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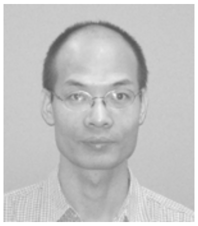

VOLATILITY RISK

by
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Classical capital asset pricing theory tells us that risk-averse investors would require higher returns to compensate for higher risk on an investment. One type of risk is price (return) risk, which reflects uncertainty in the price level and is measured by the volatility (standard deviation) of asset returns. Volatility itself is also known to be random and hence is perceived as another type of risk. Investors can bear price risk in exchange for a higher return. But are investors willing to pay a premium to enjoy lower volatility? In this essay, I try to answer this question by (1) introducing two different measures of volatility, (2) summarizing findings about volatility risk and its premiums in financial equity markets and (3) presenting preliminary research on volatility risk premiums in the markets for corn, wheat and soybeans, which are relevant to the South Dakota economy.

Measures of Volatility

There are two measures of volatility: historical volatility (HV) and implied volatility (IV). Historical volatility is the standard deviation of asset returns during a sample period. Because historical returns are directly observable, historical volatility is also referred to as realized volatility. The formula for calculating historical volatility can be found in standard finance textbooks.[1]

Implied volatility refers to the volatility that underlies option prices. Because options deal with future prices of the underlying asset, volatility implied by options prices is forward-looking and reflects traders' expectation of future volatility. According to option pricing theories, implied volatility is a highly nonlinear function of an option price with a functional form dependent on the assumed option pricing model. Therefore, there is no unique measure of implied volatility, although option prices are observable.

One well-accepted (although not perfect) measure of implied volatility comes from the classical Black and Scholes (1973) and Black (1976) models. Take the Black (1976) model as an example. The pricing formulas[2] for a call option and a put option are non-linear functions of implied volatility and other known inputs (futures price, strike price, risk-free interest rate and time to expiration). Conversely, implied volatility can be backed out from the formulas. The traditional approach is to infer the volatility from the at-the-money (when futures price is equal to strike price) option price, although one can do so using a combination of option prices.

Historical vs. Implied Volatility in Equity Markets

If investors have a rational expectation of volatility, implied volatility would be an unbiased proxy for historical or realized volatility of the same period based on the measures above. In other words, an investor's expectation of future volatility can fluctuate around, but not consistently move in one direction away from historical volatility. However, it is well documented that implied volatility is larger than historical volatility in equity markets (Bakshi and Kapadia, 2003, Carr and Wu, 2009). The difference is called the *volatility risk premium*. Risk-averse investors in equity markets are willing to pay a high premium or bear a loss to realize a lower volatility in the future. As a result, historical volatility is lower than implied volatility in equilibrium.

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Historical vs. Implied Volatility in Agricultural Commodity Markets

Although abundant studies in the finance literature find the negative volatility risk premium in equity markets, it remains unknown whether such an observation applies to agricultural commodity markets. Given the random nature of volatility, investors of agricultural commodities should also be concerned with volatility risk. If there exists a non-zero volatility risk premium, investors may want to manage or hedge volatility risk.

Figures 1 and 2 compare 30-day historical volatility with 30-day implied volatility levels of corn and wheat front-month futures (as of mid December of 2009) for the period of 2006-2009 from Bloomberg. Historical volatility is based on settlement prices, whereas implied volatility is inferred from at-the-money option prices. The volatility risk premium is defined as the difference between them, which is called "spread" in the figures. The upper portion of each figure presents historical volatility (dashed line) and implied volatility (solid line). The lower portion reports the volatility risk premium (spread).

Figure 1 shows that the risk premiums for December 2009 corn futures are negative for the majority of the sample period (08/2006-11/2009) with a mean of -9.39 percent and a t-statistic of 32.8. Both volatilities are at a relatively low level in 2007 while they increase during the crisis in 2008 and decrease in early 2009. Figure 2 shows that the risk premiums for December 2009 wheat futures, with a mean of -8.55 percent and a t-statistic of 25.61, are also negative for the majority of the sample period (06/2007-11/2009). Both volatility measures show a mild (relative to corn futures) upward trend in 2008 and a downward trend in 2009. Like January 2010 corn and wheat futures, soybeans futures (not shown) also exhibit negative risk premiums with a mean premium of -3.39 percent and a t-statistic of 6.72. Both volatility measures trend downward in 2009.

The volatility risk premiums are different in magnitudes for corn, wheat and soybeans. More importantly, the premiums are statistically different from zero (negative) at any conventional significance level. Results are robust (not shown) for March 2010 corn, wheat and soybeans contracts and to two measures of historical volatility based on the past-30-day prices and future-30-day prices. Although volatility risk premiums are significantly negative, some positive premiums do exist for some periods of time. For instance, all three commodities show positive premiums from August to October 2008. One explanation for such phenomena is that during the credit crisis, the historical realized volatility reflected the instant drastic price movements while the forward-looking implied volatility was expected to go back down. Therefore, historical volatility can surpass implied volatility for a prolonged period, especially during a crisis.

Conclusion

Given the existence of significantly negative volatility risk premiums in corn, wheat and soybean futures, investors of these commodities may need to hedge against volatility risk. Commodity markets do not have products designed to trade volatility directly. Equity markets have liquidly traded volatility products like variance swaps and VIX (volatility index) futures and options to hedge against volatility risk. Investors of agricultural commodities have to resort to various combinations of options to trade against stochastic volatility, such as straddle and strangle strategies. My ongoing research on the pricing and risk management of agricultural commodities will investigate alternative strategies for dealing with volatility risk.

Endnotes

[1] Denote S_t the asset price at time t, historical volatility from time 1 to time T is computed as follows: $HV = \sqrt{\frac{1}{T}\sum_{t=1}^{T}[\ln\left(\frac{S_t}{S_{t-1}}\right) - \overline{\ln\left(\frac{S_t}{S_{t-1}}\right)}]^2}$, where $\ln\left(\frac{S_t}{S_{t-1}}\right)$ and $\overline{\ln\left(\frac{S_t}{S_{t-1}}\right)}$ are one-period return and the average return for T periods, respectively. This method is commonly used in the finance industry.

[2] The formulas can be found in finance textbook, e.g. Hull (2008).

Figure 1. Historical and Implied Volatilities of Corn December 2009 Futures

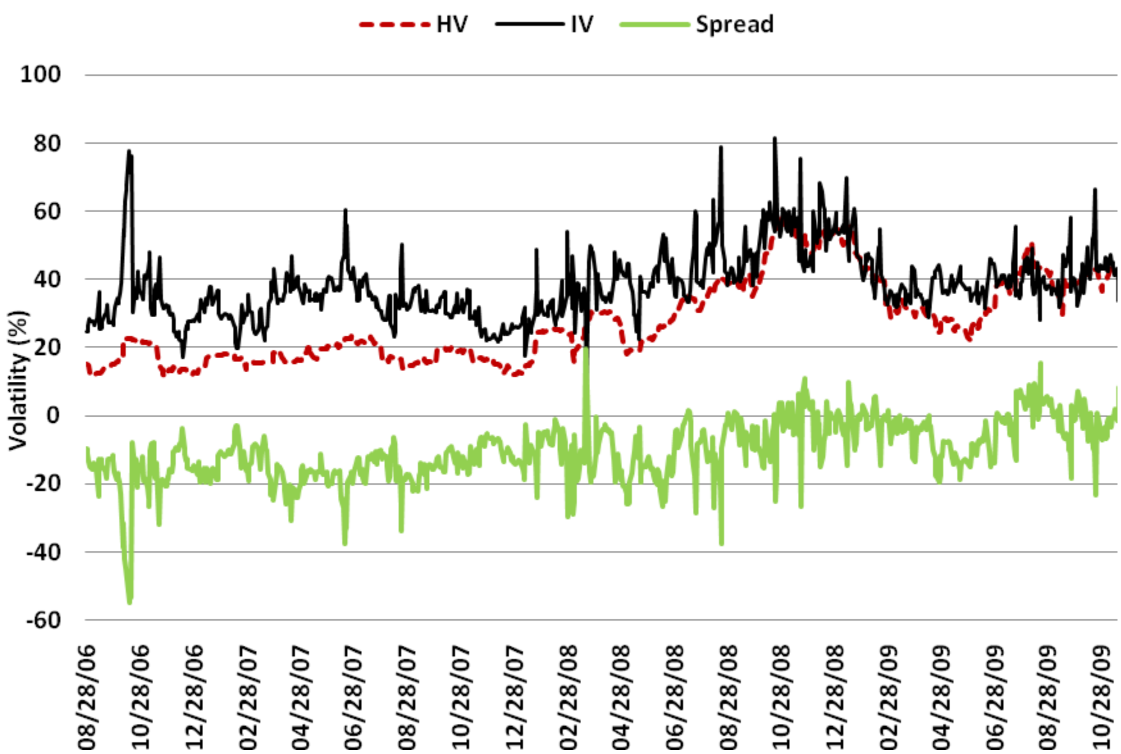
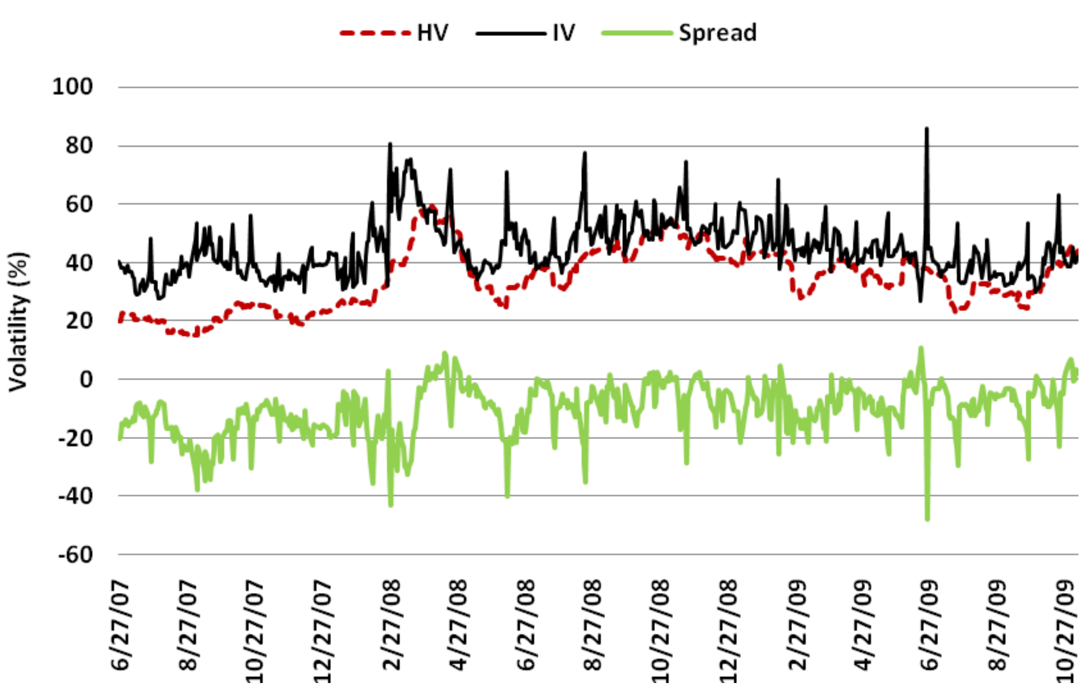


Figure 2. Historical and Implied Volatilities of Wheat December 2009 Futures



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