Appendix A

The Greeks

Understanding the Greeks makes us smarter options traders. By Greeks, I don't mean Zeus, Plato, or Aristotle, but rather delta, gamma, theta, vega, and rho. While these concepts are somewhat complex in the beginning, you don't need a degree in quantum physics to understand the concepts or to use them in real-world trading.

Indeed, while computing the Greeks requires the use of options pricing models, many websites and brokerage platforms offer the information for free, but a few traders actually compute the numbers themselves. It is much easier to pull up an options chain with the numbers already computed.

If you have already traded puts and calls, you know that options prices change as the price of the underlying moves higher or lower. But have you ever purchased a call option only to see it lose value despite a move higher in the underlying? That might happen when other factors, such as time decay (theta) or volatility (vega), chip away at the options premiums. The Greeks can help us understand why this happens and what factors are having the greatest influence on options premiums.

In fact, it's a common mistake to assume that the change in the price of the stock, index, or other underlying instrument is the only factor that determines the value of the options contract. Although it is the one that changes most often, there are other important determinants of options prices as well. The Greeks are variables that isolate how factors such as time and volatility impact the value of the contract. Let's start with a discussion of delta.

Delta Defined

If Zeus was the king of the gods in Greek mythology, delta is the Zeus of the Greeks in the world of options trading. Understanding how it works helps make sense of why options prices are changing as the stock, index, or underlying instrument moves higher or lower. Knowing the position delta is valuable when trading more advanced strategies with more than one options contract.

But let's not put the cart before the horse. While the underlying instrument, like a stock, has a fixed delta of 1.0, each individual options contract has a unique delta that is always changing. It tells us, approximately, how much the value of the options contract can be expected to change for each one-point change in the underlying asset.

Call options have positive deltas ranging from 0 to 1, because they increase in value when the underlying asset moves higher. Put options have negative deltas of between −1 and 0, because the value of the contract will typically increase as the price of the underlying instrument heads lower. Very low delta options see relatively little reaction to the underlying's move. High delta options approaching 1 or −1 move almost point-for-point with the underlying.

An equity call option with a delta of 0.25 can be expected to increase in value by $0.25 for a $1 move higher in the underlying stock. Because the multiplier for a standard options contract is one hundred, an increase of 0.25 equals $25. On the other hand, a put with a delta of −0.25 can be expected to increase in value by $25 for each $1 decline in the underlying stock price.

As we saw in Chapter 9, delta is sometimes described as the thumbnail probability that an option will expire in-the-money (ITM) by at least a penny. It's not an actual calculation; it's simply a thumbnail and a useful way of thinking about delta.

For example, an at-the-money (ATM) call option, which has a strike price equal to the stock price, should have a delta of roughly 0.50 because there is a 50 percent chance that it will expire ITM. This should make sense given that an ATM call has an equal probability of being ITM or out-of-the-money (OTM) at expiration because there is a fifty-fifty chance that the stock will move higher or lower from current levels.

As expiration approaches, the delta of an OTM option will approach zero and see little reaction to the underlying. After all, the contract is about to expire worthless. On the other hand, the delta of an ITM call option will approach 1, and an ITM put will move toward −1 heading into the expiration.

Changes in the value of the underlying can lead to very fast changes in delta as expiration approaches because of the rapidly decreasing or increasing probabilities of the option expiring ITM or OTM. This fast change in delta is measured by another Greek called gamma, which we cover after I explain the concept of delta neutral.

Delta Neutral

Each options contract has a unique delta. When combined into strategies with multiple contracts or shares, the total delta of the trade is called the position delta. A stock has a delta of 1. Therefore, a position in one hundred shares of stock and one ATM put with a −0.5 delta has a position delta of 0.5. The position is expected to increase in value by $0.50 if the underlying gains $1 or lose $0.50 if shares drop $1. Again, because the multiplier is one hundred, a 0.5 delta would equal $50 for every one hundred shares held (and one put).

The term *delta neutral* refers to a position that theoretically doesn't react at all to price changes of the underlying instrument. To create a position that is neutral with respect to delta with call options with a 0.5 delta, the investor might sell short one hundred shares and buy two call options. The result is a position delta of 0, or 0.5 plus 0.5 minus 1. Or, an investor could buy two −0.5 delta puts against a stock and create a protective put, or a short-term hedge. Of course, the delta will change as the price moves higher or lower, and a true delta neutral strategy will continually buy or sell shares or options as needed. Position deltas can also be greater than one hundred. For instance, buying ten 0.5 delta options will yield a position delta of 500 (10 × 0.50).
While a market maker or some other institutional investor, rather than an individual investor, is more likely to initiate a strictly delta neutral strategy, the concept of position delta is relevant to all options strategists. It can help make sense of why positions, whether simple or complex, change in value as the underlying instrument moves higher or lower. As you start out, this is not as important a concern. However, make sure that you understand how many deltas you are long or short, as that is theoretically how many dollars you are risking with a one dollar move in the underlying.

Of the Greeks, delta seems to make the most sense intuitively. As the price of the underlying asset moves higher, calls will increase in value and puts will decrease in value. On the other hand, if the price falls, calls decrease in value and puts increase in value. The same is true for more complex strategies, and the position delta is the way of quantifying the expected changes in premiums.

Importantly, delta and the other Greeks are computed using options pricing models, and the calculations are theoretical. The option might or might not behave exactly as the models suggest. Therefore, delta is really a guide and not a precise measure of potential changes in options premiums as the price of the underlying moves higher or lower. The same is true of the other Greeks. In addition, delta is dynamic and constantly changing. A call option with a delta of 0.25 might have a delta of 0.33 after a $1 move higher in the underlying stock and a 0.5 delta if the stock moves $2 higher.

Gamma

If deltas are constantly changing as the price of the underlying moves higher and lower, gamma measures the change in delta for every point change in underlying. If delta is speed, gamma is the accelerator, and the options with the highest gammas see the greatest reactions to changes in the underlying.

Gamma is a positive number (or sometimes zero) for both puts and calls. Unlike delta, it is not a measure of the changes in premiums. It only reflects changes in delta. In addition, gamma will be the greatest near the ATM strikes, while steadily decreasing moving out to the further ITM and OTM strikes.

An option that is near the money heading into the expiration will have high gamma because the delta can change quickly from a low number to a high value if shares go through the strike price. For instance, an OTM call might have a delta of 0.25 the day before expiration, but if shares rally through the strike price of the contract on expiration day, the call might suddenly see its delta increase to 1. It has very high gamma. Note that if you are having trouble getting your arms around this, do not fret; it takes a while, and closing your positions out before expiration week will limit your exposure to gamma.

Theta

Options are wasting assets. Have you heard that before? The adage refers to the fact that options lose value over time and suffer from time decay. Theta measures the amount of time value that is expected to be lost with each passing day. It is always expressed as a negative number, because both puts and calls lose value over time.

You can think of time loss like a snowman melting after the winter. It slowly melts away when temperatures are still cold, but the speed will increase as the weather gets warmer. Similarly, time decay is nonlinear and affects short-term options at a faster rate than longer-term ones. Time decay is the greatest in the days and hours immediately before expiration.

Meanwhile, ATM options will have higher thetas (relative to ITM or OTM options), because there are greater losses in premiums (as measured in dollars and cents) at those strike prices. In other words, there is more to lose in the bigger time value of ATM or near-the-money strikes, and that's where time decay occurs the most. That's because these are the options with the highest amount of premium as well.

Theta only relates to the extrinsic (or time) value of the option and has no impact on intrinsic value. Meanwhile, OTM strikes will have lower thetas than ITM, because there is less time value. However, the percentage losses associated might be greater for OTM strikes because of the smaller absolute levels of time value. After all, losing $0.02 per day on a contract trading for $0.50 is a much larger percentage loss than losing $0.03 on a contract trading for $5.

Vega

Vega is not actually a Greek letter, but in the world of options trading, it is considered one of the Greeks. It offers estimates about the potential changes in options prices for each one-point move in the volatility of the price of the underlying. As volatility increases, the value of the option increases. Falling volatility results in lower premiums. Like theta, changes in vega only affect the extrinsic (or time) value of the option.

Each options contract has a measure of volatility known as implied volatility (IV). Computed using an options pricing model and always in a state of flux, IV is a percentage and will vary from one option to the next. Even two options on the same underlying stock can have very different levels of implied volatility. Vega measures how much the premium might change as IV moves 1 percent higher or lower.

Vega is always a positive number regardless of whether the option is a put or call. It is typically higher for ATM or near-the-money options and declining in the further ITM or OTM strikes. Lastly, longer-dated options can often have substantially higher levels compared to short-term ones as well. The higher vega option premiums are more responsive to changes in implied volatility. In addition, longer-dated options are slower to respond to volatility changes, but when they respond, it is in a much bigger way.

An options pricing model is a useful tool to see how changes in implied volatility (and other factors) affect premiums for puts and calls. Figure A.1 shows an example from The Options Industry Council website (www.optioneducation.net/calculator/main_advanced.asp). In this example, we are looking at a stock option expiring in March with a $105 share price and a 105 strike price. We assume a 0.50 percent interest rate, no dividend payments, and implied volatility of 25 percent.

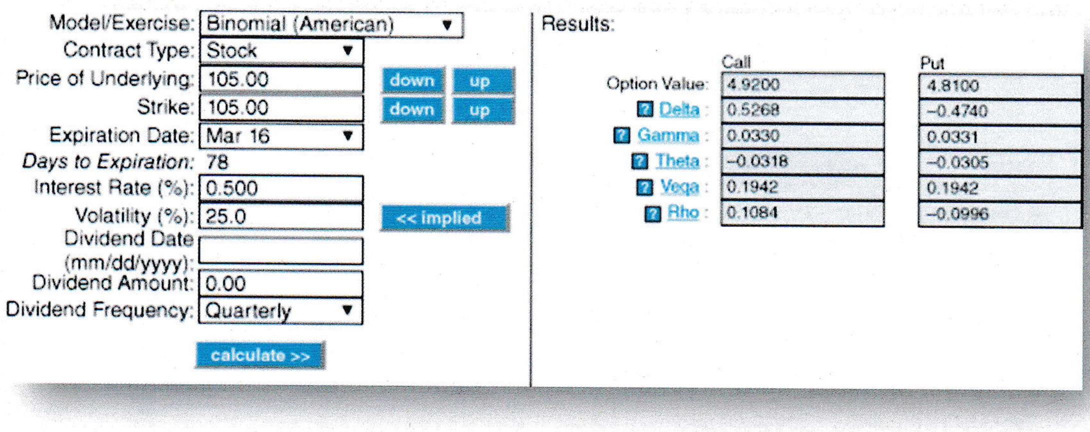

Figure A.1 Options Calculator
Source: Options Industry Council

With shares at $105, both the 105-strike puts and calls are ATM with deltas of −0.47 and 0.53, respectively. The prices are $4.92 and $4.81 per contract, respectively. Now, suppose the implied volatility of the options increases to 35 percent from 25 percent, or ten points. Because vega was 0.194 and implied volatility moved ten points higher, both options should increase by roughly $1.94.

As we can see from Figure A.2, if implied volatility is changed to 35 percent from 25 percent, the premiums increased to $6.86 for calls and $6.75 puts, respectively. On the other hand, a ten-point drop would see the premiums drop by roughly $1.94 per contract. The fact that changes in implied volatility can have an important impact on premiums helps explain why a call option might lose value, even if shares move higher. In that case, the impact of vega was larger than the impact of delta.

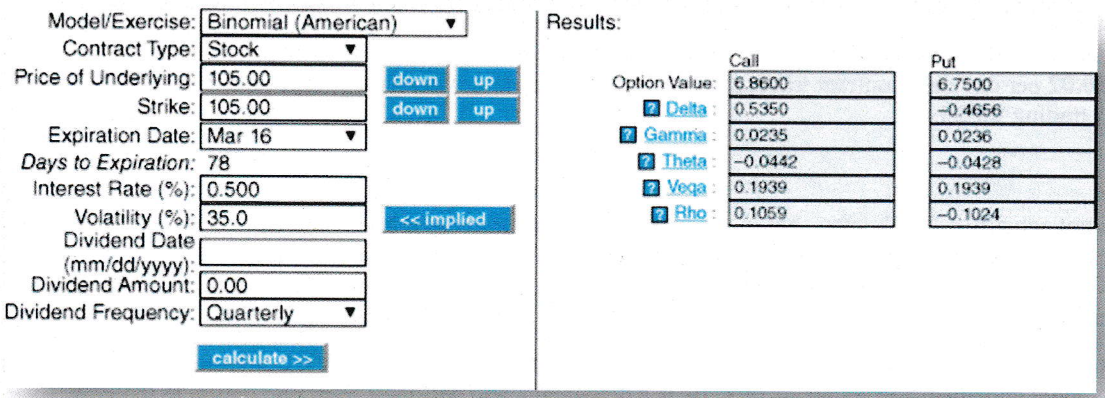

Figure A.2 Options Calculator
Source: Options Industry Council

Using an options calculator, we can also substitute out IV with other measures of volatility to see theoretical options prices. One measure often used with pricing models is historical volatility (HV, also called statistical volatility, actual volatility, or realized volatility). While IV is computed using options pricing models, HV is computed using the past prices of the underlying asset over a number of previous trading sessions. Mathematically, it is the annualized standardized deviation of stock returns and is also expressed as a percentage. (See Appendix C for more on HV in the section about volatility studies.)

Indeed, volatility is always changing and will vary for each underlying asset. Even individual contracts listed on the same underlying can have very different levels of implied volatility. Vega helps us understand how the next changes in IV might affect the premiums.

Lastly, it's also possible to see vega and some of the other Greeks using an options chain in a trading platform. Figure A.3 provides an example of one using Microsoft (MSFT) March options. In addition to the bid-ask prices, the columns include delta, gamma, theta, and vega.

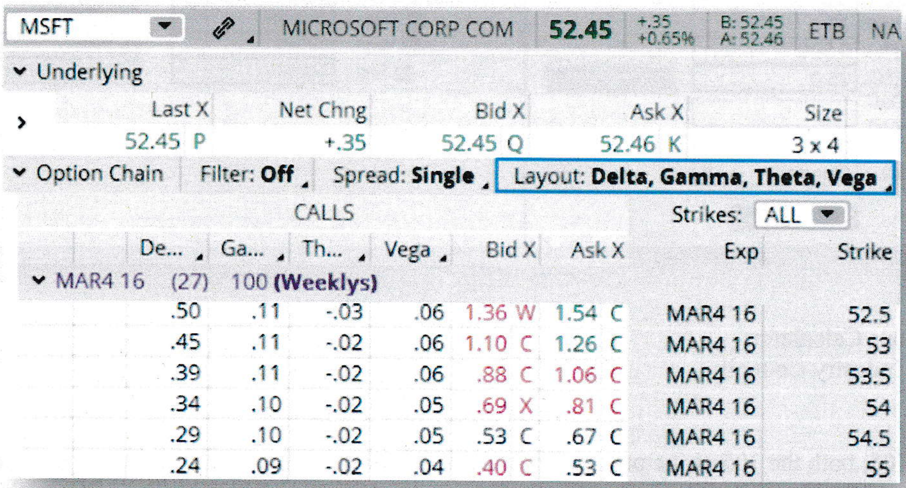

Figure A.3 Options Chain with the Greeks

Rho

Rho is the Greek that measures how the options value may change due to a 1 percent change in interest rates. Rho for a call is positive, because the contract will increase as rates rise. The rho for a puts has a negative value. If overall rates are at low levels, the impact from rates on options premiums are not a major factor. However, in periods of higher interest rates, the changes to options premiums are sometimes more meaningful. Rho is the measure for gauging the potential impact. Again, try using an options calculator to see how changes in rates and other variables can affect the prices of puts and calls.

Reference

1. www.optioneducation.net/calculator/main_advanced.asp