How Much Would You Pay to Resolve Volatility Risk in the Agricultural Markets?

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Introduction

- It is a well-established fact that price volatility changes in commodity markets.
- A changing volatility poses important challenges for market participants. An unexpected increase in volatility can cause a deterioration of hedging effectiveness.
- Research has focused on exploring the sources of variation in volatility and developing better volatility forecasts, but paid less attention to the costs of volatility risk.

Research Questions

- How much would people pay to resolve volatility risk?
- Is the cost of volatility risk constant across markets and maturities?
- How does the cost of volatility risk change with time and market conditions?

Methods

- The idea is to use delta-neutral straddle returns as a proxy of the cost of volatility risk (Coval and Shumway, 2001).
- Delta-neutral straddles are constructed by solving
  \[ U = xC + (1 - x)P, \text{ s.t. } x\Delta_C + (1 - x)\Delta_P = 0, \]  
  where \( U \) is the straddle price, \( C \) is the call price, \( P \) is the put price, \( x \) is the weight invested in the call, and \( \Delta_C \) and \( \Delta_P \) are the deltas of the call and put, respectively.
- Assume that futures price \( (F) \) and volatility \( (\sigma) \) are stochastic and follow a two-dimensional diffusion process,
  \[ \frac{dF^t}{F^t} = \mu[F_t, \sigma_t]dt + \sigma_t dW^1_t, \]  
  \[ d\sigma_t = \theta_1[\sigma_t]dt + \theta_2[\sigma_t]dW^2_t, \]
  where \( \mu[F_t, \sigma_t] \) is the drift coefficient on futures return, \( \theta_1[\sigma_t] \) and \( \theta_2[\sigma_t] \) are the drift and diffusion coefficients on volatility, and \( W^1_t \) and \( W^2_t \) are Brownian motions with a correlation coefficient of \( \rho \).
- In this general stochastic volatility model, we show that
  \[ \frac{E[dU]}{U} = \rho dt + \sqrt{\lambda} d\omega, \]
  where \( \lambda \) is the vega that measures the sensitivity of straddle price to volatility and can be interpreted as an exposure to volatility risk, and \( \lambda \) is the volatility risk premium.
- In the presence of a stochastic and priced volatility, delta-neutral straddle returns reflect costs of bearing volatility risk.

Data

- The dataset consists of daily settlement prices, volumes traded, and open interests for futures and options for corn, soybeans, Chicago wheat, live cattle, and lean hogs for 1/2/2002–12/31/2016.
- Several filters are applied to the option data:
  - Maturity is between 0.5 and 12 months.
  - At least one contract must have been traded when an option position is set.
  - Option prices must be at least three times the minimum price fluctuation.
  - Only closest to at-the-money options are used.
  - Option should be worth at least as much as the value of an immediate exercise.

Results (cont.)

- Temporal variation of volatility risk
  - Straddle returns are linked to the variability of volatility, time to maturity, and a set of economic and commodity specific factors in a regression model,
  \[ \frac{dU}{U} = \alpha + \beta_1 dV_{t-1} + \beta_2 TTM_{t-1} + \gamma X_{t-1} + \epsilon_t, \]
  where \( dV_{t-1} \) is the one-day lagged absolute change in implied volatility of options, \( TTM_{t-1} \) is the time to maturity, and \( X_{t-1} \) includes VIX, option volumes, futures basis, dummy variables for quarters, the 2008-09 crisis, and USDA announcements, and lagged dependent variable.
  - \( \beta_1 \) is significantly negative, confirming that delta-neutral straddle returns are directly related to volatility variability.
  - \( \beta_2 \) is significantly positive, consistent with the earlier finding about the term structure of volatility risk.
  - Estimate on the USDA dummy is significantly negative, suggesting that the costs of volatility risk increase substantially before the USDA announcements.
  - Estimates on other factors do not statistically differ from zero.

Conclusions and Remarks

- Returns to delta-neutral straddles are negative, ranging between -0.87% and -0.06% per day, suggesting that investors are willing to pay a cost to avoid volatility risk.
- Volatility risk is priced mainly at short maturities (within 2 months) and negligible at longer maturities in agricultural markets.
- Volatility risk is more pronounced on dates immediately prior to the USDA announcements but can hardly be explained by economic and commodity specific factors.
- The term structure of volatility risk in commodity markets, along with similar findings in financial markets, suggests that there are some common forces in pricing risk in the maturity dimension but not in the time series dimension.
- The cost of volatility risk provides a potential explanation for the seeming overpricing of options identified by prior research.
- The finding that volatility risk is priced mainly at short maturities can be exploitable to develop more accurate pricing models for options by allowing for a horizon-dependent price of volatility risk.

References


Table 1: Average Daily Straddle Returns and Correlations

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<th>Corn</th>
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<th>Wheat</th>
<th>Live Cattle</th>
<th>Lean Hogs</th>
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Figure 1: Term Structure of Delta-Neutral Straddles Returns