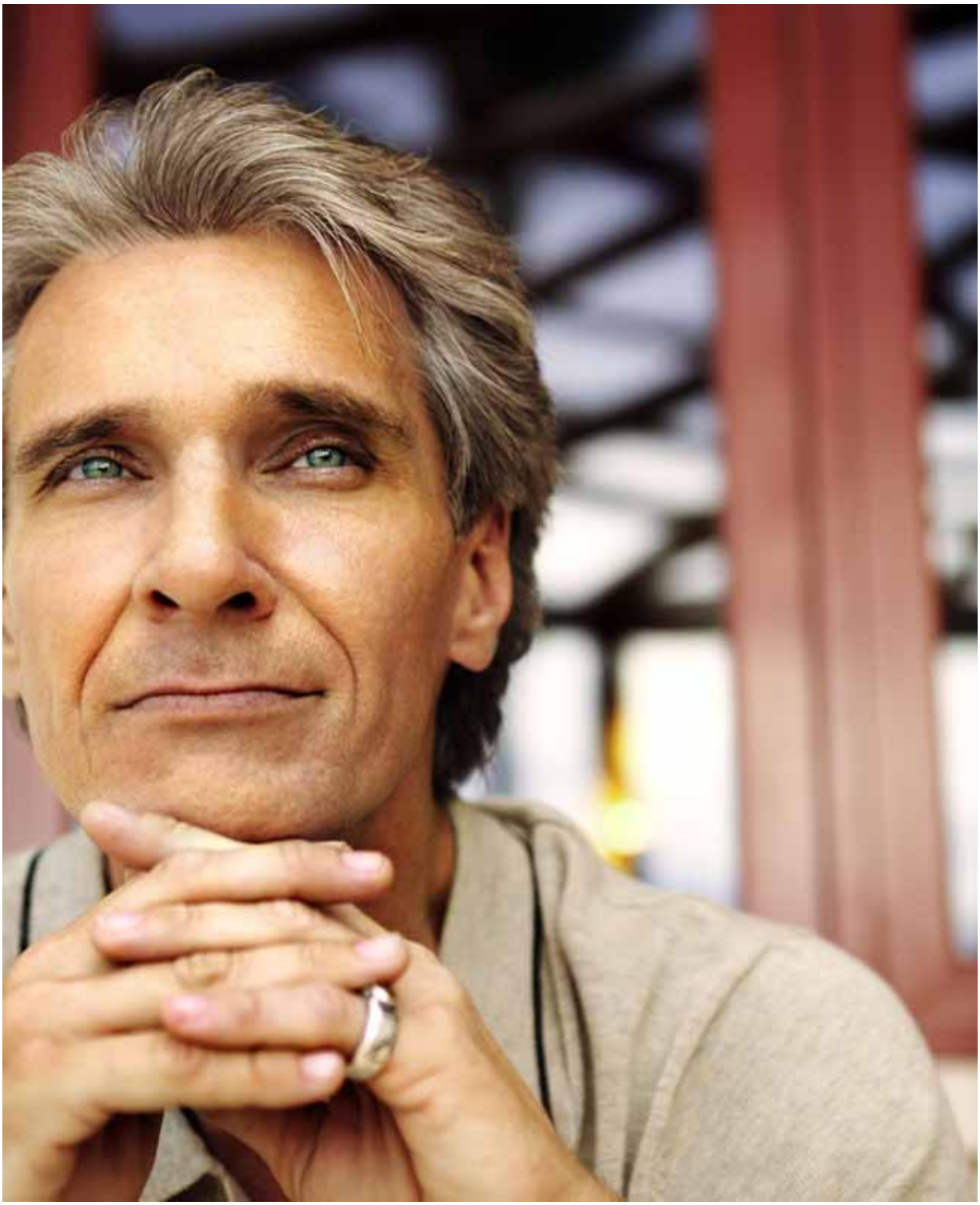
Module 3

Volatility Analysis



Contents

Introduction & Objectives

This module will give you a greater insight into how shifting volatilities impact on the premiums of options. This understanding is the cornerstone for finding trades and implementing the correct trading strategy.

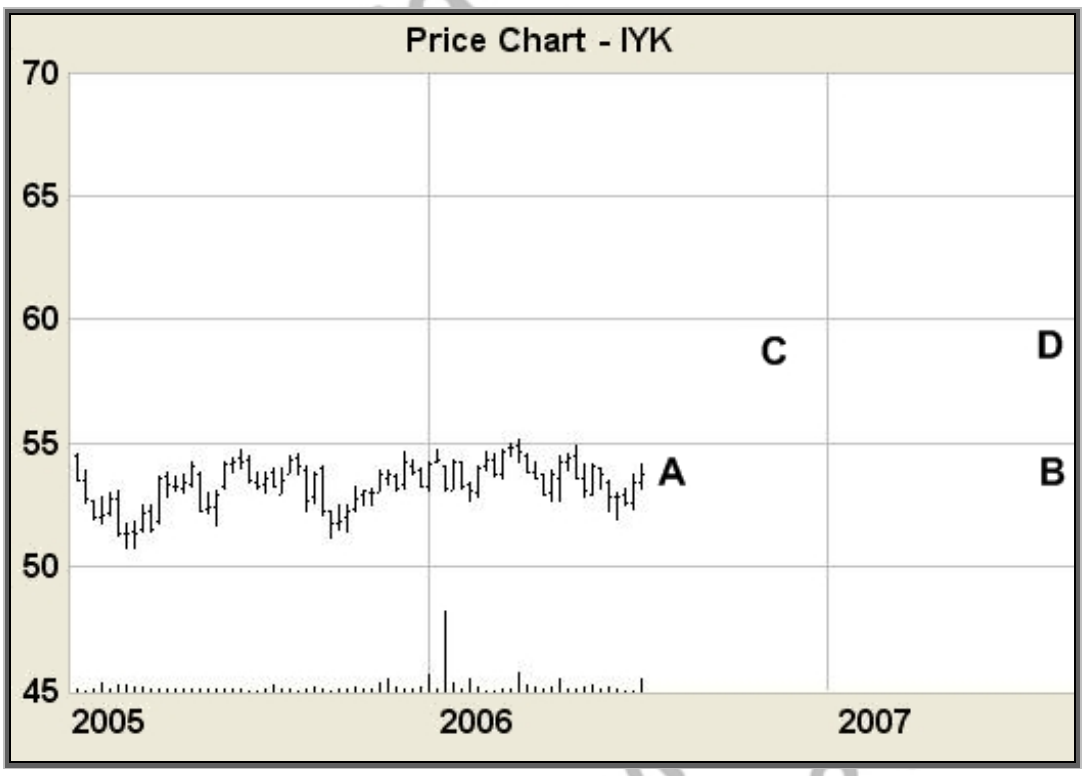
After completing this module you will understand:

- Historic or statistical share price volatility.
- How volatility affects option premium.
- Vega.
- Option fair value calculation.
- Implied volatility.
- Volatility skew.
- How to read volatility charts.
- The mean reversion tendency.
- Percentile rankings.
- How to identify expensive and inexpensive options.
- How to identify overvalued and undervalued options.

Share Price Volatility

The three most important factors for successful options trading are price, time and volatility: **T V P**. This module examines volatility.

Imagine that the price chart of stock IYK shown below is an aerial view of a tract of land. Imagine a drunken person standing with a loaded rifle at location "A" aiming broadly in the direction towards "B". He is unsteady. His eyesight is not clear. The barrel sways from left to right. The safety catch is off. Where would you prefer to stand: "C"? Or "D"?



If you were to wager that the IYK share price would reach $59, given the same odds, would you choose target "C", four months away, or target "D" a year away? These decisions are the decisions options traders make every day.

In the chart above it looks like the price has been reasonably steady since the beginning of 2005, confined to a 10% range between $51 and $55 for a year and a half. We can't know in advance if or when the price might break out of that range, but it seems that "C" has a lower chance of being hit than "D". Without other information we might guess that there would be a reasonably good chance that the price might end up within 10% of the range, say between $45 and $60 by the end of 2006. We might also guess that the chances would be low that the price ends up more than 10% outside the range. In this section of the course we are not so much concerned with the actual price forecast. We are concerned here with chance.

Key Point

Options traders assess the chances of a share price finishing in a future price range.

The Time Value of Chance

If you were to write a $60 call option over IYK stock, would you prefer it to expire in November 2006, four months away, or July 2007, a year away? Where would you be safer: "C" or "D"? Where would you prefer to stand? Remember if you write a call, you lose money if the share price rises too high. As a writer you want the option to expire worthless, so you keep the premium. You would want the share price to remain below $60 or so. Of course your answer would depend on the premium you receive for the risk you take.

The important point is that writers of options will make an assessment of risk, and expect a premium which would satisfactorily reward them for their risk. An options writer would want more premium for a call option at "D" than at "C" because there is more time remaining until expiry, during which the share price will fluctuate. Waiting nearly a whole year until "D" increases the chance that the price will exceed $60, and that the holder will exercise the call option at the writer's expense. The longer you wait, the greater the chance of ending up in the money. This is another way to look at "time value", introduced in Module 1.

Options traders need to quantify risk in monetary terms. Without understanding the price of chance, it becomes difficult to decide whether to buy or to write, and which options to trade.

Compare the above example with the price chart of Pozen shown below.

Key Point

More time until option expiry gives more chance for the underlying share to reach the strike price and be in the money.

Share Price Volatility

The share price is fluctuating wildly, by more than 300% from $6 to over $18 and back down. Without other information, it is much more difficult to try to guess where the price might go. The price might go anywhere. It would be much more risky to write, say, a $22 call option with six months until expiry over Pozen stock, than a $60 call over the earlier more stable IYK stock.

But people do write calls over wildly fluctuating stock. Those options are available on the market. Why do people risk writing options over such highly volatile stock? They do so because they are rewarded with a high premium income. When the share price fluctuates wildly, the premiums are very high. The risk is much higher that the options will end up in the money and then be exercised. Options writers are paid a higher premium for options over volatile stocks than for options over tight price range bound stocks.

We've now introduced two very important concepts.

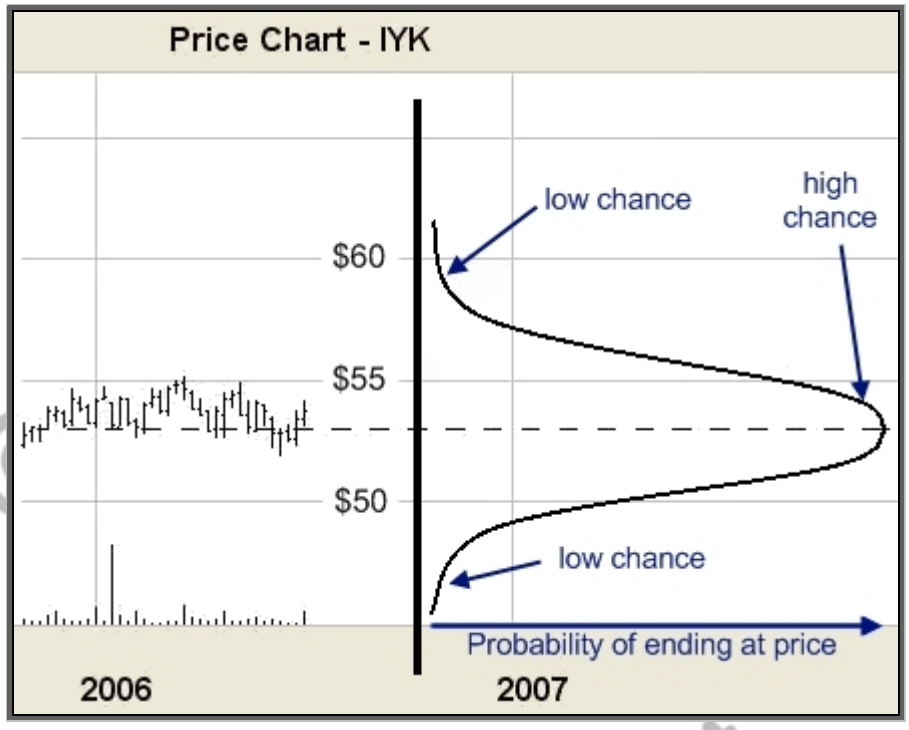
Firstly: share prices can have different levels of volatility. The Pozen share price was highly volatile during the period shown. The share price traversed a 300% range during an 18 month period. The IYK share price was not very volatile. It only traversed a 10% range over the same period of time.

Secondly: volatility affects option premiums. Options writers would want a large premium for writing options over the highly volatile Pozen stock, because it seems likely the share price could easily jump a long way from the current price. Options writers would not need to be compensated as much for taking risk on the less volatile IYK, because it seems less likely that the share price will jump too far away from the current value. Options premiums are lower for low volatility underlying shares. Premiums are high for high volatility underlying shares.

Option writers are paid a high premium for writing options over highly volatile stock.
Options over highly volatile stocks have higher premiums.
Options over low volatility stocks have lower premiums.

How Volatility Affects Premium

We learnt in Module 1 that an option premium consists of two components: time value and intrinsic value. We now reconsider time value in terms of volatility. The IYK chart is shown again below, but overlaid is a profile of the chance that IYK will be at a certain price in September 2006.



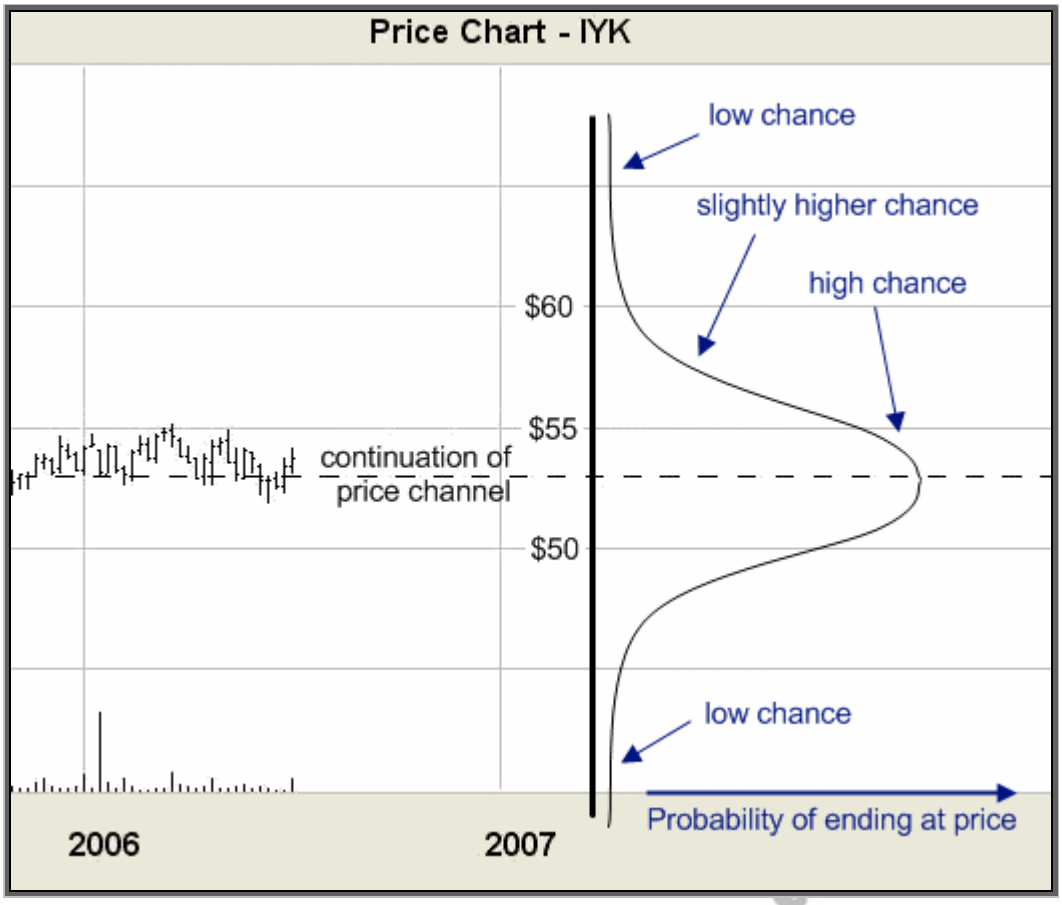
The bold curve at the right shows that there is a very high chance the price will continue along the channel to finish somewhere around $51-$55 at the bold vertical line at September, 2006. There is a lower chance that the price will deviate too far away from that range. Importantly there is a low chance that IYK will hit $60 by September 2006. We would expect the premium for a $60 September call to be low.

But looking further into the future the chances become distributed more flatly over a wider price range, as shown below. The curve of chance flattens and becomes wider. There is a greater possibility that the price will deviate further away from the $51-$55 range.

Key Point

There is a high chance that a price will finish close to its current value. There is a lower chance that the price will deviate too far.

How Volatility Affects Premium



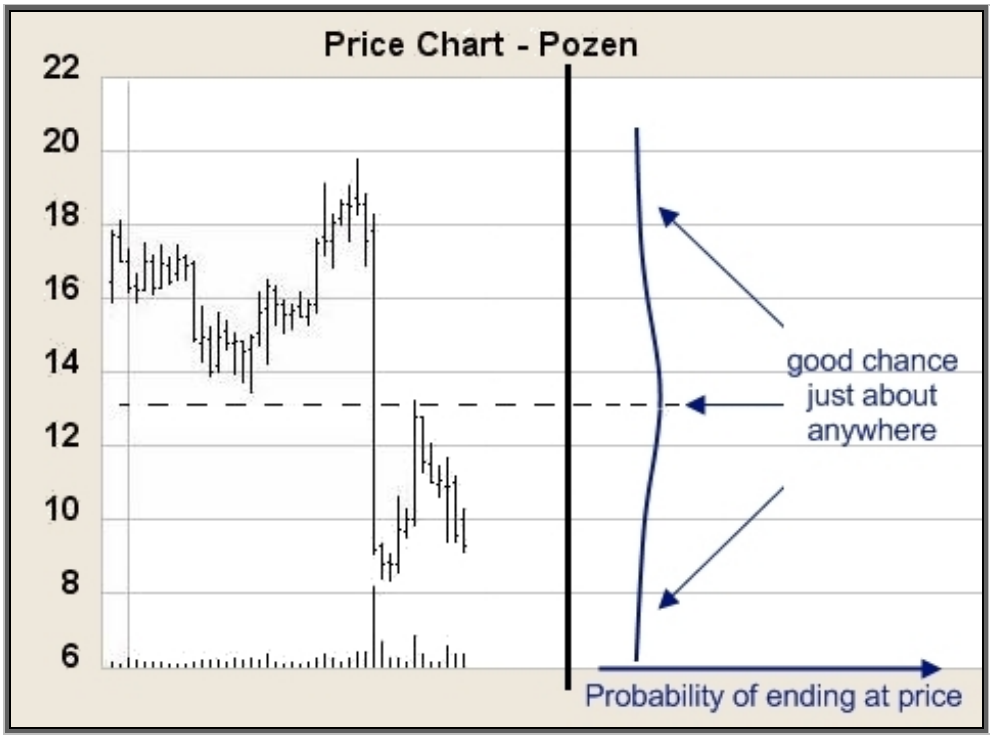
The chance of the price ending up over $60 in mid-2007 is now higher than before. There is more time available for the price to wander. As the curve flattens the chance increases that the price will finish above $60. That's why options premiums are higher when expiry is further away into the future. And that's why the time value part of the premium decays as the option approaches expiry.

But there is more to it than simply the passage of time. Consider Pozen again, which had a very volatile share price.

Key Point

With more time, there is a greater chance that a share price will move further away from the current price.

How Volatility Affects Premium



Because the share price is highly volatile there is a reasonable chance the price might end up anywhere. Options premiums would be higher across a larger range of strike prices because of the greater chance that they will end up in the money at expiry.

Volatility affects time value. Volatility inflates premium. Options over highly volatile shares have higher time value. Options over low volatility shares have lower time value.

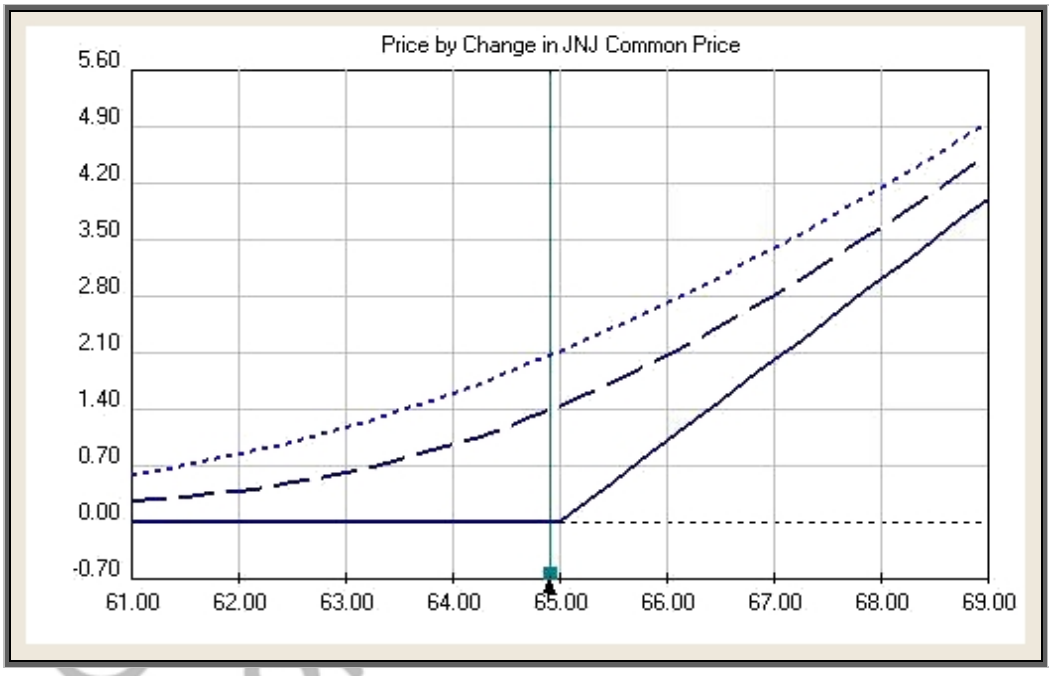
The following three charts demonstrate how an option premium expands and contracts with volatility. The charts show the premium (or value) of one $65 call over Johnson & Johnson with 92 days remaining until expiry. The first chart shows the option premium for a nominal current level of volatility. The second chart shows how an increase in volatility inflates the premium. The third chart shows how a fall in volatility deflates the premium.

In each chart the current value of the call is shown by the uppermost small dotted line, the value in 46 days time by the large broken line, and the value at expiry by the lower most solid line with the knee at the strike price.

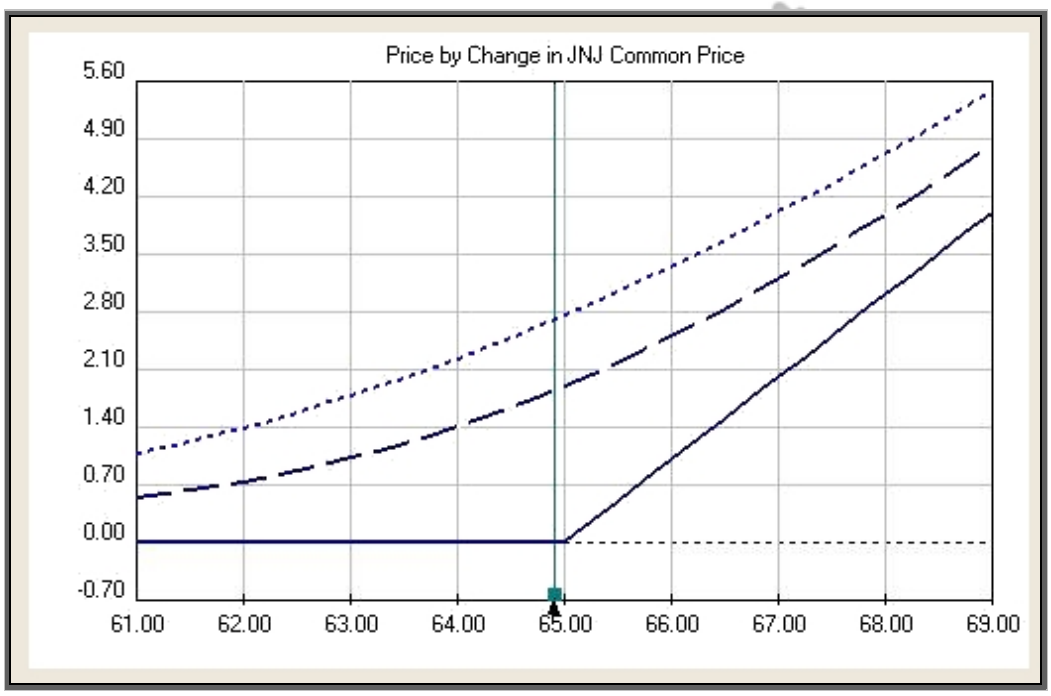
Key Point

Options premiums are higher for highly volatile underlying stocks.

How Volatility Affects Premium



The chart above shows that today, with the underlying share price just below $65 (at the vertical green line), the option premium is approximately $2.10. Being out of the money, that premium is all time value. If volatility were to increase by 5%, and if the share price and all other factors were to remain equal, the option premium would rise as shown below.



Key Point

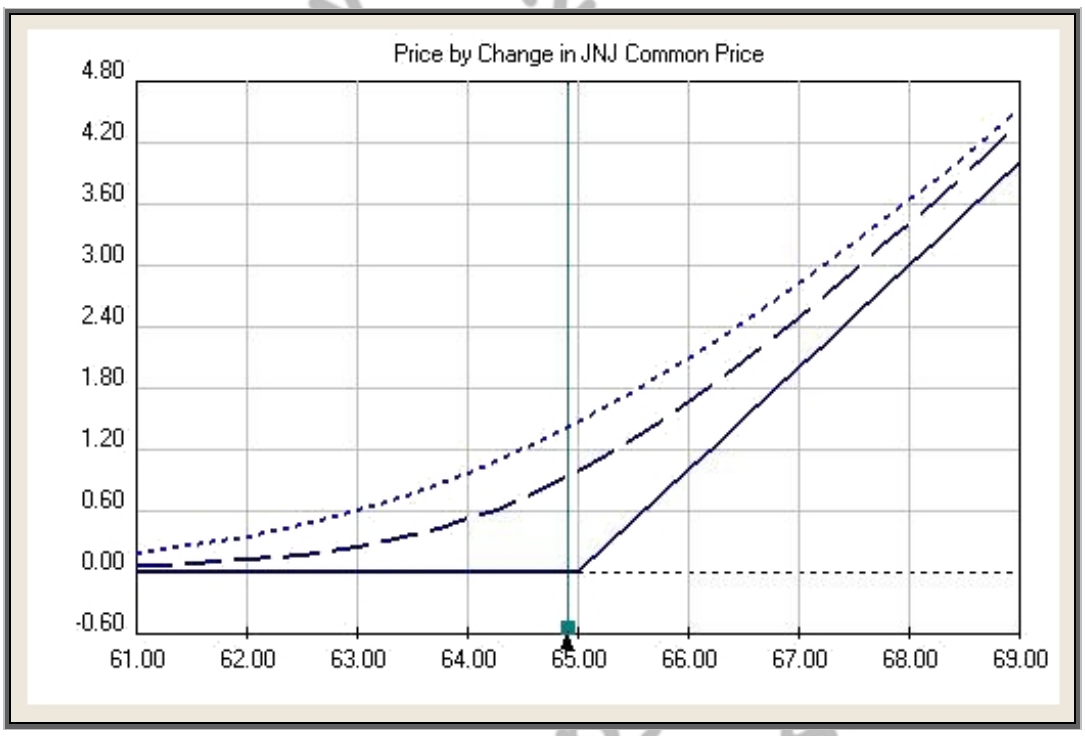
Small changes in volatility can produce major changes in option premium.

How Volatility Affects Premium

The current premium is now $2.80. The increase in volatility has increased the time value of the option. The share price remains at just below $65. The option value did not change as a result of a change in the price of the underlying share. The time remaining until expiry did not change. The change in premium is due solely to volatility.

Notice that the change is significant. A volatility change of 5% has increased the premium from $2.10 to $2.80, and increase of one third.

On the other hand, if volatility falls by 5% the premium falls also, as shown below.



A fall in volatility decreases the time value. In this case the premium, or the value of the option, has plunged from $2.10 to approximately $1.40, a loss of one third of its value.

Small shifts in volatility can have very large impacts on option premiums. Volatility can be traded by buying and selling options when their premiums change with changes in volatility. Therefore an understanding of volatility can be very profitable. This course will demonstrate how to trade volatility changes.

Key Point

Volatility can be traded by buying and selling options when their premiums change in response to changes in volatility.

Historic Volatility

The level of volatility of a share price can be calculated mathematically. A numeric value can be calculated each week and plotted on a chart. The calculations are usually made by options analysis software, which uses historical price data to measure how far and how quickly the price has tended to deviate from an average value. It is not necessary in this course to understand the mathematics. The results are known interchangeably as "statistical volatility" or "historic volatility", and are expressed as percentages. "Historic" and "statistical" both refers to the fact that the volatility is calculated from past statistical data. We will see examples later.

Volatility is measured and quoted as a percentage. The historic volatility of a stock might be quoted at 18% or at 53%, for example. The value is not really the percentage of anything directly observable, but it is related to a percentage of the price. The volatility of a share price can exceed 100%. The volatility of an underlying stock is often available at options trading exchange websites and options trading brokers' websites.

We use the adjective "statistical" or "historic" to distinguish this volatility from "implied" volatility which is a different type of volatility, and which will be described later in this module.

Historic volatility does not remain constant for a given share. The historic volatility of a stock can change reasonably quickly. The time value of an option expands and contracts with changes in volatility. If volatility increases rapidly enough, it is possible for an option premium to rise faster than other factors would tend to make the premium fall, such as time decay and the underlying share price.

Historic and Statistical volatility both refer to volatility calculated from past underlying share price movements.

Vega

An understanding of volatility is critical to successful options trading. There is a "Greek" which describes how volatility affects an option's premium, just as delta and theta describe how price and time affect the premium. The "Greek" is called "Vega", although curiously Vega is not in the Greek alphabet. It is easy to simply remember that the "V" from Vega stands for volatility.

Option premiums are sensitive to changes in volatility. If volatility increases, the premium rises. If volatility decreases, the premium falls.

Vega measures how much a premium will rise or fall as a result of a given change in volatility. Vega is often expressed as a dollar value which specifies how much the premium of a single option would change in dollars for a change in volatility of one percent. For example a Vega of $0.28 means that the option premium would rise by 28 cents if the volatility of the underlying share increased by 1%.

Sometimes Vega is expressed as the dollar amount by which a whole options contract might change for a volatility change of one percent. If the 28c Vega of above described a US options contract for 100 shares, Vega would be expressed as $28.00, because it is the amount by which the value of the whole contract increases or decreases.

We have seen so far that three important factors can affect the value of an option: the price of the underlying, time, and volatility. We'll now see how our knowledge of those factors can be used to estimate a fair value for the premium of an option.

Key Point

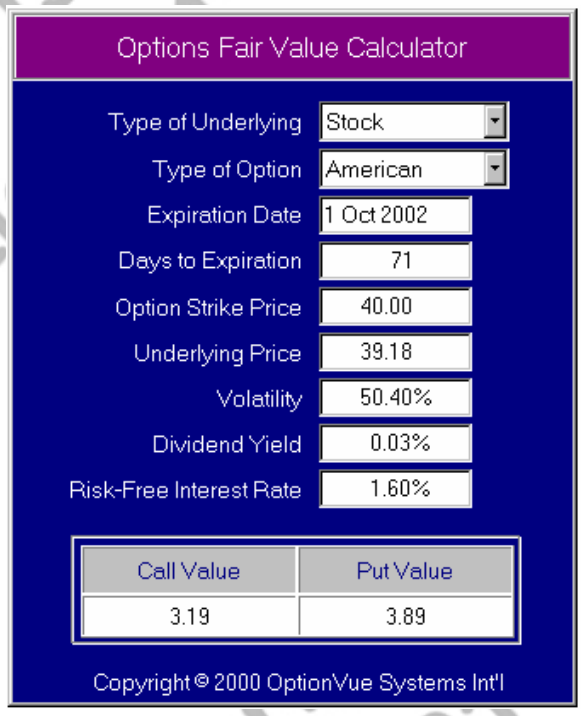
Vega measures how much an option premium will change for a 1% change in volatility.

Fair Value

The theoretical value of an option may be calculated mathematically. This theoretical value of an option is also known as the "fair value". A fair value calculator uses mathematical models to estimate the theoretical value of an option, given certain input information. We've seen that the premium depends upon the price of the underlying, the amount of time remaining until expiry, and volatility. The premium also depends on some other factors, which need to be specified to calculate an option's fair value. Fair value calculators are freely available on the internet, often at websites of exchanges and brokers. An example is shown below.

To estimate the theoretical value of an option a fair value calculator needs the following variables as inputs to the model.

- Type of Underlying
- Type of Option
- Expiration Date
- Days to Expiration
- Options Strike Price
- Underlying Price
- Volatility (historic)
- Dividend Yield
- Interest Rate



Once the variables above have been defined, the calculator furnishes a theoretical value for the call and the put for the defined values.

The fair value calculator can help determine whether you would pay too much or sell for too little on the market.

It may be all very well to calculate a theoretical value of an option. But when you go to buy or write an option in the real market the price will usually be different. So what use is a theoretical value in the face of cold hard market forces? You can't argue with the market to try to realise a "fair" price! Well, the calculator, and an understanding of fair value, are very useful because they underpin the concept of implied volatility.

Fair value calculators freely available on the internet calculate the theoretical value of options.

Implied Volatility

If you were considering an option whose fair value did not match the actual market price, you might wonder why. What does the mismatch mean? It means the market disagrees with the theoretical value. It means the market has a different view of the inputs to the fair value calculation. There can be no disagreement on most of the input values: the strike price, days until expiry and so on are fixed.

Only one input is open to disagreement: volatility. The market can have a different view. We have seen that statistical volatility is the measure of past or historic volatility of the share price. But that data is stale: it's history. Options traders and the market are not interested in the past. They are trading options because of future fears or expectations. There might be an impending announcement or earnings report. Or disaster. Options premiums reflect future expectations of volatility, not the past.

If the market knows a company will issue a report then there might be an expectation of a sudden change in the underlying share price. The option premium on the market will reflect those expectations. If the market price of an option does not match the theoretical price, it is because the market expects volatility to be different in the future from what it has been to date.

Therefore, instead of using the fair value calculator to calculate a theoretical premium from past volatility, we use it in reverse. Instead of entering a value for volatility as an input to calculate fair value, we enter the current market premium to determine what the volatility theoretically should be. That theoretical volatility is called the "implied volatility".

Implied volatility is the volatility implied by the current market price of the option. Implied volatility is the volatility the underlying share would need to have for the fair value calculator to produce a theoretical option price which matches the actual market price. It reflects the future volatility expected by the market.

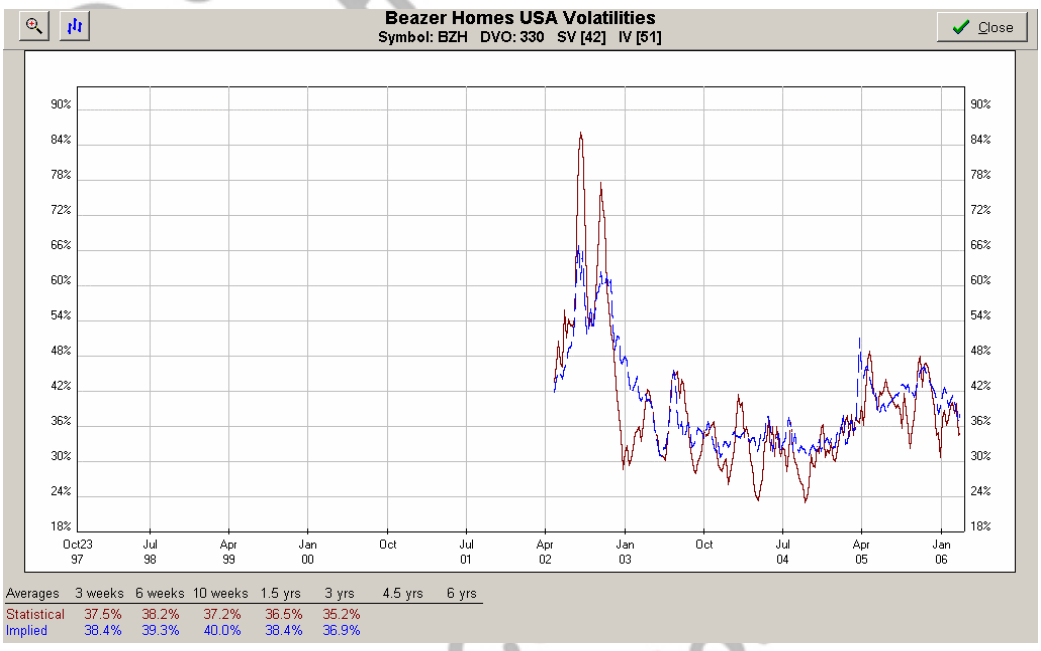
Implied volatility is very important and useful knowledge. Implied volatility can give forewarning of changes in share price. If option premiums suddenly rise without explanation, it is possible to deduce that something important might be about to occur in relation to the price of the underlying share.

Implied volatility is calculated from current option market premium using the fair value calculator backwards.

Volatility Charts

The volatility of a stock changes with time. Sometimes a stock can trade within a very narrow price band in which case it would have low volatility, like IYK shown earlier. At other times the price might fluctuate wildly like Pozen, in which case volatility would be high. The volatility of a stock can increase or decrease as time passes. Statistical or historic volatility can be calculated from the underlying share price each week and plotted on a chart. Similarly implied volatility can be calculated from the option prices and plotted. It is useful to plot both statistical and implied volatility on the same chart so they can be compared.

A volatility chart is a graphical representation of the average statistical and implied volatilities of a stock calculated each week over a period of one to six years. Statistical volatility is calculated from an exponential average of the daily price volatility over the previous 20 trading days. Implied volatility is calculated from the daily volatilities implied by option premiums over a week. A volatility chart showing both can be seen below.



The solid red line is statistical or historic volatility, calculated from the underlying share price. The broken blue line is the implied volatility, calculated from the option prices.

The historic and implied volatilities should generally track together. If they diverge, it indicates that the options prices are not reflecting the volatility of the underlying stock. The market expects the future to be different from the immediate past.

Key Point

Volatility charts overlay historic or statistical volatility with implied volatility, so they can be compared.

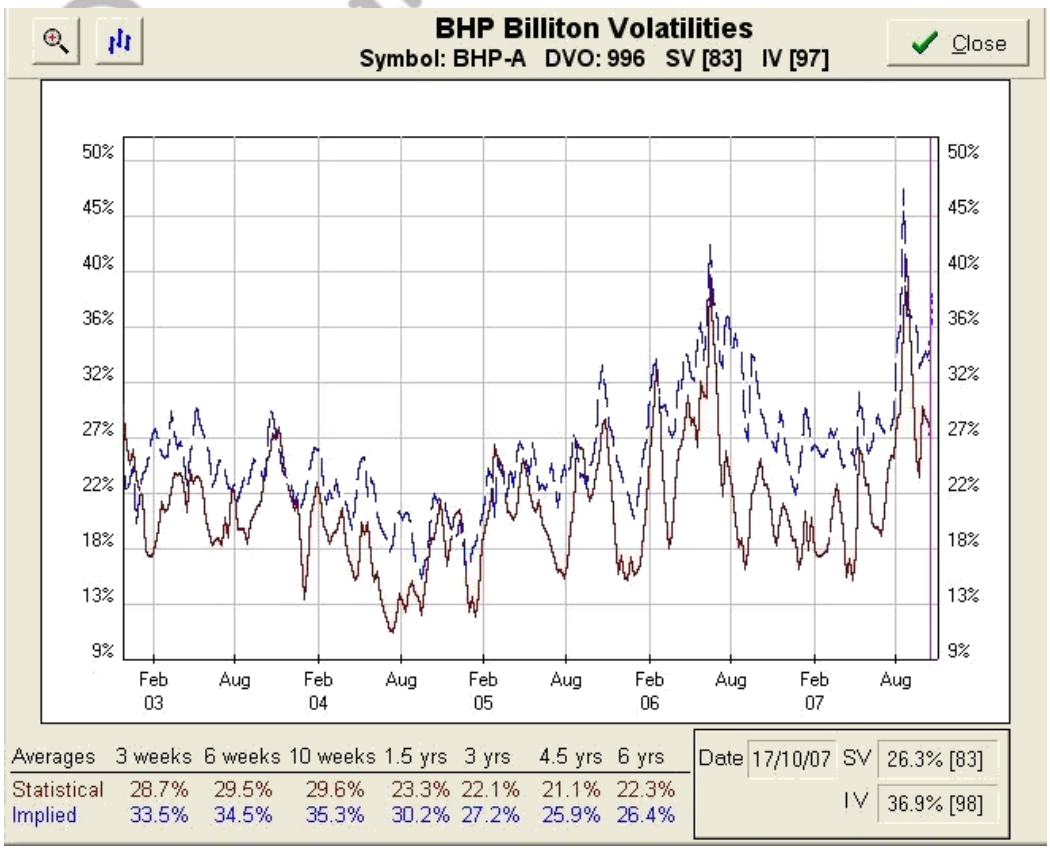
Interpreting Volatility Charts

Volatility charts are the cornerstone of developing a trading edge over other traders, who only trade on price. An understanding of volatility provides that edge. Volatility charts are an invaluable tool. They make it easy to understand the volatility characteristics of a trade, and therefore the behaviour of the time value of the options being traded.

Volatility charts are used to determine what is "normal" volatility.

- They enable forecasts to be made of future likely movements in volatility.
- They enable traders to profit from expected changes in volatility.
- They enable traders to readily identify whether volatility is at an extreme away from the average.
- They enable traders to identify overvalued and undervalued options.
- And they enable traders to identify expensive and inexpensive options.

We'll examine a typical volatility chart shown below.



Statistical volatility IS historic volatility.

Interpreting Volatility Charts

At the top of the screen is the name of the underlying stock and its exchange code.

On both sides of the chart are scales which show the percentage levels at which statistical and implied volatility are trading. The percentage value is a manufactured mathematical value. It is not really a percentage of anything tangible. Indeed volatility can exceed 100% for some shares.

Time is shown across the horizontal axis until the current day. At the lower left hand corner are calculated the averages of volatilities over the preceding 3 week, 6 week, 10 week, 1.5 year, 3 year, 4.5 year and 6 year periods. The averages are shown for both statistical / historic volatility and implied volatility.

Two very important pieces of additional Information are shown at the top.

"DVO:996" stands for the Dollar Volume of Options traded, which is the average of the daily dollar amount of options traded over the last five days. The figure is expressed in thousands. The chart above shows DVO of 996 which means on average $996,000 worth of options were traded daily in the preceding five trading days. This is useful, because as traders we prefer to trade in liquid markets.

Also shown are the current percentile rankings SV[83] for statistical volatility and IV[97] for implied volatility. The implications of volatility percentile rankings are very significant to options traders. We will see shortly how to apply that information.

Notice on the chart that statistical and implied volatilities approximately track each other, but not exactly. This is also an important observation.

The vertical purple line is a cursor which can be moved left and right to any selected date. At the lower right are shown the statistical and implied volatilities along with the percentile rankings for the date at the cursor position. In this case the cursor is not quite at the most recent day, and shows statistical volatility is 26.3% and implied volatility is 36.9%, which can also be read from the vertical scales at the sides.

Key Point

Why Volatility Is Important

Exploiting Implied Volatility

Key Point

Volatility Skew

Key Point

Volatility Skew

Key Point

Mean Reversion Tendency

Mean Reversion Tendency

Percentile Rankings

Percentile Rankings

How to Identify Expensive Options

Key Point

How to Identify Inexpensive Options

Key Point

How to Identify Overvalued Options

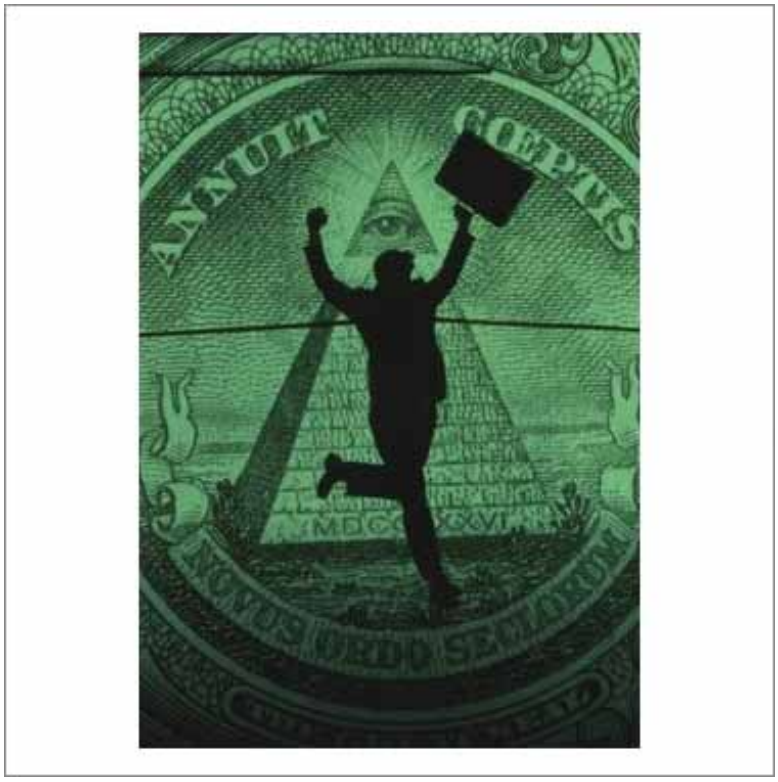
How to Identify Undervalued Options

Applying Knowledge of Volatility

Applying Knowledge of Volatility

Summary

We now understand the impact that shifting volatility has on both bought and sold options premiums. Reading and understanding the valuable information contained within volatility charts gives us a source for many potential trades and a trading edge over just picking price direction.



Key Point