The Color of Money

How many more traders will have to sink to their knees, sobbing and begging, "But I don't do derivatives, I just trade futures and options!" Sad, very sad. Why, besides a few well-publicized multimillion-dollar blunders by a few isolated neophyte trades, (who never will work again) and their clueless supervisors (all of whom will emerge unscathed) should derivatives have such a tarnished reputation?

The answer probably lies in the decidedly non-linear behavior of many derivatives, especially those with significant option components. The Black-Scholes option pricing formula incorporates the roles of volatility, interest rates, time to expiration and the proximity of the underlying asset's price to the strike price. In a particularly pernicious form of divine retribution for not paying attention in your long-ago calculus class, the derivatives of the Black-Scholes formula with respect to these factors have been given exalted status:

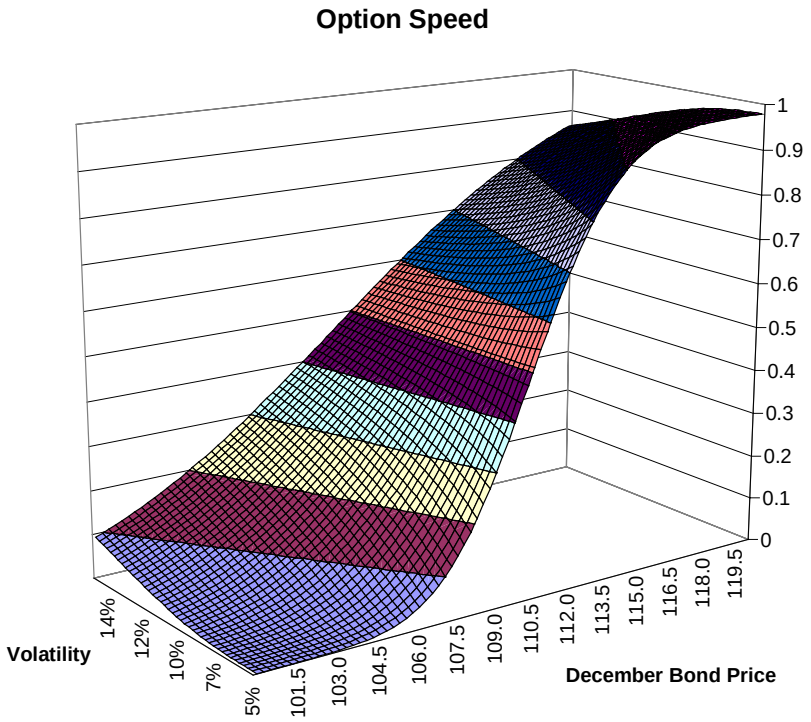
Delta: First derivative of option price with respect to underlying asset price
Gamma: Second derivative of option price with respect to underlying asset price
Theta: First derivative of option price with respect to volatility
Rho: First derivative of option price with respect to interest rates

After a while, most traders become comfortable with these statistics and intuitively understand their effects: For example, option decay (theta) accelerates with time, the price movement of an option becomes more sensitive to changes in the underlying asset as it becomes in-the-money, (delta effect) or short out-of-the-money option positions in fast-moving markets have inherently large risk (gamma effect). Is there anything else lurking around to sabotage our best-laid plans?

Of course there is! Because most option horror stories can be traced to being short gamma - the equivalent of writing earthquake insurance prior to a fault zone forming - further quantification of gamma may be in order. The first step in this process is to measure how fast gamma changes with respect to the underlying price.

Speed: Third derivative of option price with respect to the underlying asset price

The speed of an option depends on other factors as well: It changes significantly with both volatility and time. Moreover, the interplay between time and volatility on delta is itself non-linear. At higher volatilities, delta is higher when the option is out-of-the-money and lower when the option becomes in the money. This is illustrated for a T-bond 110 call option with 87 days remaining to expiration.



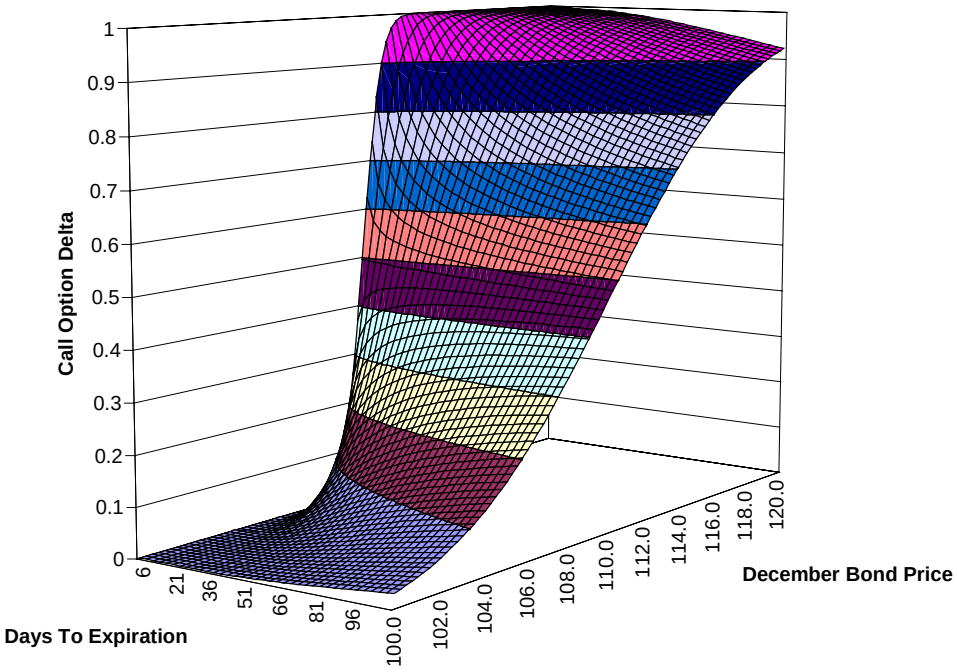
Speed can transform delta-neutral positions into directional positions quickly. The practical effect of speed is that option-based hedge strategies must be re-evaluated continuously in markets with rapidly changing volatility.

Another source of option-trading miscues is the assumption that delta is only sensitive to price, whereas it is also quite sensitive to time (delta changes more rapidly as expiration approaches):

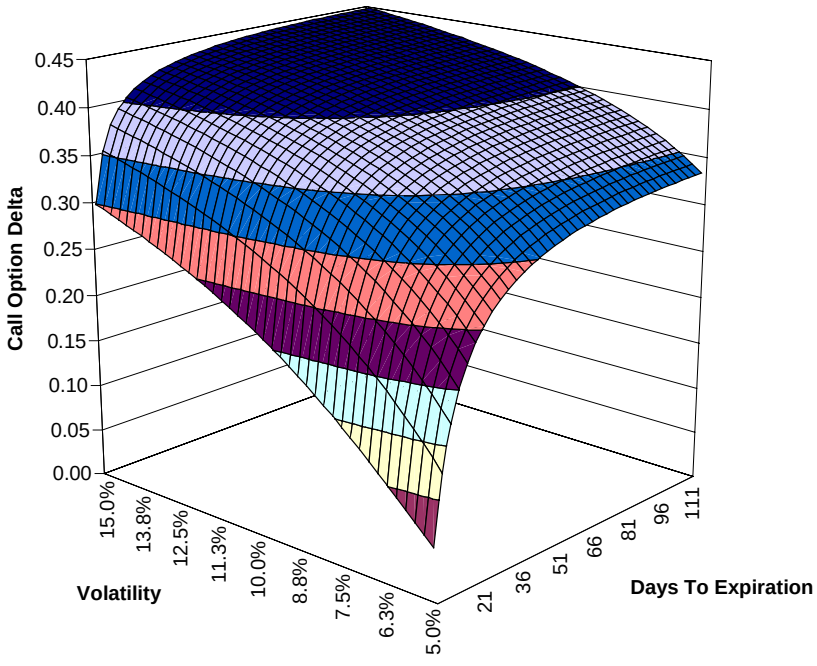
Charm: First derivative of delta with respect to time

The chart "Charmed Life" depicts the delta of a T-bond 110 call option at a constant 9.5% volatility over a range of time to expiration. In this model, the effects of charm appear to be relatively linear and straightforward, with the sensitivity of delta being a direct function of time. However, charm also is affected by volatility: A higher volatility reduces the sensitivity of delta to time, as seen in "The Volatility Effect."

Charmed Life



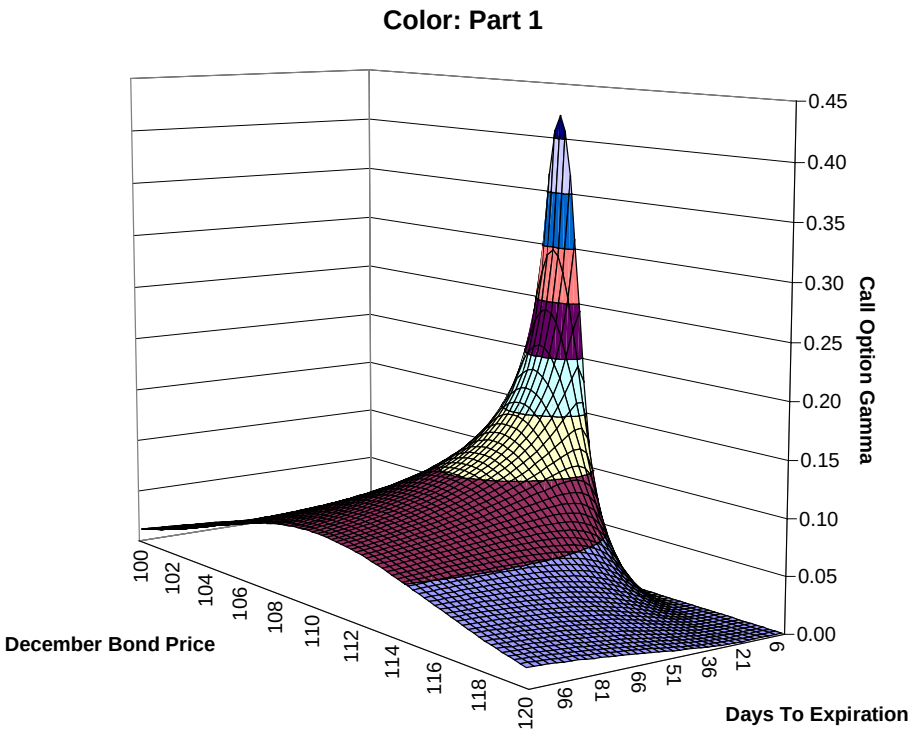
The Volatility Effect



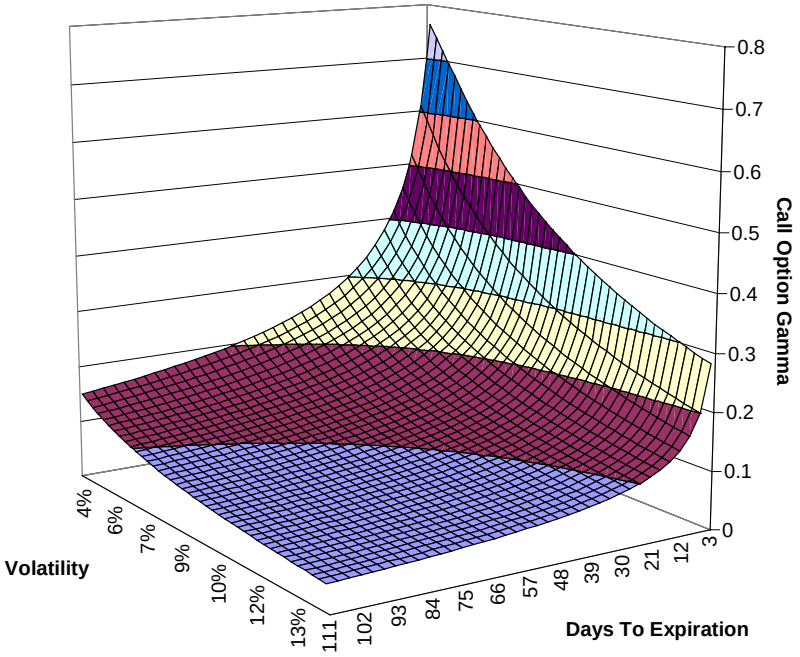
Like speed, the effects of charm can destroy a seemingly neutral position (especially as expiration approaches). Similarly, if delta is time-sensitive, then gamma must be time-sensitive as well:

Color: First derivative of gamma with respect to time

Because gamma is the rate at which delta changes with respect to price, then color must be even more skittish than charm. This is shown in the charts, "Color: Part 1" and "Color: Part 2." The first chart shows the sensitivity of gamma to time; the second demonstrates the effects of volatility on gamma.



Color: Part 2



The behavior of speed, charm and color may explain why so many traders find option-based hedges and derivative instruments difficult to understand and manage. Unlike stocks or real estate, options are not conducive to the "buy-and-hold" approach. These positions must be examined beforehand, scenarios must be constructed and a dynamic plan must be designed to maintain the original characteristics of the position. Finally, management must be made aware of the structure and nature of these positions.