Price Discovery for Stocker Cattle Futures and Options

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Paper presented at the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management

Chicago, Illinois, April 17-18, 2000

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Low trading volume in the CME stocker cattle contracts has made hedgers and speculators reluctant to use the contracts. Traders need decision tools to discover prices or to evaluate quoted prices that may not contain all the information in the market. The number of head of stocker weight cattle sold on the spot market has increased in recent years while the practice of cross-hedging stocker weight cattle against the feeder cattle contract remains risky. A model explains the spread between feeder cattle and stocker cattle futures prices as a function of feed prices, live cattle prices, and seasonal factors. The volatility of spot stocker cattle prices is comparable to spot feeder cattle prices, supporting the idea of using feeder cattle implied volatility measures as estimates of stocker cattle futures implied volatility in option pricing models. The model and relations proposed should be useful for traders evaluating observed prices or placing limit orders for stocker futures and options.

Key words: stocker cattle, cross-hedging, volatility, limit order, thin markets.

Introduction

In 1998, the Chicago Mercantile Exchange introduced stocker cattle futures and options contracts. Trading volume and open interest in these contracts has been small relative to feeder cattle and live cattle contracts. Possible reasons for the lack of activity may include a lack of knowledge about the contracts' existence, a lack of demand for the stocker cattle contracts by hedgers, and difficulty with price discovery methods suitable for arriving at the necessary initial bids and offers. This article addresses the latter two reasons for this thin market and offers suggestions for existing and potential traders of stocker cattle contracts.

Because stocker cattle contracts reflect a different weight class of steers, they are quite similar to feeder cattle contracts already used by traders. There may not be a need for another contract unless enough producers face price risk with stocker weight cattle that is not easily hedged using feeder cattle contracts. A strong seasonal pattern exists in prices of both feeder weight and stocker weight cattle. The result of combined supply and demand forces is a price spread between the weight classes. The timing of price peaks and troughs results in a dynamic price spread that varies widely within and across years. The price spread is a fundamental reason for the potential risk management benefits of using the stocker cattle contracts. Hedgers with stocker weight cattle may seek to reduce their price risk of holding cattle in general and to minimize cross-hedging risk (from using feeder cattle contracts) in particular.

The introduction of the stocker cattle contracts was somewhat burdensome from a price-discovery perspective. The Chicago Mercantile Exchange introduced both the futures and options at the same time. Other cattle options contracts were introduced after the futures contracts had been trading for a number of years. Consequently, there is no history of stocker futures volatility to use for inferring about implied volatility of stocker options. Hedgers, especially new hedgers, seem more willing to consider using options versus futures. However,

without regularly quoted options prices hedgers are faced with the task of discovering prices on their own.

The objectives of this article are to quantify the scope and magnitude of cross-hedging risk potentially reduced by the stocker cattle contracts and to identify feeder/stocker and futures/spot price relationships that would facilitate price discovery of stocker cattle contracts. The results provide practical insights and recommendations for hedgers and traders seeking to use the stocker cattle contracts.

Cross-Hedging Risk

Price variability is present in the stocker and feeder cattle markets. The Chicago Mercantile Exchange has made a historic data series of index calculations available for both the stocker index and the updated feeder index (www.cme.com). As shown in figure 1, the indexes fluctuate over time, as does the spread between them. Before the introduction of the stocker cattle contracts, hedgers would have to cross-hedge stocker weight cattle against the feeder cattle contracts (Elam and Davis). Cross-hedging risk occurs because the price spread between different weight classes of cattle is not constant. The stocker cattle contracts should help hedgers offset the risk from a collapsing price spread.

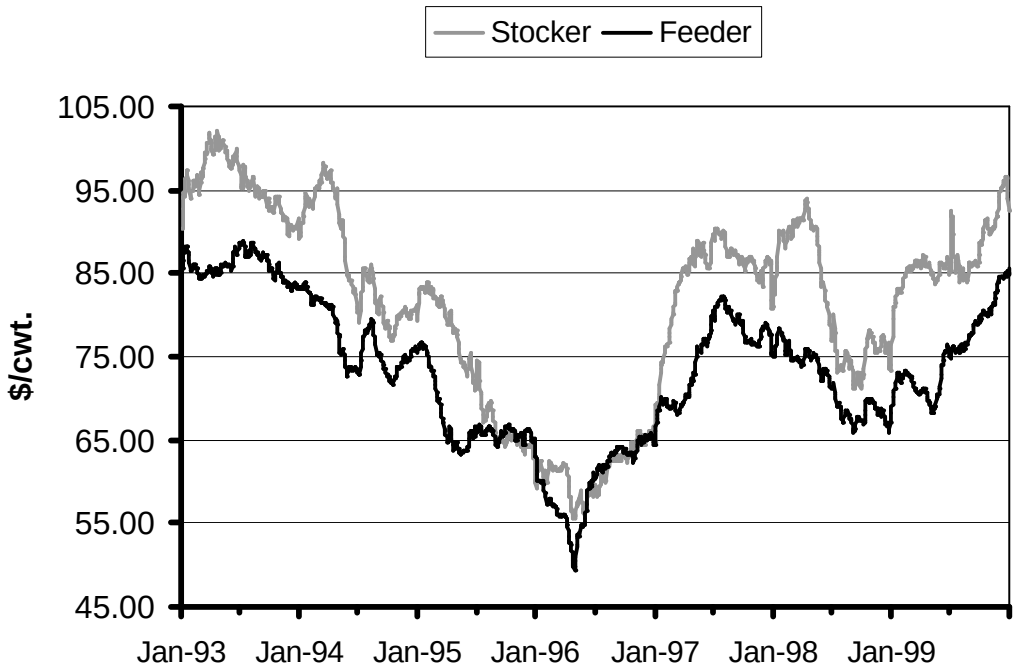

Figure 1. Stocker cattle and feeder cattle indexes, 1993-1999.

The stocker cattle contracts are similar to the feeder cattle contracts except for the smaller weight class in the specifications (Chicago Mercantile Exchange). The contract size is 25,000

pounds of 500-599 pound steers, or 42-50 head. The contract months are October, November, December, January, February, and March. There is no delivery as the contracts are cash-settled to an index of stocker weight cattle. It should also be noted that the feeder cattle contract specifications were changed in late 1999 to reflect 700-849 pound steers. The historical feeder futures prices in this study reflect the 700-799 pound prices.

Demand for the stocker cattle contracts would ultimately depend on the volume of cattle presenting price risk to producers. Relating the number of stocker cattle sold to the number of feeder cattle sold provides an indication of the potential trading volume of stocker contracts. Included in the index data are the daily number of head sold that meet the respective contracts' grades. The annual total number of head sold meeting the contract specifications for stocker and feeder indexes are shown in table 1.

Table 1. Number of Head Comprising the Cash-Settled Indexes

Year	Stocker	Feeder
1993	372,879	1,026,962
1994	419,547	1,218,621
1995	456,756	1,088,297
1996	466,293	1,158,595
1997	522,625	1,114,490
1998	572,484	1,159,261
1999	643,011	1,334,805

The number of stocker weight cattle sold and comprising the index has increased from under 400,000 head in 1993 to over 600,000 head in 1999. The trend during that period has been for a steady increase in the number sold, unlike the feeder cattle where the number sold has fluctuated without a clear trend. The absolute number of stocker head is still only about half the number of feeder head sold. Hence, a smaller volume of stocker contracts could be anticipated, even after accounting for the difference in the number of head necessary to fill the contracts (about 65 for a feeder contract and 45 for a stocker contract).

In addition to the number of head sold, an important factor is the price risk faced by those selling stockers versus feeders. An indication of price risk is the annual variability in stocker prices. In an effort to assess the risk that could potentially be hedged, the values of the stocker and feeder indexes were obtained for the last Thursday of the months of January, March, and November from 1993 to 1999 (table 2). For January, the stocker index close had a range from $61 to $95 with an average of $83 and standard deviation of $12. Likewise, during January the feeder index close ranged from $60 to $86 with an average of $75 and a standard deviation of $9. However, a direct comparison between the absolute prices is somewhat limited, as the variability of prices would not translate directly into returns per dollar invested.

The variability in the price spread between stocker and feeder prices indicates that sizeable cross-hedging risk exists. The spread is computed as the difference between the stocker and feeder index values on the expiration dates. It would be indicative of the cross-hedging risk faced by someone long spot stockers and short feeder cattle futures. The spread in January

ranges from $1 to $12 with an average of $8 and a standard deviation of $4. The standard deviation is about one-third of that of the stocker price. The impact on individual hedgers would depend on their risk aversion. The price risk and cross-hedging risk faced by stocker hedgers can thus be large, and if they seek to offset those risks, the stocker contract could be a viable tool.

Table 2. Index Values and Differences on Implied Settlement Dates

Contract	Year						
Month	1993	1994	1995	1996	1997	1998	1999
				Stocker Cattle Index			
January	94.97	93.43	82.95	61.04	74.71	89.78	82.84
March	100.71	96.90	79.38	62.13	84.83	91.60	85.82
November	89.58	80.75	63.83	65.31	84.95	75.67	91.91
				Feeder Cattle Index			
January	86.34	82.88	76.10	59.60	69.35	77.61	72.51
March	85.22	81.26	65.42	55.92	69.24	74.29	70.65
November	83.42	74.64	65.54	64.57	77.49	68.36	82.84
				Spread			
January	8.63	10.55	6.85	1.45	5.36	12.17	10.33
March	15.49	15.64	13.96	6.21	15.59	17.31	15.18
November	6.16	6.11	(1.70)	0.74	7.46	7.31	9.07

Note: The reported index values are for the last Thursday of the contract month.

Stocker-Feeder Price Spread

Assuming demand for stocker futures exists, efficient stocker futures prices would concern traders. Several factors determine the level of stocker prices (Pennington & Company Ltd.). However, without a historical forward contract market for stocker cattle, the question becomes how high the stocker futures should trade relative to observed feeder futures prices. Stocker cattle typically trade at a premium to feeder cattle on a per-hundredweight basis because of cost of gain and value of the cattle on a per-head basis. A positive price spread between stocker and feeder futures would be expected, unless the average cost of gain for the stocker cattle was anticipated to exceed the average cost of gain for the feeder cattle at a point in time. Seasonal supply and demand factors also drive the spread reflecting the desire for spring calving and greater demand for beef during the summer.

The difference or spread between the daily stocker and feeder cattle indexes (for the updated 700-849 weights) is generally positive as shown in figure 2. A clear seasonal pattern exists with a relatively narrow spread from July to January. A gradual increase occurs from January through April and a gradual decrease occurs from April through June. The spread is generally widest from March to May. The pattern largely reflects the underlying supply and demand for both stocker and feeder cattle. However, other factors would also influence the spread. A model would be useful for forecasting the spread between stocker and feeder cattle for

points in time when stocker futures prices are desired. The spread can be added to observed feeder cattle futures prices to obtain forecasts of the stocker futures prices.

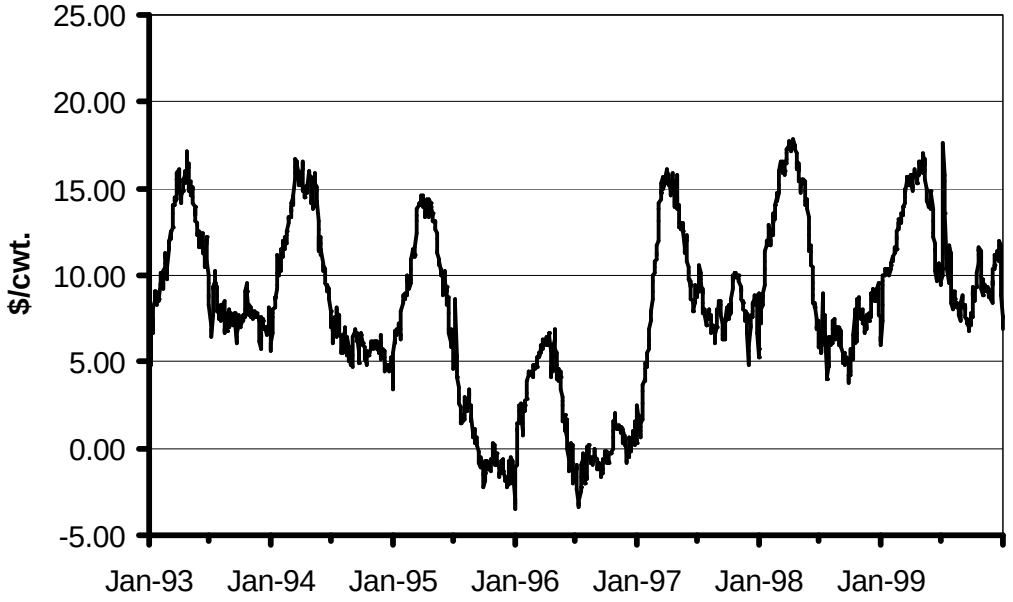

Figure 2. Difference between daily stocker cattle and feeder cattle indexes

The spread reflects the relative feeding margins and supply and demand factors for the different weights. Corn is a major input when finishing cattle and often in backgrounding too. Hence, the price of corn is expected to negatively influence feeding margins and the price spread. Because live cattle are the ultimate products regardless of the weight, the price of live cattle determines the upper end of the feeding margin. The price of live cattle is expected to positively influence the price spread. Dhuyvetter and Schroeder showed that corn prices have a negative impact and live cattle prices have a positive impact on the calf price and weight relationship. Hence, a similar impact on the price spread is anticipated. Because steers are often grazed, pasture conditions and the price of other feedstuffs are also anticipated to influence the spread. The price of hay is included as a proxy for these other factors, but without a clear anticipated relationship. Lower hay prices could lead to stockers being held back for additional winter grazing, thus lowering the supply to be marketed and increasing the spread. Higher hay prices could indicate low supplies of feedstuffs, which could send more cattle to feedlots, thus pressuring feeder prices and increasing the spread. The number of cattle on feed is included as an indicator of increasing costs of feeding as feedlots reach capacity. An increase in the number of cattle on feed is expected to reduce demand for feeder cattle and increase the spread.

The spread between the stocker and feeder indexes, S_t, is specified as a linear function of independent variables:

(1) $$S_t = b_0 + b_1 P_t^{CORN} + b_2 P_t^{HAY} + b_3 P_t^{LC} + b_4 COF_t + b_5 D2 + b_6 D3 + b_7 D4 + e_t,$$

where P_t^{CORN} is the price of corn, P_t^{HAY} is the price of hay, P_t^{LC} is the price of live cattle, COF_t is the number of cattle on feed, *D2* is a quarterly dummy variable for December – February, *D3* is a quarterly dummy variable for March – May, *D4* is a quarterly dummy variable for June – August, and e_t is an iid error term. Thus the intercept, b_0, reflects the quarter September – November. The model was estimated using OLS.

The data are monthly from January 1993 through December 1999, giving 84 observations. S_t is the monthly average of the daily spread between the seven-day stocker and feeder indexes from the Chicago Mercantile Exchange. P_t^{CORN} is the monthly cash corn price in \$/bu. at Omaha from USDA-AMS. P_t^{HAY} is the U.S. monthly average hay price received by farmers in \$/ton from USDA-AMS. P_t^{LC} is the monthly price of live cattle in \$/cwt. at Omaha from USDA-AMS. COF_t reflects the number of head on feed in the historic seven states, in thousands, at the beginning of the month as compiled by USDA-NASS and reported by Livestock Marketing Information Center. The dummy variables used, although not the typical quarterly seasonal dummies, were selected as such to reflect the seasonal patterns in the stocker-feeder spread numbers, with the spread being the narrowest from September to November and the widest from March to May. These dummy variables were chosen over monthly variables because they capture the same seasonal effects without as many variables.

The results, shown in table 3, reveal that the variables significantly explain 74% of the variability in the spread. The P_t^{CORN} coefficient is negative as expected. The P_t^{HAY} coefficient is positive, which is partly explained by a seasonal pattern in the hay price that is consistent with the spread (not shown). The P_t^{LC} coefficient is positive as expected as is the cattle on feed coefficient. $D3_t$ (Mar-May) has the highest coefficient, as expected, which reflects the peak demand for stockers for grazing programs at a time when feeder prices are seasonally declining. The late autumn months (Sep-Nov) not only reflect the time of year when both stocker and feeder prices experience lows, but also when the spread between the two is the narrowest, as reflected in the fact that all three other seasonal dummy variables have positive coefficients.

Table 3. Parameter Estimates of Price Spread Model

Variable	Coefficient Estimate	Standard Error
$Intercept_t$ (Sep-Nov)	-11.57	7.80
P_t^{CORN}	-3.69**	0.46
P_t^{HAY}	0.08**	0.03
P_t^{LC}	0.13*	0.06
COF_t	0.001*	5.1E-4
$D2_t$ (Dec-Feb)	1.73*	0.86
$D3_t$ (Mar-May)	8.20**	0.82
$D4_t$ (Jun-Aug)	3.04**	0.81
Adjusted OLS R^2 = 0.74		

Notes: An F-test with 83 degrees of freedom was significant at the 1% level. * indicates significance at the 5% level and ** indicates significance at the 1% level.

Stocker Futures Volatility

In order to value stocker cattle options, some indication of implied volatility is necessary. Conceptually, it seems reasonable that the returns from holding stocker futures would not differ greatly from holding feeder futures. Some support for the argument is the similarity of the historic volatility patterns of feeder cattle futures and live cattle futures in Moore Research Center, Inc. However, stocker futures values would reflect additional time until the final product (live cattle) is obtained, where both feeder cattle and corn prices may fluctuate. Hence, the volatility of stocker cattle futures may exceed that of feeder cattle futures. The strong seasonal pattern of stocker prices (relative to feeder prices) may actually make the stocker futures more predictable than feeder futures. Stocker cattle tend to be marketed during periods of relatively low price uncertainty for feed inputs. The volatility-reducing factors need to be weighed against any volatility increase due to relatively less transparency of stocker values versus feeder values.

Although a historic series of stocker futures is not yet available, a series of the stocker index is available. Hence, it is possible to observe the historic volatility of the stocker cash price. However, historic volatility is not necessarily indicative of future volatility and cash price volatility would not necessarily reflect volatility associated with a futures price. The historic feeder futures prices are available and allow for a comparison of cash and futures volatility for feeder cattle. The historic volatility of returns can be obtained using daily price data (Hull). For each price series, the ratio of the current price to the previous day's price was computed. Then, the natural log of the ratio was taken to obtain the continuously compounded return from holding the asset.

The returns from holding different stocker and feeder prices (not shown) were consistent across prices from 1993 to 1999. Stocker cash returns were computed from both the daily totals and seven-day totals of the stocker index. Feeder cash returns were also computed from the feeder index. In addition, the nearby feeder cattle futures prices were compiled using closes from the Livestock Marketing Information Center. Prices through expiration were included, but returns associated with the first dates following rollovers to the next month were excluded.

The variability of the returns, measured as the monthly standard deviation of returns, showed distinct patterns across different sets of prices. The variability of the stocker index returns closely resembled the variability of the feeder futures returns (not shown). This relationship is understandable considering that uncertainty surrounding a futures price would carry over into general uncertainty of cash values for lighter weight animals. Both the stocker index and feeder futures returns variability levels exceeded that of the feeder index returns. Perhaps the feeder index dampens variability, making it smaller than the futures returns variability. The stocker index, comprised of fewer head, is perhaps not dampened as much. To avoid problems associated with dampened variability, the feeder futures returns are compared to the stocker spot and feeder spot returns (where spot refers to the daily total for the respective index and not the seven-day total). The stocker spot and feeder spot returns variability is similar for the sample period as shown in figure 3. The spot returns are consistently more variable than that of the feeder futures – consistent with the conjecture that cash prices could fluctuate more than futures prices.

The similarity of the spot returns variability would lend credibility to using the implied volatility of feeder futures as a forecast of the volatility of stocker futures. One could argue that a larger volatility is needed because the stocker prices are more variable than the feeder prices. Indeed the variance of the stocker prices exceeded that of the feeder prices across years on the implied expiration dates. However, that is not a prerequisite for greater futures volatility. The volatility patterns or expectations are thus important to understand because uncertainty surrounding prices would not have to be constant throughout the year. The appropriate feeder cattle futures months for use as proxies for different stocker futures need to be determined.

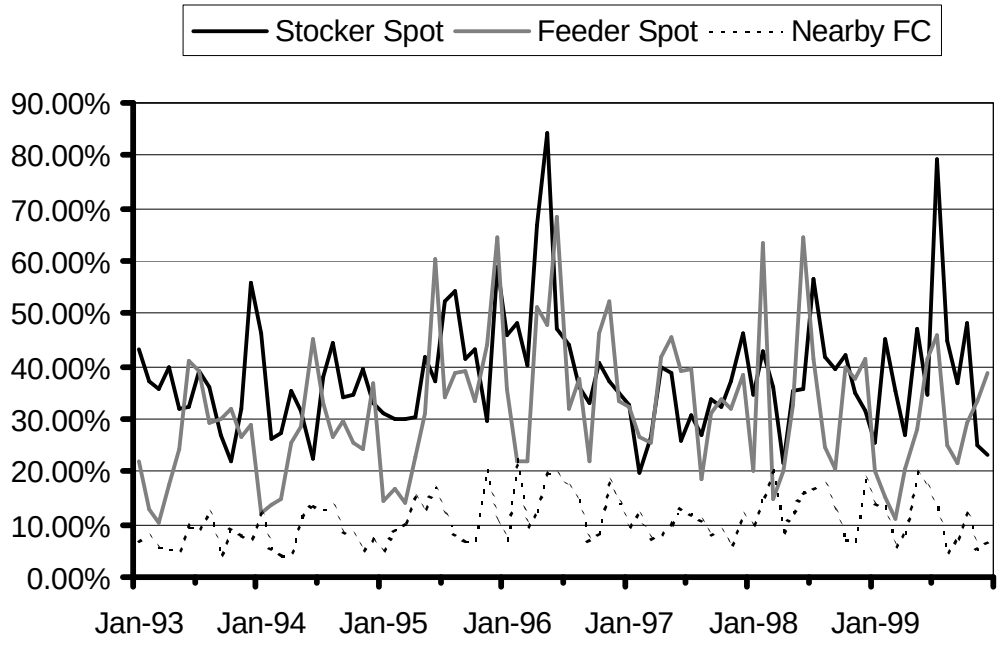

Figure 3. Monthly standard deviation of daily returns, 1993-1999

There are seasonal patterns in the uncertainty of feeder futures prices. Charts of the historic volatility of feeder cattle futures (average 20-day volatility) by contract month show a tendency for volatility to rise for much of the trading period and to decline towards expiration (Moore Research Center, Inc.). The charts also show that volatility tends to peak during July and August regardless of the contract under examination. The standard treatment of volatility of agricultural commodities is to examine historic volatility (Manfredo, Leuthold, and Irwin; Kenyon et al.). However, a thinly traded market such as stocker cattle futures perhaps warrants a different perspective on volatility.

The level and path of volatility are needed to determine stocker option prices. To gain insight into stocker volatility, two feeder cattle contract months were examined based on the anticipated relationship between the stocker weight calves and their potential marketing as feeder weight calves. Stocker calves sold from October through December and backgrounded on grain would tend to reach feeder weight in time to correspond to March feeder futures. Stocker calves

sold from January through March and primarily run on grass would tend to reach feeder weight in time to correspond to August feeder futures.

The returns for March and August feeder cattle futures from 1993 to 1999 were gathered and computed following the same procedure as the nearby futures returns. The returns were computed for the life of each contract. The standard deviation was computed starting at expiration and subsequently considering each trading day's return in the calculation. For example, at 5 days until expiration the standard deviation used 5 observations. Each standard deviation was then multiplied by the square root of 250 (assuming 250 trading days) to obtain volatility per annum (Hull). The volatilities were then averaged across the sample years by contract (figure 4). The actual volatility of the August contracts exceeds that of the March contracts, consistent with the patterns in Moore Research Center, Inc. and with the increased uncertainty of feed prices during the summer months. Regardless of the contract, volatility tends to increase until about 3 months before expiration when it usually declines, and at an increasing rate until expiration.

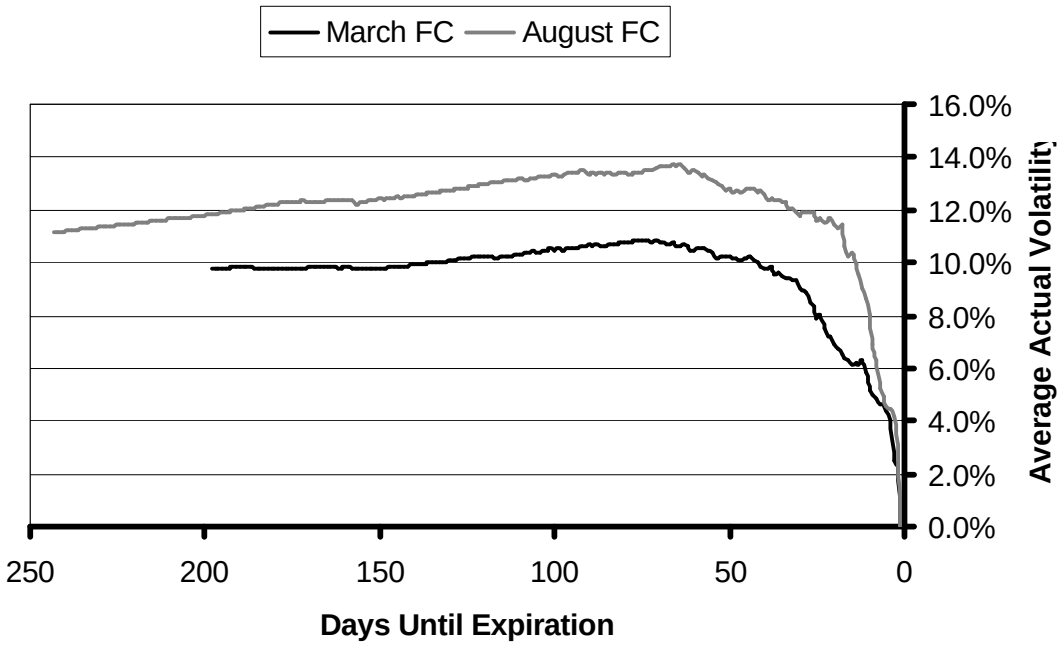

Figure 4. Average actual volatility of feeder cattle futures, 1993-1999

Knowing that volatility tends to depend on the time of year and days until expiration, traders can adjust or improve volatility forecasts for stocker option pricing. Annualized volatility is likely to be greater for the January, February, and March contracts than for the October, November, and December contracts. Hence, option premiums in those former months will be higher than the latter months regardless of futures prices or days until expiration. The pattern in the days until expiration suggests that annualized volatility is likely to decline as expiration nears.

Practical Implications and Conclusions

Faced with price risk and cross-hedging risk, stocker cattle traders may want to use stocker futures and options as hedging tools. The model presented demonstrates that various seasonal and fundamental factors influence the spread between stocker and feeder cattle prices. The model could be used to forecast the spread, then the spread could be added to an observed feeder futures price to obtain a forecast of the corresponding stocker futures price. Given the advent of market makers (Hakes), the model could alternatively be used as a decision aid when determining the favorableness of observed stocker futures prices.

Traders can conceivably price stocker cattle options using observed or forecasted futures prices and forecasted volatility. Because spot stocker price volatility is similar to spot feeder price volatility, implied volatility of feeder cattle futures may be useful when forecasting stocker options volatility. However, seasonal differences in volatility and time to maturity need to be considered. These features imply that a pricing model should be used to translate the price spread and annualized volatility into options prices.

The growing number of cattle comprising the stocker index suggests a potential for increased use of stocker contracts by both buyers and sellers of stocker cattle. However, until substantial liquidity exists, traders may want to use limit orders (Stasko) to guard against the dangers of trading in a thin market and to aid in the price discovery process. Finally, additional research into the relation between the actual and implied volatility may guide future volatility forecasts. Likewise, factors that further explain feeder and stocker volatility would also be beneficial.

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