolio; R_f=riskless rate; α and β are fixed intercept and slope parameters; and e=random (non-autocorrelated) error term. The subscript t represents the time period. The size of an asset's beta value provides a measure of the risk level of the asset. The market portfolio of all assets has β=1.0. An asset with $\beta<1.0$ is less risky than the market portfolio (and vice versa). An asset with β=0 has zero systematic risk.

Eq. (1) was estimated to determine the amount of systematic risk in live cattle futures. R_m was proxied with the S&P 500 stock index, and the one-month T-bill rate was used for R_f (Ibbotson Assoc.). The return on a cattle futures investment was defined as the percentage change in the futures price over the month, i.e., $R_t=(P_t-P_{t-1})/P_{t-1}$, where P_t and P_{t-1} are, respectively, cattle futures closing prices for the last day of the current month and the previous month (Dusak).[3] Futures prices were obtained from Technical Tools, Inc. The results reported here are for contracts 1-2 months from maturity. Results for contracts 3-4, 5-6, ... , 11-12 months are similar.

The regression results for eq. (1) are reported in Table 3. The beta estimates range from .09 to .16, with only the .16 value being significantly different from zero at the .05 level. The small beta estimates indicate little (if any) systematic risk in live cattle futures.

The expected return on an asset can be estimated using an empirical market line (EML), which expresses the return as a linear function (including a constant term) of the beta (risk level) of an asset (Copeland and Weston, p.

[3]Eq. (1) was also estimated with $R_t=\log(P_t)-\log(P_{t-1})$, where log is the natural logarithm. The results using logs are similar to those using percentage changes.

216).[4] A recent estimate of the EML is reported in Bjornson and Innes (1992b):

(2) $\widehat{R} = .099 + .032\ \beta$,

where $\widehat{R}$ is the required return on a futures asset (in % per month),[5] and $\widehat{\beta}$ is the estimated beta coefficient from eq. (1). The positive relationship in eq. (2) indicates that as the risk level for an asset increases, the expected return increases also.

The required return from owning live cattle futures can be calculated using eq. (2) along with the beta estimate for cattle futures (from Table 3). First, substitute the beta estimate into eq. (2), and then solve for the required return. For the entire period of available data, 1965-92, and for contracts 1-2 months from maturity, $\widehat{\beta}$=.11 and the resulting required return is $\widehat{R}$=.10% per month. Additional estimates of the required return were derived using other estimates of the EML (Table 3, panel B). For the period 1965-92, these estimates range from .10-.16% per month.

The required returns in Table 3 (panel B) should be compared to the actual returns in Table 1. Generally, the actual returns are higher than the required returns, with the difference being relatively greater for the period 1965-92 compared to 1979-92. For the period 1965-92, the actual returns are two to seven times the required returns, whereas for 1979-92, the actual returns for contracts up to six months from maturity are one to four times the required returns. The comparison of actual and required returns clearly shows that an investment in live cattle futures has received a reasonable return, given the systematic risk level in cattle futures and the return on other financial assets.

Another way to use the CAPM to evaluate the actual returns in Table 1 is to use Black's result for a zero-beta asset. This applies to cattle futures because they are approximately zero-beta assets (largest $\widehat{\beta}$=.16 in Table 3). In relaxing some of the assumptions of the pure CAPM, Black showed that the expected excess return on a zero-beta security should be between zero and the risk premium on the market portfolio (R_m-R_f). A futures contract is different from a security in that there is no investment capital required to trade a futures contract. The <u>actual</u> return on a futures position is comparable to the <u>excess</u> return on a security because of the difference in the capital requirements for investing in futures versus securities. Black's result applied to a futures investment indicates that the range in expected returns should be between 0 and (R_m-R_f).

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[4]An EML is used due to the biased predictions of expected returns based on the theoretical CAPM. Empirical studies of asset returns show that the theoretical CAPM under predicts the return on low-risk assets, such as cattle futures (Copeland and Weston, p. 215).

[5]The term "required return" is the return that must be paid to attract investment in the asset. The required return is the expected return based on an asset pricing model (such as the CAPM). See Copeland and Weston, pp. 204-05.

For the period 1965-92, the risk premium on the S&P 500 stock index is .36% per month (Table 2). The actual returns on cattle futures for this period are generally equal to, or above, this level (Table 1). Thus, the returns on cattle futures for 1965-92 are mostly higher than Black's range (0-.36% per month). For the period 1979-92, the risk premium on the S&P 500 stock index is .69% per month; thus Black's range for a zero-beta futures contract is from 0-.69% per month. The actual returns on cattle futures for this period fall in this range (except for the negative return for 11-12 months which falls below the low end of the range). The return on contracts 1-2 and 3-4 months from maturity (.45% per month) fall in the upper half of the range, while contracts 5 (or more) months from maturity fall toward the lower (0%) end of the range.

To summarize, the actual returns from owning live cattle futures over the periods 1965-92 and 1979-92 are mostly higher than (or as high as) the required returns based on the empirical market line from the CAPM. Thus, the conclusion is that over this period an investor in cattle futures received, at a minimum, a "reasonable return," given the risk level of cattle futures (as measured by the CAPM) and the returns on other competing assets.

Arbitrage Pricing Theory (APT)

Arbitrage pricing theory (APT) is a multi-factor approach to determining asset prices. In contrast to the CAPM which uses only one factor (risk premium on the market portfolio) to explain asset returns, APT uses several factors. These factors can be specified either implicitly using factor analysis, or explicitly based on economic reasoning from a discounted dividends model for securities. When the factors are determined implicitly with factor analysis, there is usually a search for explicit factors that are related to the unknown implicit factors (Bjornson and Innes, 1992b). An alternative approach to applying APT is to explicitly specify the APT factors using observable economic variables. Financial economists have variously identified five economic factors that have significant market risk premia in APT models (Chen, Roll, and Ross; Ferson and Campbell; Bjornson and Innes (1992a)). The economic factors are DEI = change in expected inflation; UI = unanticipated inflation; IP = growth rate in industrial production; UPR = bond default risk premium (Baa bond return - T-bond return); and UTS = maturity risk premium (T-bond return - T-bill return). An economic rationale for including these five factors and the details on measurement of the factors are reported in Chen, Roll, and Ross (CRR).

In APT, the expected return on an asset is linearly related to the systematic risk levels for the asset. The arbitrage pricing equation from CRR is shown below:

$$(3)\ \hat{R} = -.243 - .020\,\hat{\beta}_1 - .089\,\hat{\beta}_2 + 1.384\,\hat{\beta}_3 + .817\,\hat{\beta}_4 - .827\,\hat{\beta}_5$$

where $\hat{R}$ = estimated required return on an asset (in % per month), and the $\hat{\beta}_i$'s are the sensitivities of an asset's return to the five economic factors listed above (i.e., $\hat{\beta}_1$ is the asset's return sensitivity to DEI; ... ; and $\hat{\beta}_5$ is the asset's return sensitivity to UTS).[6] The sensitivities--called risk levels in APT--are determined from a multiple regression of the asset's return on the five economic factors (discussed below).

The estimated coefficients in eq. (3) are the risk premiums (RPs) for the particular risk factors. The RPs represent the price of risk, i.e., the change in an asset's return given a one-unit increase in the risk level ($\hat{\beta}_i$ values). The RPs in eq. (3) are positive for two factors (IP and UPR) and negative for three factors (DEI, UI, and UTS).

The $\hat{\beta}$s in eq. (3) are the quantities of risk, or levels of risk. An asset has its own individual risk levels, which are estimated by regressing the asset's return on the five risk factors to obtain the asset's $\hat{\beta}$ coefficients. The required return for an asset depends on the risk levels for the asset ($\hat{\beta}$s) and the price of these risks (i.e., the risk premiums from an arbitrage pricing equation such as eq. (3) from CRR). The required return can be estimated by substituting the asset's $\hat{\beta}$ coefficients into eq. (3) and solving for the required return.

Before we can estimate the required return for a cattle futures investment, we must estimate the amount of risk in cattle futures. In APT, the betas (risk levels) are determined from a multiple regression of the asset's return on the APT factors (five factors from CRR). The betas for live cattle futures were estimated by regressing the percentage return from a buy position in cattle futures on the five explicit economic factors from CRR. The results are reported in Table 4 for contracts 1-2 months from maturity. (Results for contracts 3 months (or more) from maturity are similar.) For the entire sample period 1965-92, the overall F-statistic for the null hypothesis that all slope coefficients are zero (i.e., H_0: $\beta_1 = \ldots = \beta_5 = 0$) is rejected at the .05 significance level.[7] And, for one of the four subperiods the

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[6]CRR developed their estimates of the APT equation using data from 1958-84. They report results for subperiods, including 1968-77 and 1978-84. The coefficients in eq. (3) above are weighted averages of CRR's estimated coefficients for these two periods. (Weights are based on the number of years in each subperiod.) The period 1968-84 covers part of the period over which we have calculated risk premiums for live cattle futures.

The intercept in eq. (3) has been modified from CRR to accommodate pricing of futures contracts. CRR's equation applies to pricing of securities which require a capital investment. The intercept in eq. (3) has been reduced by the average T-bill (riskless) rate for the period 1968-84 (estimation period of CRR's equation). The fact that a futures contract requires no investment capital compared to a security which does justifies the reduction in the intercept.

[7]Notwithstanding the significant F's, the amount of total variation in cattle futures returns explained by the five factors is quite small. For the entire period 1965-92, the R^2 is .05, which indicates that only 5 percent of the variation in cattle futures returns is explained by the five factors. The highest R^2 is .13 for the period 1965-74. It is

hypothesis of zero-slope betas is rejected. A significant F-statistic indicates systematic risk in live cattle futures.

For the period 1965-92, three of the estimated $\hat{\beta}$ coefficients (DEI, UI, and UPR) in Table 4 are significantly different from zero at the .05 level. One would expect agricultural assets to be impacted by inflation, and this is reflected by the significant coefficients for DEI and UI. The positive coefficient for DEI indicates that cattle futures prices tend to move higher as inflation is expected to increase. By contrast, the negative coefficient for UI indicates that an increase in inflation that was not anticipated (UI) is associated with a decrease in cattle futures prices. Studying farm asset values, Bjornson and Innes (1992b) found just the opposite effects, i.e., farm asset values were positively associated with UI and negatively associated with DEI.

Using the live cattle futures betas in Table 3 along with eq. (3) from CRR, we estimated the required return for a buy position in cattle futures. The estimates range from -1.19% to .24% per month, depending on the period. The APT required returns are generally lower than the required returns based on the CAPM (.10-.16% per month, Table 3, panel B).

The negative required returns for cattle futures from APT are due to the favorable risk reducing characteristics of a cattle futures investment. For example, consider the risk factor, change in expected inflation (DEI). The RP in eq. (3) for DEI is -.020. The negative RP calls for a reduction in return for assets whose returns have a positive association with DEI; these type assets are good inflation hedges because their returns tend to increase as expected inflation increases. The regression results in Table 3 indicate that live cattle futures are positively related with DEI and thus provide protection from increased inflation. The required (expected) return on inflation hedge assets are lower than the returns on otherwise similar assets that are not inflation hedges, because investors seek out inflation hedge assets and bid up their prices (and consequently reduce the return). For a live cattle futures investment, the reduction in the estimated required return due to its inflation hedge protection is .17% per month ($-.020 \times \hat{\beta}_1=8.34$).

In summary, in this section we compared the estimated RP for live cattle futures to the required returns for a cattle futures investment developed from CAPM and APT asset pricing models. The results show that the RP for the period 1965-92 was sufficient to compensate for the level of systematic risk in owning cattle futures. A buy position in live cattle futures during 1965-92 produced a mean return of over 9% per year. The estimated required return for an asset with the same risk level as live cattle futures is less than 2% per year (based on .16% per month required return from CAPM, Table 3, panel B). For comparison, the mean annual excess return for the S&P 500 stock index was 4.4% over the same period. The reader should remember that cattle futures ($\hat{\beta}$=.11) is a low-risk investment compared to the S&P 500 stock index (β=1.0). The fact that a favorable return can be earned from buying cattle futures is recognized by large cattle futures traders, as shown by Hartzmark's analysis

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important to note that the amount of systematic risk in cattle futures is determined by the size of the beta coefficients, and not the degree of correlation as represented by R^2.

of daily positions of large cattle futures traders. He found that large traders made substantial profits from long positions, and they had relatively small positions on the short side of the market.

RISK PREMIUM, HEDGING COSTS, AND FEEDING RETURNS

A cattle feeder can use live cattle futures to reduce price risk. However, there is a cost to hedge, and the risk premium (RP) is part of this cost. The hedge cost (along with the feeder animal cost and the feeding cost) is subtracted from the sales revenue (price x finish weight) to obtain the feeding return. The objective of this section is to relate the hedging cost (RP, etc.) to the feeding return.

The percentage RPs reported in Table 1 are shown below on the basis of dollars per 100 lbs.:

Months to Maturity of Futures Contract	Risk Premium ($'s per 100 lbs.)
1-2 Months	.24
3-4 Months	.25
5-6 Months	.08

The values above are for 1979-92, a period where the ending and beginning futures prices are approximately equal. This period reflects the recent history of RPs, and represents the RP for a period where increases in price level did not cause an inflated RP (as in 1965-92). The results for 1979-92 may be more relevant to the current economic conditions of low inflation.

Using the RP values above, we can calculate a feeding-period risk premium (FRP) to reflect the total RP paid by hedgers over the feeding period. It is assumed that cattle are hedged when they are placed on feed, and the feeding period is five months. The five-month feeding period is based on Hoelscher's feeding performance data (published in <u>Feedstuffs</u>). The FPR is equal to the sum of the monthly RPs over the five months, i.e., FPR = 2 x RP for months 1-2 + 2 x RP for months 3-4 + 1 x RP for months 5-6. This calculation yields FPR = $1.06 per 100 lbs. (2x$.24 + 2x$.25 + 1x$.08). The RP can be calculated on a per head basis by multiplying FRP by the weight of the finished animal (in 100's of lbs.). This yields FPR = $11.66 per head ($1.06 x 11).

The RP is part of the cost to hedge feedlot cattle; the other costs are the futures commission and the execution cost. The futures commission cost for a non-member of the Chicago Mercantile Exchange ranges from $25-$60 per 40,000 pound contract, depending on the volume of business. The commission cost is $.06-.15 per 100 lbs. of finish weight. The execution cost for a live cattle futures trade is represented by the difference between the ask and bid prices. The cost to execute a trade in the corn futures market is estimated to be less than 1/4 cent per bushel, or one tick (Brorsen and Nielson). One tick (minimum price increment) in live cattle futures is $.025 per 100 lbs. Using the results from corn futures, the total cost to place and lift a cattle futures hedge would be two ticks, or $.05 per 100 lbs.

The hedging costs for a cattle hedge are shown in Table 5. The total cost to hedge an animal ranges from $12.87 to $13.86 per head. The hedging costs should be compared to the estimated mean feeding returns which range from -$6.75 to $35.60 per head (Table 5, panel B). The estimate from Trapp's study ($10.65 per head) falls toward the middle of this range.[8] The hedging cost estimates in Table 5 are $2-3 per head above Trapp's middle-range estimate of the mean feeding return. For the average pen of cattle, the hedge costs would reduce the feeding return from +$11 per head to -$2 to -$3 per head.

The full cost to hedge feedlot cattle may not be clearly recognized by cattle feeders. A hedger may consider the cost of a hedge to include only the futures commission, and possibly the execution cost. From Table 5, we know that the RP is the largest cost in hedging feedlot cattle. Because there is controversy as to the size of the RP in the cattle futures market, it is easy to simply conclude that it does not exist. For the period 1979-92, the RPs in Table 1 are not statistically significant at acceptable levels, even though they are economically significant to a cattle hedger (as demonstrated in Table 5). From a strict statistical viewpoint, one could argue that the null hypothesis of a zero RP is not rejected.

Another reason the full cost of hedging may not be recognized is because cattle feeders tend to be selective hedgers, rather than continuous hedgers. A continuous hedger will place a hedge when cattle are initially put on feed, and will hold the hedge until the cattle are sold to the packer. By contrast, a selective hedger will place a hedge only when prices are expected to fall; and if prices are expected to rise, no hedge will be placed. Because a selective hedge is held for a limited time period, the RP cost is not as great as for a continuous hedge held for the entire feeding period.

The fact that there is a cost for a hedge is evident from simulated studies of hedging strategies. In these studies, researchers have found that a continuous (routine) hedge strategy usually has a lower return than a strict cash marketing (no hedge) strategy (Leuthold and Tomek). The difference between the return from cash marketing and the return from a continuous hedge represents the dollars lost in the futures position (plus the small futures commission cost).

SUMMARY AND CONCLUSIONS

The conclusion of this research is that the RP in live cattle futures is higher than required to compensate for the systematic risk in a cattle futures position. We estimated the systematic risk level for live cattle futures using the CAPM and APT, and found there is little systematic risk. In contrast with the low risk level, we found the return from owning cattle futures to be above the estimated required returns based on asset pricing models. Speculators who buy cattle futures, and assume the price risk from hedgers, are paid at a minimum a reasonable return for the level of the risk.

[8] Trapp's estimate is for the 11-year period 1978-88, and is based on feeding returns from a consulting firm with 120 feedlot clients.

From a hedger's perspective, the RP cost of a cattle hedge is conservatively estimated to be $12 per head (based on low RPs for the period 1979-92 in Table 1). The total cost of a hedge including futures commission cost and futures execution cost is $13 to $14 per head. A middle-of-the range estimate of the mean feeding return, excluding hedging cost, is approximately $11 per head (Trapp). The mean return from feeding cattle is $2-3 per head less than the estimated hedge costs. For the average pen of cattle, the hedge costs reduce the unhedged feeding profit to a loss.

Suggestions for additional research are the following. (1) Attempt to discover what causes the large RPs in live cattle futures. One answer is hedging pressure from the excess of short hedging over long hedging. Hirshleifer's model of hedging pressure could be applied. (2) Apply alternative estimation techniques to obtain a more precise statistical estimate of the RP. Our results consistently show positive RPs (with one exception), but the t-values are not significant at acceptable levels in several cases.

REFERENCES

Baxter, J., T.E. Conine, and M. Tamarkin. "On Commodity Market Risk Premiums: Additional Evidence." <u>J. Futures Markets</u> 5(1985): 121-125.

Bjornson, Bruce, and Robert Innes. "Risk and Return in Agriculture: Evidence from an Explicit-Factor Arbitrage Pricing Model." <u>J. Agr. and Res. Econ.</u> 17(1992a): 232-252.

_____. "Another Look at Returns to Agricultural and Nonagricultural Assets." <u>Amer. J. Agr. Econ.</u> 74(1992b): 109-119.

Black, Fischer. "Capital Market Equilibrium with Restricted Borrowing." <u>J. of Business</u> 45(1972): 444-455.

Brennan, M.J. "Supply of Storage." <u>Amer. Econ. Rev.</u> 48(1958): 50-72.

Brorsen, B.W., and R.J. Nielsen. "Liquidity Costs in the Corn Futures Market." Unpublished paper, Dept. of Agr. Econ., Purdue Univ., 1986.

Carter, C.A., G.C. Rausser, and A. Schmitz. "Efficient Asset Portfolios and the Theory of Normal Backwardation." <u>J. Pol. Economy</u> 91(1983): 319-331.

Chang, Eric. C. "Returns to Speculators and the Theory of Normal Backwardation." <u>J. Finance</u> 40(1985): 193-208.

Chen, Nai-Fu, R. Roll, and S. Ross. "Economic Forces and the Stock Market." <u>J. of Business</u> 59(1986): 383-403.

Copeland, T.E., and J.F. Weston. <u>Financial Theory and Corporate Policy</u> (3rd ed.). Reading, Massachusetts: Addison-Wesley Publishing Co., 1989.

Dodson, C., and Emmett Elam. "Returns to Custom Cattle Feeding." <u>J. Agribusiness</u>, Fall 1992: in press.

Dusak, K. "Futures Trading and Investor Returns: An Investigation of Commodity Market Risk Premiums." <u>J. Pol. Economy</u> 81(1973): 1387-1406.

Elam, Emmett W., and Daniel Vaught. "Risk and Return in Cattle and Hog Futures." <u>J. Futures Markets</u> 8(1988): 79-87.

<u>Feedstuffs</u>. Minnetonka, MN: The Miller Publishing Co., various issues.

Ferson, W.E., and C.R. Campbell. "The Variation of Economic Risk Premiums." <u>J. Pol. Economy</u> 99(1991): 385-415.

Gray, Roger. "The Search for a Risk Premium." In <u>Selected Writings on Futures Markets</u>, vol. II, edited by A.E. Peck. Chicago: Chicago Board of Trade, 1977, pp. 71-78.

Hartzmark, M.L. "Returns to Individual Traders of Futures: Aggregate Results." J. Pol. Economy 95(1987): 1292-1306.
Hayenga, M.L., D. DiPietre, J.M. Skadberg, and T. Schroeder. "Profitable Hedging Opportunities and Risk Premiums for Producers in Live Cattle and Live Hog Futures Markets." J. Futures Markets 4(1984): 141-154.
Hirshleifer, David. "Determinants of Hedging and Risk Premia in Commodity Futures Markets." J. of Fin. and Quant. Anal. 24(1989): 313-331.
Ibbotson Associates. Stocks, Bonds, Bills, and Inflation: 1992 Yearbook. Chicago: Ibbotson Assoc., 1992.
Keynes, J.M. A Treatise on Money, vol. 2. London: Macmillan, 1930.
Kolb, R.W., and G.D. Gay. "The Performance of Live Cattle Futures as Predictors of Subsequent Spot Prices." J. Futures Markets 3(1983): 55-63.
Kolb, Robert W. "Is Normal Backwardation Normal?" J. Futures Markets 12(1992): 75-91.
Lakonishok, Josef, and Alan C. Shapiro. "Systematic Risk, Total Risk and Size as Determinants of Stock Market Returns." J. of Banking and Finance 10(1986): 115-132.
Langemeier, M., Ted Schroeder, and James Mintert. "Ten Years of Data Show Importance of Marketing Plan." Feedstuffs, Jan. 27, 1992, pp. 17-18.
Leuthold, R.M. Actual and Potential Use of the Livestock Futures Market by Illinois Producers. Univ. of Illinois, Dept. of Agr. Econ., AERR-141, Dec. 1975.
Leuthold, R.M., and W.G. Tomek. "Developments in the Livestock Futures Market Literature." In Livestock Futures Research Symposium, Chicago Mercantile Exchange and NC-117 Food System Research Group, Chicago, Illinois, June 1979.
Prinsky, R.D. "New Dow Jones Commodity, Spot Indexes." Wall Street Journal, Jan. 4, 1982, p. 46.
Raynauld, J., and J. Tessier. "Risk Premiums in Futures Markets: An Empirical Investigation." J. Futures Markets 4(1984): 189-211.
Shukla, Ravi, and Charles Trzcinka. "Research on Risk and Return: Can Measures of Risk Explain Anything?" J. of Portfolio Management, Spring 1991: 15-21.
Trapp, J.N. "Seasonal Aspects of Cattle Feeding Profits." Current Farm Economics 62(1989): 19-30.
Trapp, J.N., and Jeane Webb. "Cattle Feeding Profit Variances: Private Versus Public Data Comparisons." Current Farm Economics 59(1986): 10-17.
U.S. Dept. of Agriculture, ERS. Livestock and Poultry Situation and Outlook (LPS-58), Washington, D.C., February 1993.

FIG. 1.a. RISK PREMIUM IN LIVE CATTLE FUTURES

FIG. 1.b. LIVE CATTLE FUTURES PRICES

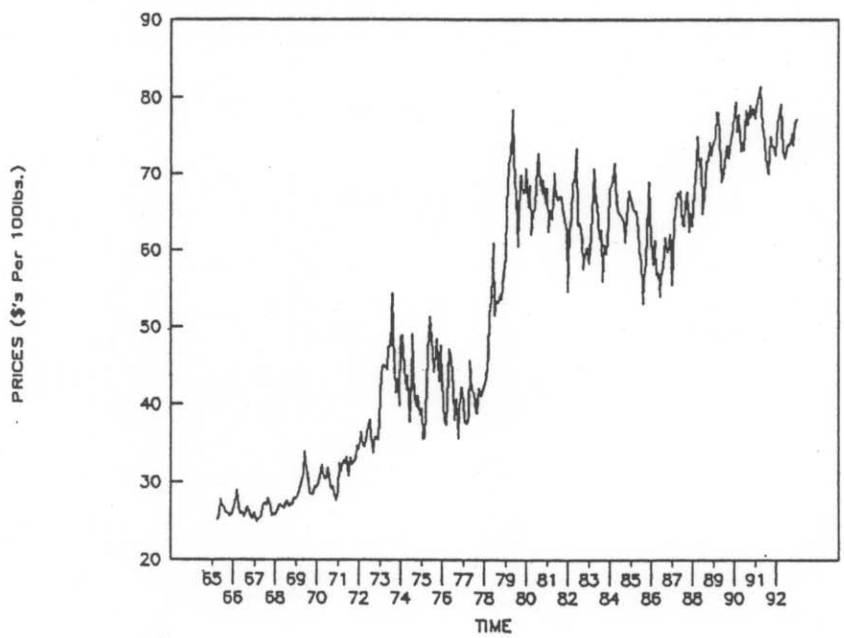

Figure 1. Live Cattle Futures Price and Risk Premium, 1965-92.

Table 1. Estimated Risk Premium for Live Cattle Futures, by Periods.

Period/Statistics	Months to Maturity of Futures Contract 1-2	3-4	5-6	7-8	9-10	11-12
	% per month					
1965-92:						
Mean a/	.73*	.66*	.44*	.43*	.35	.34
t-value b/	(2.40)	(2.44)	(1.81)	(1.85)	(1.50)	(1.26)
No. Obs.	335	336	336	334	323	238
1965-74:						
Mean	.64	.63	.62	.64	.49	.68
t-value	(1.27)	(1.25)	(1.28)	(1.34)	(.99)	(.92)
No. Obs.	119	120	120	118	109	62
1975-84:						
Mean	.76	.62	.25	.32	.28	.28
t-value	(1.27)	(1.23)	(.60)	(.80)	(.74)	(.62)
No. Obs.	120	120	120	120	118	89
1985-92:						
Mean	.79*	.78*	.47*	.34	.28	.17
t-value	(1.89)	(2.35)	(1.65)	(1.32)	(1.13)	(.65)
No. Obs.	96	96	96	96	96	87
1979-92, Eq. Begin and End Prices c/						
Mean	.45	.45	.18	.12	.08	-.04
t-value	(1.17)	(1.44)	(.64)	(.52)	(.34)	(-.15)
No. Obs.	158	164	156	154	156	129

<u>a</u>/Mean monthly percentage change in futures prices:

% change = $(P_t - P_{t-1})/P_{t-1}$,

where P_t=closing futures price at the end of the current month, and P_{t-1}=closing futures price at the end of the previous month.

<u>b</u>/t-value for null hypothesis that risk premium equals zero.

<u>c</u>/Periods were selectively chosen so that the ending futures price was approximately equal to the beginning futures price (based on Gray; see text for additional explanation). Periods with beginning and ending prices are shown below:

Time to Maturity of Futures Cntr.	Dates for Periods and Contracts: Begin	Contract	End	Contract	Futures Prices: Begin	End
1 - 2 months	03-30-79	June 79	05-29-92	June 92	71.35 -	71.92
3 - 4 months	04-30-79	Aug. 79	12-31-92	Apr. 93	76.50 -	76.67
5 - 6 months	02-28-79	Aug. 79	02-28-92	Aug. 92	68.62 -	68.82
7 - 8 months	10-31-79	June 79	08-28-92	Apr. 93	72.57 -	72.67
9 -10 months	02-28-79	Dec. 79	02-28-92	Dec. 92	68.60 -	68.62
11-12 months	05-31-79	Feb. 80	06-30-92	June 92	69.20 -	69.20

*Significantly different from zero at .05 level for one-tail t-test.

Table 2. Comparison of Returns and Standard Deviations for Stocks, T-bonds, Commodity Futures, and Live Cattle Futures, by Periods.

	1965-92			1979-92		
Asset or Futures	Mean Return	Mean Excess Return[a]	SD[b]	Mean Return	Mean Excess Return	SD
			% per month			
Cattle Futures, 1-2 months	.73	---	5.5	.45	---	4.8
S&P 500 Stock Index	.92	.36	4.4	1.37	.69	4.7
Long-term T-bonds	.62	.06	3.1	.97	.29	3.8
DJ Futures Index[c]	.43	---	4.1	.02	---	4.2
T-bills	.56	---	.2	.68	---	.2

a/Mean excess returns for stocks and T-bonds (i.e., mean return - T-bill rate). In the case of futures, because there is zero investment capital, the mean futures return is not reduced by the T-bill rate (see text for discussion).

b/Standard deviation.

c/Dow Jones commodity futures index is an equal weighted index of five-month forward futures prices for 12 commodities: cattle, coffee, copper, corn, cotton, gold, hogs, lumber, silver, soybeans, sugar, and wheat (Prinsky).

Table 3. Empirical CAPM Applied to Live Cattle Futures, by Periods.

A. Systematic Risk Level (ß) Based on CAPM

Period	Intercept	Slope ($\hat{\beta}$)a/	R^2	DWb/
1965-92 (n=335)c/	.69	.11	.008	1.84
	(2.26)	(1.64)		
1965-74 (n=119)	.67	.09	.004	1.82
	(1.31)	(.73)		
1975-84 (n=120)	.70	.11	.005	1.86
	(1.16)	(.76)		
1985-92 (n= 96)	.65	.14	.027	1.80
	(1.56)	(1.62)		
1979-92 (n=157)d/	.27	.16*	.026	1.86
	(.72)	(2.03)		

B. Required Return Based on Empirical Market Line

Period	Bjornson and Innes	Shukla and Trzcinka	Lakonishok and Shapiro
		% per month	
1965-92	.10	.14	.16
1965-74	.10	.13	.16
1975-84	.10	.14	.16
1985-92	.10	.17	.17
1979-92d/	.10	.19	.18

Note: The EML equations are shown below with the estimation period in parentheses:

Bjornson and Innes	Exp. ret. = .099 + .032 $\hat{\beta}$	(1963-84)
Shukla and Trzcinka	Exp. ret. = .049 + .870 $\hat{\beta}$	(1962-83)
Lakonishok and Shapiro	Exp. ret. = .120 + .390 $\hat{\beta}$	(1962-81)

The intercept in the Shukla-Trzcinka equation was reduced by the average T-bill rate to adapt the results to pricing of futures assets (see discussion in text).

a/The symbol * indicates the estimated slope coefficient is significantly different from zero at .05 level for a one-tail t-test.

b/Durbin-Watson (DW) statistics do not reject null hypothesis of random residuals for any of the regressions at the .05 level of significance.

c/Number of observations for regression estimation.

d/This period includes the second half of the data set; it is also the period where the beginning futures price is approximately equal to the ending price (based on Gray; see footnote c in Table 1 for exact dates).

Table 4. Estimates of Systematic Risk and Required Returns for Live Cattle Futures Using APT, for Futures Contracts 1-2 Months from Maturity, by Periods.

A. Systematic Risk Levels ($\hat{\beta}$s) from APT Regressionsa/

Period	DEI	UI	IP	UPR	UTS	R^2	DWb/	Fstatc/
1965-92 (n=335)d/	8.34*	-3.20*	.184	-.449*	.083	.049	1.77	3.37#
	(2.08)	(-2.52)	(1.54)	(-2.18)	(.77)			
1965-74 (n=119)	2.98	-6.84*	.142	-.496	-.190	.128	1.65	3.32#
	(.37)	(-3.25)	(.87)	(-1.82)	(-0.89)			
1975-84 (n=120)	8.37	-2.87	.280	-.962	.392	.074	1.79	1.81
	(1.31)	(-1.22)	(1.13)	(-1.89)	(1.84)			
1985-92 (n= 96)	12.23	2.86	.114	-.645	-.087	.114	1.77	2.32
	(1.78)	(1.38)	(.54)	(-1.46)	(-.55)			
1979-92, Eq.	6.57	.78	.248	-.259	.254*	.050	1.89	1.60
Begin and End Prices (n=158)	(1.55)	(.48)	(1.36)	(-.86)	(2.22)			

B. Required Return Based on Arbitrage Pricing Equation

Period	Chen, Roll, and Rosse/
	% per month
1965-92	- .32
1965-74	.24
1975-84	- .89
1985-92	-1.19
1979-92	- .52

a/The explicit economic factors are: DEI = change in expected inflation; UI = unanticipated inflation; IP = growth rate in industrial production; UPR = bond default risk premium (Baa return - T-bond return); and UTS = maturity risk premium (T-bond return - T-bill return).

b/Durbin-Watson (DW) statistics do not reject null hypothesis of random residuals for any of the regressions at the .05 level of significance.

c/F-statistic for the null hypothesis that all slope parameters (β_i's) are zero. The symbol # indicates a significant F-statistic at the .05 level. Degrees of freedom for F-test are (5,n-6), where n=number of observations for regression estimation.

d/Number of observations for regression estimation.

e/Based on arbitrage pricing equation from Chen, Roll, and Ross (eq. (3) in text).

*Significantly different from zero at .05 level for one-tail t-test.

Table 5. Estimated Hedging Cost and Mean Cattle Feeding Returns.

A. Hedging Costs for Five-Month Feeding Period:

Cost Item	$'s Per 100 lbs.	$'s Per Heada/
Futures Commissionb/	.06-.15	.66- 1.65
Futures Execution Costc/	.05	.55
Risk Premiumd/	1.06	11.66
Total Cost	1.15-1.26	12.87 -13.86

B. Mean Feeding Returns (Steers):

Study and Study Period	Mean ($'s per head)
Trapp (1978-88)	10.65
Trapp and Webb (1978-09 to 1985-07)	-6.75
Langemeier, et al. (1980-90)	20.18 to 35.60
Dodson and Elam (1980-90)	3.63

a/Assumes the finished weight is 1,100 lbs. for steer cattle.

b/Per contract commissions of $25-60 for 40,000 lb. live cattle futures contract.

c/Estimated difference between ask and bid prices.

d/Feeding-period risk premium (FPR) is equal to the sum of the monthly risk premiums (RP) over the five months, i.e., FPR = 2 x RP for months 1-2 + 2 x RP for months 3-4 + 1 x RP for months 5-6.