12-5-2001

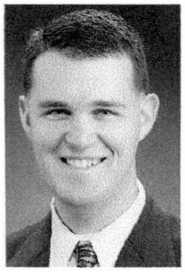
Volatile Times and Volatile Prices

Matthew A. Diersen
South Dakota State University, Matthew.Diersen@SDSTATE.EDU

SDSU

ECONOMICS COMMENTATOR

South Dakota State University | No. 425 | December 5, 2001



Volatile Times and Volatile Prices

Matthew A. Diersen
Assistant Professor
& Extension Specialist

"Amid much uncertainty, the beef sector continues to make progress in reducing cattle on feed inventories." Economic Research Service (2001)

Similar to many markets these days, the cattle market has seen its share of price fluctuation. Prices are impacted from the supply side by a large number of cattle on feed and from the demand side by uncertainty about consumer income levels and export demand. The result has been several days of price limit moves in the live cattle futures and a general decline in the price level. Limit moves and drastic changes in price levels often leave the trade and producers confused and concerned about future moves. In this ***Commentator***, I examine put-call parity, which can be useful for gauging price changes on limit move days. I also show the recent relationship between the futures price level and the implied volatility of options. Understanding these concepts can help determine whether a limit move is the result of technical trading or a more fundamental price shift.

Put-Call Parity

Put-call parity is a theoretical relationship among futures and options prices. Put-call parity depends on the ability of traders to arbitrage different markets. With the ability to buy or sell futures and options, traders can eliminate any excess profits in any one contract and bring prices in line with one another. The result is that prices tend to look rational across contracts. Arbitrage is facilitated by the ability to buy or sell cash at a risk-free rate of interest.

Following Hull (2000), consider a pair of investment portfolios. One consists of a call option and cash and the other consists of a put option, a futures position, and cash, where the put and call have the same strike price on the same futures contract. With some assumptions (e.g., no transactions costs), these portfolios will have the same payoff in the future and be worth the same amount today. The put-call parity relation follows as:

$$c + X e^{-rT} = p + F_0 e^{-rT},$$

where c is the value of a European call option, X is the strike price of the call and put options, e is the exponential, r is the annualized risk-free interest rate (generally from government securities), T is the time until maturity (days until expiration divided by 365), p is the value of a European put option, and F_0 is the current futures price. Unlike American-style options, one cannot exercise European-style options before their expiration date.

Typical Relationship

An example will demonstrate how put-call parity works. While the calculations that follow are not difficult, they may be easier to do with a calculator. On July 12, 2001 the August feeder cattle futures contract, F_0, settled at $89.98 (per cwt.). On that day there were 49 days until the August futures and options contracts expired, giving T = 49/365. At that time, T-bill rates were about 3.5%, giving r = 0.035. Call options with a $90.00 strike price, X, settled at a price, c, of $1.05 and put options with a $90.00 strike settled at a price, p, of $1.07. An option's premium is the price the option would cost to purchase and is in $/cwt. for the cattle contracts.

Put-call parity implies:

$$\begin{aligned} c + Xe^{-rT} &= p + F_0e^{-rT} \\ \$1.05 + \$90.00e^{-0.035\left(\frac{49}{365}\right)} &= \$1.07 + \$89.98e^{-0.035\left(\frac{49}{365}\right)} \\ \$90.63 &= \$90.63 \end{aligned}$$

and the relation held to the penny on this day.

In reality, the options are not European-style, but are American-style, which becomes more important as the time to maturity increases and as the difference between the futures and strike prices increases. The observed prices resulted on a given day of actual trading, where prices can and do fail to follow the relation as closely as shown because competitive forces can overwhelm arbitrage actions.

Theoretically for American-style options, a different relation holds because of the ability to exercise such options before their maturity date. The relation is:

$$F_0e^{-rT} - X \leq C - P \leq F_0 - Xe^{-rT},$$

where C is the value of an American call option and P is the value of an American put option.

Synthetic Futures on a Limit Move Day

Traders can use put-call parity when any one price in the relation is not observed. Often futures contracts have daily limits on the size of price changes allowed for a given trading session. This allows for an orderly collection of margin money. The same limits often apply to options, but they are reached less often because, by their very nature, option prices do not move the same level as futures prices. Hence, on days when futures prices are locked in limit moves and are no longer signaling prices, traders can look to options prices.

On Monday October 15, 2001, the December live cattle futures contract closed at \$65.92, down the \$1.50 limit for that contract. Was the limit a cause of great concern, or was this just a nervous trading day? Looking at option prices will help clarify the mood of the trade in light of the limit move in the futures price. On that day there were 62 days until the December options expired, giving T = 62/365. Interest rates dropped to 2.5% by October, giving r = 0.025. The strike price closest to the futures close that had both put and call options traded was \$66.00. The call option premium at that strike settled at \$1.70 and the put option premium at that strike settled at \$1.10.

The put-call parity relation can be rearranged to find the synthetic or implied futures price as:

$$\frac{c - p + Xe^{-rT}}{e^{-rT}} = F_0$$

$$\frac{\$1.70 - \$1.80 + \$66.00e^{-0.025\left(\frac{62}{365}\right)}}{e^{-0.025\left(\frac{62}{365}\right)}} = \$65.89$$

The relation indicates that the futures price may have fallen another \$0.03 had trade been allowed. The implied futures price suggests that the limit had barely been reached. The next day, in fact, the market reversed completely and the December contract finished limit-up. Had the implied futures price been much lower, it would have been a strong signal that trading would have resumed in the downward direction on October 16.

On limit-up move days, put-call parity can also be used to infer a futures price level. When futures rally, hedgers with output price risk can look at the synthetic futures price to determine whether to price their product or wait for the next day's move before taking action by using futures.

Volatility-Driven Price Changes

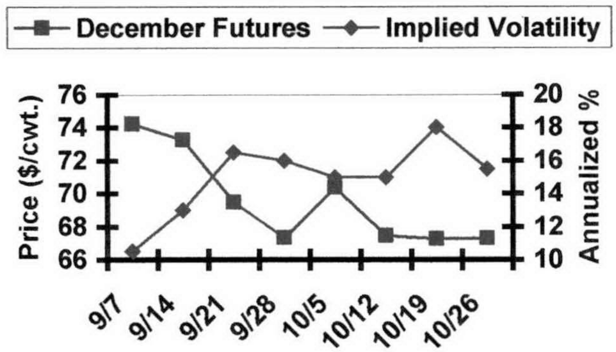
Another type of change is a sustained move in prices (either up or down). Usually when prices move quickly and sharply, hedgers take notice and look into taking action before things get worse. However, the recent trend in the live cattle market makes taking action relatively expensive. As often happens in commodity markets, large price moves are accompanied by corresponding increases in volatility.

Grain and oilseeds markets provide a common example of price and volatility moves. It is common for corn and soybean prices to spike at some time during the summer months. Usually these moves are volatility-driven. The result is that option premiums increase and hedgers fail to see much of an increase in the floor prices that can be obtained. Downside price moves can be just as frustrating, as a given floor price from using options can become more expensive to obtain when volatility increases.

The price movement of the December 2001 live cattle futures contract trended lower in a volatile manner through September and October. Shown in figure 1 are the Friday closing prices for that contract. Corresponding to the sharp decline

in prices was a marked increase in the implied volatility of options prices for the December contracts. Implied volatility was measured for the at-the-money put option at the close on Fridays and computed using Black's pricing model (see Hull, 2000 for more information). Volatility levels in the high teens for live cattle are unusual, but not unprecedented.

Figure 1. Futures Prices and Implied Volatility of December Live Cattle Contracts.



The combined effects of futures prices falling and volatility increasing drove put option premiums higher. For example, the premium for a put option with a strike price of $66.00 increased from $0.10 on September 7 to $1.37 on September 28. Often options are studied using "Greeks", measures of how option-pricing components affect option premiums. "Delta" and "Vega" measure the respective effects of futures price and volatility changes (Hull, 2000).

Traders can track volatility just like they track prices. Volatility will likely return back to more normal levels as cash prices stabilize. As for the "Greeks", however, in the commodity markets their usefulness may have limited value given the prevalence of volatility-induced price changes.

Management Implications

Uncertainty can occur in any market at any time. In light of the mechanisms in place to maintain order when prices change quickly (e.g., daily limit moves), hedgers may feel at a loss when gauging the mood of the market. Put-call parity allows a hedger to use options prices to assess the extent of the seriousness of a limit move. A longer-run shift in price or volatility can also occur and combine to drive up the cost of price protection. The implication for managers is to plan early and watch for times of favorable prices and low volatility to purchase price protection and manage risk.

References

Economic Research Service. *Livestock, Dairy and Poultry Situation and Outlook.* Washington, DC: U.S. Department of Agriculture, LDP-M-88, October 2001.

Hull, J. *Options, Futures, and Other Derivatives.* Upper Saddle River, NJ: Prentice Hall, 2000.

****

2002 COMMODITY PRICE OUTLOOK MEETING

February 19, 2002
9:30 a.m. - 3:00 p.m.
Registration 9:00 a.m.
Brookings Inn Conference & Convention Center

Please join us as we hear from industry and educational experts regarding expectations for commodity prices.

****

ECONOMICS COMMENTATOR

****

ECONOMICS DEPARTMENT
South Dakota State University
Box 504
Brookings, SD 57007-0895

Phone: (605) 688-4141
Fax: (605) 688-6386
E-mail: Stover_Penny@sdstate.edu

350 copies of this newsletter were produced at a cost of less than $100