Risk and Expected Returns in Cattle Feeding

by

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Numerous studies have shown average return on investment in cattle feeding compares favorably with returns on alternative investments. However, the volatility in cattle feeding returns is extremely high. The high profit risk in cattle feeding and the infrequency of profitable hedging opportunities when cattle are placed on feed raise questions regarding the relationship between perceived risk and expected returns. Previous research has not sought to explain the variation in expected cattle feeding returns. Under the assumptions of portfolio theory, a risk averse investor requires higher expected returns for investments that increase portfolio risk. A model is presented to test for a risk-return tradeoff in expected cattle feeding returns. Hedgeable returns are used as a proxy for expected returns. Alternative proxies for the risk perceptions of cattle feeders are tested in the model. Only one proxy, implied live cattle option volatility, proved statistically significant. Historical measures of risk were not significant, implying that cattle feeders are forward looking. Cattle on feed inventories and recent profits in cattle feeding did not affect expected returns. Since expected returns are shown to vary with risk, it is conceivable that futures prices are at least partially used as expectations.

Introduction

Average returns to cattle feeding compare favorably with the returns to popular alternative investments such as the stock market. However, cattle feeding is a relatively risky investment (Figure 1). The volatility in cattle feeding returns is likely attributable, at least in part, to illiquidity of the investment over the required holding period of several months. The investment is "sunk" at the time cattle are placed on feed. Numerous events occur during the feeding period that ultimately affect cattle feeding profits. Weather can directly affect the performance of the cattle on feed as well as feed prices. The expected supply of finished cattle cannot be accurately estimated until well into the cattle feeding period, causing expected fed cattle prices to change rapidly in response to new information. Because of illiquidity, investors may not be able to respond to new information about the expected performance of cattle feeding investments as easily as they might with investments in common stock or storable commodities. However, the futures market provides a mechanism for transferring price risk.

Under the assumptions of expected utility theory, a risk averse investor requires a higher expected return on a riskier investment. Thus, expected returns are a function of the perceived risk in that investment. Expected returns, however, are unobservable. Since the risk in cattle feeding is largely price risk, expected returns are closely tied to expected prices. One proxy for expected fed cattle prices is the futures market (Gardner). Experience or historical performance can also proxy for expected performance.

Under the assumptions of portfolio theory, a risk averse investor is only concerned with how an individual investment, such as cattle feeding, affects the risk of his or her entire portfolio. The effect is weighted by the correlation between cattle feeding returns and all other assets in the portfolio. If the portfolio is well diversified, and cattle feeding returns are not positively correlated with the rest of the portfolio, the risk in cattle feeding is diversified away and not a factor in the investor's expected return on investment.

Previous studies show that risk influences processing margins of rice, soybeans, wheat, beef, and pork (Brorsen, Chavas, and Grant; Boyd, Brorsen and Grant; Brorsen et al.; Holz; Schroeter and Azzam). However, little is known about the risk effects on expected margins of non-storable commodities that have a relatively long and illiquid holding period. The high degree of profit risk in cattle feeding and the infrequency of profitable hedging opportunities at the time cattle are placed on feed (Hayenga et al.; Koontz, Hudson, and Hughes) warrant further study of expected cattle feeding returns. The objective of this study is to determine the extent that expected cattle feeding returns are influenced by perceptions of risk and draw implications about the usefulness of futures market prices as proxies for price expectations and for absorbing risk. An effort is made to determine appropriate proxies for cattle feeders' perceptions of risk at the time they place cattle on feed.

Literature Review

Grain markets have shown a strong relationship between expected marketing margins and risk. Brorsen, et al. presented a theoretical model showing that if marketing firms are competitive and decreasingly absolute risk averse, then an increase in output price risk should result in higher expected marketing margins. They assume that agents base their perceptions of the riskiness of the current market situation on a weighted moving-average of the absolute value of price changes over the previous twelve-month period relative to the annual average output price. Empirical evidence from the wheat marketing channel supported their theoretical model in that increased price volatility significantly increased expected wheat marketing margins for both the farm-mill margin and the mill-retail margin. Similarly, soybean crushing margins (Boyd et al.) and rice marketing margins (Brorsen, Chavas, and Grant) increase as risk increases, where risk is defined as the annual coefficient of variation of monthly value of products from processing.

Koontz, Hudson and Hughes argued that futures market prices for competitively produced nonstorable commodities, such as live cattle, follow a rational formation process. Futures market prices reflect expected market conditions only when contracts are sufficiently close to the delivery month because supply of the underlying commodity cannot change. However, prior to the period when future supplies are relatively fixed, futures market prices should adjust to reflect the competitive equilibrium, where expected output price equals long term average costs of production. Hence, only low-cost cattle feeders can typically hedge profitably at placement. The rational formations hypothesis suggests that live cattle futures markets forecast poorly at longer time horizons and improve as the contract nears maturity.

The decision variable in expected cattle feeding returns is whether to purchase feeder cattle which is reflected in the price paid for feeder cattle. Lee and Brorsen used feedlot pen level data to show that feeder cattle prices vary with fed cattle profit risk. The lagged average absolute deviations of actual profit and expected profit of fed cattle were used as a measure of perceived fed cattle profit risk, where expected profit was zero. Neither Koontz, Hudson and Hughes nor Lee and Brorsen attempted to explain variable cattle feeding profit expectations.

Kastens and Schroeder (1994) compared the performance of expected hedgeable profit with past actual profit in explaining feeder cattle placements. Past actual profit was a more important cattle on feed placement determinant than expected profit based upon the live cattle futures market, even though hedgeable profit provided a superior forecast of future profit. Results suggested that there is either a wealth effect associated with recent cattle feeding profits and/or cattle feeders used naive expectations when placing feeder cattle. The study also demonstrated that cattle feeders continued to place cattle on feed when hedgeable profits to cattle feeding were negative. This behavior is indicative of a perception among cattle feeders that downward bias exists in the live cattle futures market, and that futures-based hedgeable profits may be poor proxies for expected profits.

Numerous studies have indicated that return on investment in cattle feeding compares favorably and has a low or negative correlation with returns to other investments (e.g., Dodson and Elam;, Jones, Mintert, and Albright). Kastens and Schroeder (1995) used a Capital Asset Pricing Model (CAPM) framework to conclude that expected returns for live cattle futures funds should be somewhere between T-bill returns (risk-free) and stock market returns. These results are explained by the small (near zero) CAPM beta coefficients, which signal low correlation with the stock market. Risk in cattle feeding can be largely diversified away. Since cattle feeding risk is largely unsystematic, cattle feeding investments may enhance the performance of well-diversified portfolios without increasing portfolio risk.

None of these studies attempts to explain the variability in aggregate expected cattle feeding returns. If expected cattle feeding returns vary with risk, the risk-return tradeoff underpinning portfolio theory can be applied and implications in support of rational and risk averse behavior can be drawn. If the market rewards unsystematic risk through higher expected returns, it is likely that the investment portfolios of cattle feeders are not well diversified. It would also provide evidence supporting the usefulness of deferred live cattle and corn futures contract prices as forecasts.

Theoretical Framework and Empirical Model

Assume cattle feeders maximize expected utility which is increasing in real profit and decreasing in profit risk. Then a cattle feeder's utility may be viewed as a function of expected return on investment (ROI) and risk. At any point in time, cattle feeders' expectations of return on an investment in feeder cattle and other inputs are derived from expectations of future output and input prices, cattle performance variables, and possibly price and performance risk. The feeder cattle purchase decision is therefore endogenous, reflecting all associated expectations. If a relatively high level of uncertainty exists in expected ROI, cattle feeders will reduce demand for feeder cattle until a risk premium large enough to entice feeder cattle investment is built into expected ROI . Expected ROI is heavily influenced by expected output price. This study uses the live cattle futures price nearby to the expected finish date as a proxy for expected output price. Live cattle futures may reflect supply risk associated with costs of production, such as feed price risk and performance risk.

To accomplish the objectives of explaining expected cattle feeding ROI at placement, the following model was formulated:

$$ExROI_t = f(Risk_t, COF_t, Days_{t+exdof}, LACFM_{t-1}, Seasonality), \tag{1}$$

where t refers to placement month, $ExROI_t$ is the hedgeable expected annualized percent return on investment for feeder cattle placed on feed during month t less a cost of capital hurdle equal to the interest rate on cattle feeding loans, $Risk_t$ is a measure of cattle feeders' perceptions of price risk in their cattle feeding investments at placement, COF_t is the cattle on feed inventory at placement, $Days_{t+exdof}$ is the number of days left to expiration of the nearby live cattle futures contract at the time of expected finish of cattle placed in month t, $LACFM_{t-1}$ is the actual cattle feeding profit in dollars per hundred weight (shrunk 4 percent) for cattle finished in the month prior to placement month t, and *Seasonality* represents monthly dummy variables. Table 1 contains summary statistics of the data.

$ExROI_t$ is based on expected profit, which is expected revenue minus the cost of feeder cattle and expected costs of feed and yardage. Investment is defined as the cost of the feeder cattle plus one half the expected costs of feed and yardage. $ExROI_t$ is consistent with an Economic Value Added (EVA) performance measure. This measure is preferred to a straight return on assets (ROA) measure because it allows for an opportunity cost of capital that varies over time, yet eliminates any effect of leverage. If $ExROI_t$ is positive, then leverage would increase $ExROI_t$. Observations for the empirical model are monthly averages for each placement month from October, 1984 through December, 1997.

The number of cattle on feed (COF) at the time the cattle feeder is contemplating the feeder cattle investment (assumed to be the same time as placement of cattle on feed) is anticipated to affect expected ROI. This is basically a feedlot capacity issue. At times when COF numbers are relatively small, feedlots not operating at optimum capacity may bid more aggressively for feeder cattle in an effort to fill the feedlot and cover fixed costs, weakening expected ROI. If cattle inventories are insignificant in explaining margins, a possible explanation is that significant barriers to entry and exit do not exist in cattle feeding. Thus, capacity shrinks and swells with the cattle cycle as high-cost cattle feedlots exit and enter the industry. An alternative explanation of insignificance or of an inverse relationship between $ExROI_t$ and COF_t is that packers also might bid more aggressively for finished cattle during times of small COF numbers in order to keep their processing plants operating near optimum. Together, higher feeder cattle prices with higher prices for finished cattle could leave feeding margins unchanged or even smaller.

To control for the possibility of downward bias in live cattle futures (Kastens and Schroeder 1995), the number of days from the projected cattle finish date to the expiration of the finish date's nearby live cattle contract is included as an explanatory variable. A negative and significant coefficient may indicate a persistent downward bias during the last several weeks in live cattle futures and capture any persistent weakening of basis toward contract expiration.

Recent actual returns to cattle feeding explain current cattle feeder placement activity and are included in the model as an explanatory variable (Kastens and Schroeder 1994). A wealth effect or naive expectation would suggest that true expected returns and recent actual performance are positively related. However, hedgeable returns are expected to be inversely related to recent profits if higher recent profits induce higher feeder cattle demand. Therefore, an inverse relationship between hedgeable returns and lagged actual returns could provide evidence that hedgeable returns are not used by cattle feeders as expected returns. Alternatively, an inverse relationship with hedgeable expected returns may imply that recent profits represent cattle feeders' perceptions of risk in cattle feeding where higher recent profits translate to perceptions of lower risk. If this is true, required expected returns would be inversely related to recent performance for a risk averse cattle feeder, which is consistent with the expected response in hedgeable ROI.

Seasonality and technology are incorporated into expected ROI via estimates of cattle feeders expectations of performance variables. Expected finish weight, days on feed, and feed conversion are estimated using historical pen-closeout data as explained in the following section. With estimates of these three variables, other performance variables such as weight gain are implicit in the model. However, the uncertainty or risk associated with seasonal performance variables must be controlled for, so the model includes seasonality as additional explanatory variables. Additional seasonality may arise from tax implications of investment decisions and any seasonal variable or risk not accounted for elsewhere.

Seasonality of expected and actual ROI is presented in Figures 3 and 4, respectively. As expected, variability in actual returns is highest for cattle placed in April, May, June and December. Feed prices are usually most volatile in early summer while cattle performance is least predictable during the winter months. Actual returns peak with June placements and are lowest for February placements. Expected returns are highest for July placements and lowest for November and December placements.

Data Description

Summary statistics for expected cattle feeding returns at placement are compared with actual results over the period February 1981 through July 1997 (Figure 2). Means and standard deviations confirm that average cattle feeding returns over time are associated with a high level of volatility (Figure 1). Mean expected returns ($ExROI_t$, -0.97%) are lower than actual returns ($ActROI_t$, 14.7%) and have less volatility (Figures 1 and 2).

Previous research has shown that live cattle, corn and feeder cattle prices explain 87 to 95 percent of the variability in cattle feeding profitability (Langemeier, Schroeder, and Mintert; Schroeder et al.). In addition, corn price and feed conversion explain 90 percent or more of feeding cost of gain variability (Albright et al.). Therefore, corn prices are used as a proxy for the price of the total feed ration. The monthly average corn price observed in the placement month for corn futures contracts that become nearby as time progresses through the feeding period is used as the expected feed price. Contract months are weighted as a proportion of expected days on feed attributable to a specific contract with prior month rollover.

Our calculated expected and actual returns series may not adequately represent true expected and actual returns due to using corn futures price as a proxy for feed costs. However, because the same feed cost proxy was used for both expected and actual returns, the difference between expected and actual returns should be a reasonable estimate of true differences between expected and actual returns.

Our futures-based expected returns are generally lower than actual returns. Possible explanations include a) investors do not formulate their expectations as we have assumed, or b) our data series is too short to allow expected and actual returns to equate in the long run. Nonetheless, $ExROI_t$ near zero is consistent with near zero beta coefficients in the CAPM model; that is, no risk premium is required for cattle feeding investment in a portfolio setting. Removing the cost of capital hurdle in $ExROI_t$ and relying on the assumption that our feed price proxy understates feed costs, average hedgeable expected ROI over the period studied likely approximates the risk-free rate.

The cost of capital hurdle rate used in both hedgeable expected ROI and actual ROI calculations is the interest rate on cattle feeding loans for the Tenth Federal Reserve District as reported by the Kansas City Federal Reserve Bank. Average monthly placement weights were provided by Cattle-Fax.

The feeder cattle price used in $ExROI_t$ is the monthly average Dodge City cash feeder cattle price observed in placement month t for 600 to 800 pound steers. Stochastic performance expectations for feed conversion, fed weight, and days on feed were constructed by regressing each variable on placement weight, season, and year using 6712 actual steer feedlot closeouts over the years 1984 through 1994 from two Western Kansas commercial feedlots. The performance variable models should provide a realistic simulation of seasonality and technology trends. Yardage was charged at fifteen cents per head per projected day on feed. The average price of the projected finish date's nearby live cattle futures contract observed during the placement month is used as a proxy for the expected fed cattle price at finish.

Aggregate actual cattle feeding returns for cattle finished in a given month were calculated using monthly average finish weights and days on feed from Cattle-Fax and monthly average feed conversions from a database of closeout data surveyed monthly from seven feedlots by extension animal scientists at Kansas State University. Daily cash corn prices were used to estimate feed prices and monthly average Texas/Oklahoma live cattle prices were used as an aggregate fed cattle price. As with $ExROI_t$, yardage was charged at fifteen cents per head per day. Finish month data were lagged five months to approximate the placement month and associated feeder cattle cost. The same average monthly placement weights used in the expected returns calculation were used in calculating actual returns. Feeder cattle prices are the monthly average Dodge City cash feeder cattle price observed in the placement month for 600 to 800 pound steers and heifers.

Empirical Results

One objective of this study is to identify appropriate risk variables. Various proxies for cattle feeders' perceptions of risk in their feeder cattle investments were considered. Monthly average implied volatility from the various futures options were tested as well as an annualized 20-day historical volatility calculated from daily percent changes in prices of the underlying futures contracts. Corn price volatility was not statistically significant using either measure. Twenty-day historical volatility in live cattle futures prices was not statistically significant either and therefore only implied cattle option volatility is included in the final model. Other measures of perceived risk that were not significant include live cattle and corn volatility over the prior 150-day feeding period, 12-month standard deviation of average monthly profits, and deviation of recent profits from expected profit. Thus, of those measures examined here, it appears that the most important risk consideration by cattle feeders when placing cattle on feed is the market's perception of expected variability in the projected finish date's nearby live cattle futures price, as determined by the options market.

Empirical results are presented in Table 2. The model was estimated using generalized least squares adjusting for first-order autocorrelation using the Yule-Walker method in SAS. The model explains 72 percent of the variation in $ExROI_t$. Neither COF_t, $Days_{t+exdof}$, nor $LACFM_{t-1}$, are statistically significant at the 0.10 level. The implied live cattle option volatility ($LCIV_t^{t+exdof}$) coefficient is significant at the 0.10 level and of the expected sign. Several seasonal dummy variables are significant, particularly for placements early in the year, which suggests higher expected returns in those months relative to the December default. This could be explained by not controlling for end-of-year tax savings incurred through deferral of income to the following year while capturing income deductions in the current year. Another possibility is that the risk variable is not capturing some seasonal risk that may be associated with feed prices or some other perception of uncertainty.

This model provides additional insights into the industry capacity issue. The negative COF_t coefficient, though only statistically significant at the 0.15 level, would imply that packers tend to reduce fed cattle prices more when inventory levels are high than cattle feeders reduce feeder cattle prices. Insofar as $Days_{t+exdof}$ can be construed as a measure of futures bias, this model did not find evidence of downward bias in live cattle futures or a weakening live cattle basis during the last sixty days of a feeding period. Of course it could be that the seasonal dummies were actually measuring perceptions of downward bias. Cattle placed in December (default dummy) to be finished during April and May, had substantially lower expected profits than those placed early in the year (to be finished in late summer).[1]

[1]The 4 to 5 month 1985-1997 average live cattle futures bias (price of contract nearby to finish date less the price of the same contract at placement on feed) corresponding to cattle placed in August through December and May was \$1.68/cwt. These were the 6 months with the lowest dummy coefficient values. On the other hand, the bias associated with January through April and June and July placements (the highest–valued dummies) was only \$0.78/cwt. That is, investors placing cattle in months of low dummy values may expect futures prices to rise more during the feeding interval than investors placing cattle in the other 6 months. Thus, investors in low-dummy months are willing to tolerate lower expected returns, as we have calculated them - hence, the lower values on those dummies. The implication is that our calculated profit expectations may not accurately measure actual profit expectations.

The lack of significance in the lagged actual profit variable (Table 2) is surprising given previous studies. In this study, a wealth effect or naive expectation does not appear to explain hedgeable cattle feeding returns. This supports the use of hedgeable returns as a proxy for expected returns because previous studies show that feeder cattle demand rises when recent profits increase. Therefore, a simultaneous increase in live cattle futures may be offsetting higher feeder cattle demand when recent profits are high, leaving the hedgeable profit relatively unchanged. Another possible explanation is that autocorrelation in expected returns offsets the wealth effect or naive expectation Kastens and Schroeder (1994) found explained feeder cattle placements.

Conclusion

If cattle feeders are risk averse and they use the futures markets for expectations of future prices, then in the aggregate, their expectations of return on investment in cattle feeding should be positively correlated with their perceptions of the relative riskiness in that investment. A possible exception may hold if cattle feeding investments are generally part of well-diversified portfolios and risk in cattle feeding can be diversified away. Cattle feeders influence their expected return through the price they are willing to pay for feeder cattle. During periods of uncertainty in their projections of profitability, cattle feeders are expected to bid less for feeder cattle. Alternatively, packers respond to supply risk by hedging in live cattle futures, which can alter hedgeable expected ROI in cattle feeding. By studying the relationship between risk and expected returns, hedging opportunities can be discovered. These implications hold only if cattle feeders are using the futures markets as price expectations.

The ability to estimate this relationship is contingent upon discovering an appropriate proxy for cattle feeders' perception of risk and other explanatory variables of expected returns. Several risk measures and explanatory variables used successfully in other studies were not significant in this model.

Perceptions of risk in cattle feeding, as measured by implied live cattle option volatility, explains some of the variation in hedgeable expected cattle feeding ROI. Evidence that expected returns vary with risk gives credence to the use of live cattle futures as price expectations at placement. If cattle feeders are risk averse, higher expected returns are required for assuming more risk. Since we have defined expected returns to be hedgeable returns, under conditions of relatively more profit uncertainty, the futures market must offer a higher hedgeable expected return and "risk premium" to entice feeder cattle investment. This study modestly supports the risk-return tradeoff hypothesis and thus risk-responsive futures markets are reflective of investors' expectations. Thus, cattle feeders appear to be using futures market prices, at least in part, as their expectation of future prices.

The significant relationship between risk and hedgeable expected ROI implies that cattle feeders are compensated for bearing diversifiable risk, since most risk in cattle feeding is unsystematic with the stock market. If so, cattle feeding investments are not generally part of well-diversified portfolios. Moreover, expected profits in cattle feeding at placement vary considerably, contradicting some previous studies and assumptions. Additional research is needed to perfect the model and further develop an understanding of cattle feeders expectations of risk and reward.

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