A Comparison Of Historic And Implied Volatility For Predicting Agricultural Option Premiums

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Individuals who trade options on agricultural futures contracts often make trading decisions based on comparisons of actual and estimated premiums using an option pricing model. Typically, traders use Black's option pricing formula to estimate premiums. According to Black's formula, the current option premium is related to the current futures price, option strike price, time to option expiration, interest rate, and expected futures price volatility. Measures of the explanatory variables in Black's formula are observable, except expected futures price volatility.

As noted by Kenyon, researchers have used two basic measures of expected futures price volatility to predict the fair market value of an option. Some have suggested the standard deviation of historical futures price changes as a measure of expected futures price volatility (Wolf; Kenyon; Choi). This measure assumes future volatility to be the same as historic volatility. Another measure of future volatility is that implied from current option premiums (Turvey). Implied volatility is calculated by substituting in Black's formula measures of all variables except expected volatility and solving for it. Techniques to estimate implied volatility include numeric search methods (Latane and Rendleman) and different direct estimates (Brenner and Subrahmanyam; Curtis and Carriker). The volatility implied in the current premium of an option provides a measure of the current expectation of future volatility (Latane and Rendleman).

If volatility is constant through time, then the use of historic volatility would be a reasonable estimate of expected volatility. However, research has shown that agricultural futures price volatility is not constant. Kenyon et al. found that futures price volatility is affected by seasonality (increasing during the growing season) and by the price level relative to the loan rate.

If the options market is efficient in incorporating all available information, we would expect the use of implied volatility to be more appropriate in estimating expected volatility. Even though historic volatility is easier to calculate, we can justify the use of implied volatility if it leads to more accurate premium estimates. This would be particularly true if the differences in calculation costs are small.

Previous research on stock options and stock index options has shown that the use of implied volatility rather than historic volatility in Black's formula resulted in smaller errors in premium prediction (Latane and Rendleman; Cotner and Horrell). Research on soybean options using seven months of transaction data during 1984-85 supported this conclusion (Jordan et al.). Our analysis will address whether implied volatility is preferred to historic volatility for premium estimation for corn and soybean options during a longer, more recent period.

Procedure

We calculated an estimate of historic volatility using the ten previous daily futures price changes, as outlined in Kenyon. While many periods and weighting schemes could have been chosen, we selected the ten day equally weighted historic volatility based on its usage by certain option traders (Shearson, Lehman, Hutton, p. 7). The formula used to calculate historic volatility is:

$$S_h = \{(365/9) \sum_{t=2}^{11} [\ln(F_t/F_{t-1}) - M]^2\}^{0.5} \quad (1)$$

where

$S_h =$ 10-day historic volatility,

$F_t =$ futures price on day t, and

$M =$ average of the log of daily futures price changes over the preceding 10 days.

We calculated the estimate of implied volatility using the direct procedure presented in Curtis and Carriker. They estimated implied volatility from Black's formula, simplified by assuming an at-the-money option:[1]

$$S_c = (2/t^{0.5})(\ln(1/(1-(C/(Fe^{-rt})^2))(\pi/2))^{0.5} \quad (2)$$

and

$$S_p = (2/t^{0.5})(\ln(1/(1-(P/(Fe^{-rt})^2))(\pi/2))^{0.5} \quad (3)$$

where

$S_c =$ expected volatility implied by nearest-to-the-money call option[2],

S_p = expected volatility implied by nearest-to-the-money put option,
t = time to expiration (in fraction of a year),
C = current premium for the nearest-to-the-money call option,
P = current premium for the nearest-to-the-money put option,
F = current futures price for the underlying contract,
r = risk-free short-term interest rate, and
π = 3.1415927.

They showed that implied volatility directly estimated using the average[3] of equations (2) and (3) can be used instead of the more commonly used iterative procedure.[4]

We placed the measures of volatility in Black's formula to calculate a predicted premium of the nearest-to-the-money put and call. We predicted the closing premium on a certain day (for example Tuesday) using the volatility estimates from the previous day (for example Monday). We then compared the predicted premiums with actual premiums to determine the relative accuracy of using the two measures of expected volatility in predicting premiums. Thus, we tested the measures of volatility out of sample.

Data

We obtained data for the November soybean and December corn futures contracts, and for the options on these contracts. We got daily closing futures prices and option premiums for nearest-to-the-money puts and calls from the Chicago Board of Trade. We analyzed data from April 1 through expiration dates of the options contract for 1986 and 1987. We also analyzed data from April 1 through June 30 for the 1988 contracts. The data used represented 383 daily observations for corn and 347 daily observations for soybeans. The monthly average interest rate on 90-day Treasury Bills was used as the estimate of the annual short-term risk-free interest rate.[5]

Premium Prediction Accuracy

We estimated the predicted daily premiums using each measure of expected volatility. We computed the prediction errors measured as differences between actual and predicted premiums. We compared the absolute values of the errors for each day to determine the number of days in which each measure of expected volatility resulted in more accurate premium predictions (smaller absolute errors). The results showed that the use of implied volatility led to more accurate predictions than the use of historic volatility on the majority of days (Table 1). For example, when we used implied volatility premium predictions for corn call options were more

Table 1.
Number and Percent of Days with Smaller Premium Prediction Errors Using Implied Volatility as Compared to Historic Volatility, 1986-88 December Corn and November Soybean Options

	Observations (days)	Implied < Historic[a] (days)	Implied < Historic[a] (percent)
Corn Calls			
1986	156	142	91
1987	164	150	91
1988	63	47	75
Total	383	339	89
Corn Puts			
1986	156	139	89
1987	164	141	86
1988	63	55	87
Total	383	335	87
Soybean Calls			
1986	141	116	82
1987	143	122	85
1988	63	52	83
Total	347	290	84
Soybean Puts			
1986	141	120	85
1987	143	125	87
1988	63	56	89
Total	347	301	87

[a] Number or percent of days that the absolute value of the prediction error using implied volatility was less than that using historic volatility.

accurate on 339 of the 383 days. For corn put options they were more accurate on 335 of the 383 days.

We compared the means of the absolute value of the errors to determine which measure of expected volatility resulted in better premium predictions, on average. For each option, the mean absolute errors were smaller when we used implied volatility as the measure of expected volatility (Table 2). In ten of the twelve cases analyzed, the mean absolute error using implied volatility was less than \$0.02 per bushel. When we used historic volatility, the mean absolute error was always greater than \$0.02 per bushel. Thus, a comparison of mean absolute errors shows that the use of implied volatility rather than historic volatility leads to more accurate premium predictions.

One may weight large errors relatively more than small errors in determining the relative goodness of predictions. In that case, a comparison of mean squared errors (MSE) is appropriate. We calculated the mean squared errors for each option with both measures of expected volatility. We also calculated ratios of the MSE, with MSE using implied volatility as the numerator (Table 2). A ratio less than one would show that the

Table 2.
Comparisons of Premium Errors Using Implied and Historic Volatility, 1986-88 December Corn and November Soybean Options

	Mean Absolute Errors		MSE
	Implied	Historic	Ratio[a]
	--------------$/bu--------------		
Corn Calls			
1986	0.004	0.030	0.018
1987	0.004	0.028	0.027
1988	0.014	0.054	0.323
Corn Puts			
1986	0.004	0.030	0.003
1987	0.004	0.029	0.002
1988	0.012	0.043	0.007
Soybean Calls			
1986	0.001	0.061	0.069
1987	0.018	0.101	0.067
1988	0.036	0.143	0.110
Soybean Puts			
1986	0.005	0.061	0.006
1987	0.015	0.099	0.268
1988	0.028	0.132	0.047

[a] The mean squared error (MSE) ratio is calculated by dividing the mean squared error from implied volatility by the mean squared error from historic volatility.

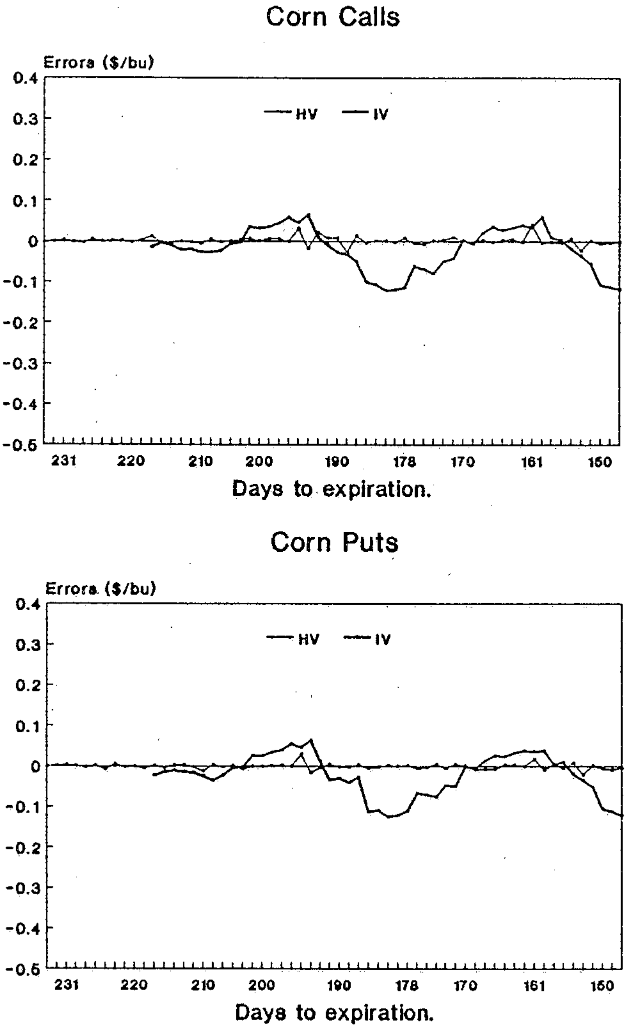
predicted premiums calculated using implied volatility are more accurate predictions of actual premiums than the predicted premiums calculated using historic volatility. A ratio greater than one would show that the use of historic volatility leads to more accurate predictions of premiums than the use of implied volatility. In all cases, the MSE ratio was much less than one. This provides additional evidence that the use of implied volatility leads to more accurate premium predictions. The superiority of premium estimates using implied volatility instead of historic volatility are visually clear (Figures 1 and 2).

Corn and soybean prices were more volatile in 1988 (because of drought) than in 1986 or 1987. This increased price volatility in 1988 led to larger prediction errors using both measures of expected volatility (Table 2). However, this difference in price volatility does not appear to have influenced the relative accuracy of the two measures of expected volatility in predicting premiums. Thus, our general conclusion seems valid regardless of price volatility in the underlying market.

Summary and Conclusions

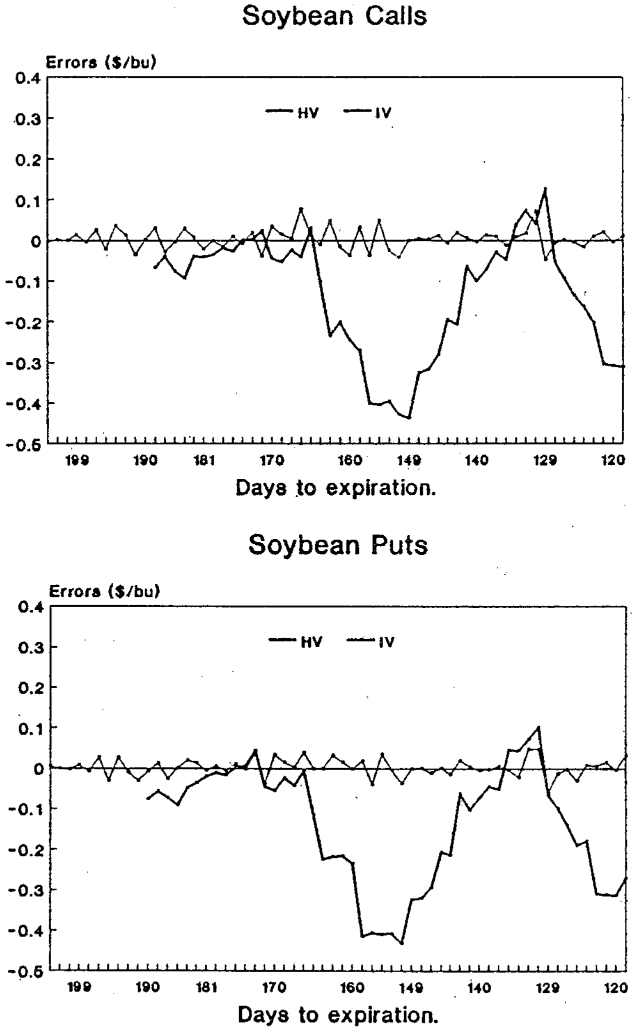
We substituted two measures of expected volatility (historic and implied volatility) into Black's formula to predict option premiums. Previous research found that the use of implied volatility rather than historic volatility

Figure 1.
Daily Errors (Actual—Predicted) in Predicted Premiums Using Historic and Implied Volatility, 1987 December Corn Option



leads to more accurate premium predictions for options on financial instruments and for soybean options during the first few months of option trading. In this paper, we compared premiums calculated using a direct estimate of implied volatility and a ten day historic volatility for options on corn and soybeans. Premiums estimated using the measure of implied volatility were more accurate on average and on more days than premiums

Figure 2.
Daily Errors (Actual—Predicted) in Predicted Premiums Using Historic and Implied Volatility, 1987 November Soybean Option



estimated using the measure of historic volatility. Thus, this research on corn and soybean options is consistent with previous conclusions about options on financial instruments and options on soybeans in earlier periods. Since we can estimate implied volatility directly and it leads to more accurate premium predictions, options traders should consider using implied volatility instead of historic volatility when predicting premiums.

Notes

1. An at-the-money option is an option in which the strike price equals the futures price.
2. We define a nearest-to-the-money option as an option with a strike price nearest to the current futures price.
3. Averaging the volatility estimated from the put and the call option premiums is consistent with previous research (King and Fackler).
4. Curtis and Carriker showed that the Mean Squared Errors (MSE's) in premium prediction using the direct method were marginally less than the MSE's using the iterative method over the period examined. They stated that the direct method was much easier to use.
5. Plato showed that premiums calculated using Black's formula were not very sensitive to changes in interest rate levels. So, we used monthly interest rate data because such data were readily available.

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