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A Look at Vanilla Options and Greeks

Kevin Barbian
Augustana College - Rock Island

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An Introduction to Vanilla Options and Greeks

Options are one of the main financial derivative products that are traded in the markets. The value of an option is dependent on some other asset, such as a stock. There are a variety of options—path-dependent options and exotic options, for example—and there are also other types of financial derivatives, like forward and futures contracts. My focus was on vanilla options: they are less specific and somewhat easier to understand. The vanilla options can be categorized as being of the American or European variety and as either a call or a put.

A call option is an option in which the buyer of the contract has the right (but not a commitment) to purchase a given asset (stock, perhaps) from the writer of the contract at a pre-determined price (strike price) established in the contract. The owner can buy the stock at the strike price and sell it for a higher price in the market to make profit. In equations, we usually refer to the strike price as the variable K or sometimes X. An example of a call option: I purchase a call option for ABC stock for $300 (100 shares * $3 = $300 premium, contracts usually include 100 shares per contract), the strike price is $42 and the stock price is $43. Currently I could purchase the 100 shares of stock for $42 each, but I'd lose money because of the $300 premium so let's not do that. Suppose the stock price never rose above $43, I wouldn't exercise my right to buy the stock because I would lose money. But suppose the stock price rose to maybe $47. I would exercise my right to purchase the stock at $42 (the strike price) and I would make $200 profit by selling off the stock at that new price (47*100 – 42*100 – 300). One could also choose to sell the call contract and make a profit. A put option works similar to a call, but sort of the opposite.

With a put option, the buyer of the contract has the right (not the commitment) to sell a stock at a pre-determined price (strike price) to the writer of the put option, who must buy it at the strike price. If the owner exercises the right, they would purchase stock at the market price and sell it at the strike price for profit. Suppose that a stock is being traded at $48 and the strike price of a put contract is $50. The premium is $200 ($2 per share). If the stock price dropped below $48, the owner of the contract would exercise the right to sell the stock at $50 (the strike) or they would just sell the contract for a profit. If the price rose above $48 you wouldn’t exercise the right.

The variety is much simpler. An American option is one in which the buyer/owner of the option can exercise the right at any time between the time of purchase and the time of expiry. An European option is one in which the buyer/owner must wait until the time of expiry before they exercise their right. Most options are American, but out of curiosity one might ask which options are more valuable? Assuming no dividends (as the Black-Scholes equation used in my program does, but also the binomial pricing model used in another program does as well) the value of an American call option is equal to an European call option, but the value of an American put option is higher than a European put option.

Now that you are slightly comfortable with options (maybe extremely comfortable?) we can talk about the “Greeks” that are used in the Black-Scholes equation I spoke of earlier. Since we can use the Black-Scholes equation to calculate the value of an option (I mentioned it is for European options, but it approximates closely enough for

American options), we can also use it to calculate some of the sensitivity measures of the option as well. The sensitivity measures under discussion are Delta, Gamma, Vega, Theta, and Rho. These are all first order partial derivatives (with the exception of Gamma, a second order partial). There are a large number of these measures, including several second order and third order partial derivative Greeks.

Delta is the measure that can be taken as the change in option value with respect to the change in the underlying asset value. This means that an increase or decrease in the underlying price will lead to an increase or decrease in the option value. A Delta of .40 would mean that a $1 increase in the stock price would lead to a $.40 increase in the option value. The Delta is important for things such as delta hedging. Derivative dealers might balance a portfolio by buying and selling put and call options (not limited to vanilla options) such that the delta is 0. This is known as a delta-neutral position. This might offset the portfolio such that if the price of some assets (stock) rose/fell, then some options contained in the portfolio would do the opposite to counteract the change.

Gamma is similar to Delta, but it is a second order partial derivative of the option value with respect to the change in the underlying asset value. This is understood as how a change (increase or decrease) in the underlying price will cause a change in the delta. Less commonly used by derivative dealers is the Gamma hedge, which is useful for achieving a gamma-neutral position (gamma = 0) so that the overall Delta of the portfolio will not deviate from 0 as the underlying price(s) change.

Rho is the change in the option value with respect to the risk-free interest rate. This means that a generous 1.5% increase in the risk-free interest would result in a 1.5% increase for the value of the option. Interest rates don’t change often/significantly so Rho isn't extremely useful for derivative dealers. The risk-free interest rate is thought of as the rate of return on an investment that has no associated risk of financial loss. It can also be thought of as the interest rate on a U.S. treasury bond, which is considered risk-free (?).

Theta is often referred to as the time decay on the value of an option (as Theta ticks down to 0 the value of the option will approach 0). It is always negative since an option is always going to be losing some value as time passes. Theta isn't as significant to traders as the other Greeks are.

Finally we have Vega. This is a measure of the option's sensitivity to a change in the volatility of the underlying asset. Volatility refers to the potential/stability of an asset: a high volatility asset is one that can experience great changes in price (could fall or rise significantly), a low volatility asset is one that doesn't experience much change in either direction (more stable). Suppose an option with a volatility of .25 and a Vega of .20: a .01 increase in the volatility to .26 would result in a $.20 increase in the value of the option.

The Python program will calculate both the value for a call option and a put option given the stock price, strike price, risk-free interest rate, volatility, and time to expiry. This program will also calculate the Greek values of the Black-Scholes equation for the call and put option of given parameters. Calculations are made by using built-in Python functions and through the Black-Scholes equation.

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