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Time / Diagonal Spreads

How to calculate the volatility of the spread?

To be able to calculate the volatility of the spread, we must equalize the volatilities of the individual options.

First, let's move the June calls by moving June's implied volatility down from 40 to 36, a decrease of four volatility ticks. Four volatility ticks multiplied by a vega of .05 per tick gives us a value of $.20. Next we subtract $.20 from the June 70 option's present value of $2.00 and we get a value of $1.80 at 36 volatility. Now the two options are valued at an equal volatility basis.

Looking at this first adjustment where we moved the June 70's volatility down to 36 from 40, we have a value of $1.80 at 36 volatility. The August 40 call has a value of $3.00 at 36 volatility. So the spread will be worth $1.20 at 36 volatility.

If you wanted to move the August 70 calls instead, you would take the August 70 call vega of .08 and multiply it by the four tick implied volatility difference.

This gives you a value of $.32 that must be added to the August 70 call's present value in order to bring it up to an equal volatility (40) with the June 70 call. Adding the $.32 to the August 70 call will give it a $3.32 value at the new volatility level of 40 which is the same volatility level as the June 40 calls.

Now, our spread is worth $1.32 at 40 volatility. August 70 calls at $3.32 minus the June 70 calls at $2.00 gives the price of the spread at 40 volatility.

It does not make any difference which option you move. The point is to establish the same volatility level for both options. Then you are ready to compare apples to apples and options to options for an accurate spread value and volatility level.

Since we now have an equal base volatility, we can calculate the spread's vega by taking the difference between the two individual option's vegas. In the example above, the spread's vega is .03 (.08 - .05). The vega of the spread is calculated by finding the difference between the vega's of the two individual options because in the time spread, you will be long one option and short the other option.

As volatility moves one tick, you will gain the vega value of one of the options while simultaneously losing the vega value of the other. Thus the spread's vega must be equal to the difference between the two options vega's. So, our spread is worth $1.20 at 36 volatility with a .03 vega or $1.32 at 40 volatility with a .03 vega.

Going back to our original spread value of $1.00 with a vega of .03, we can now calculate the volatility of that spread.

We know the spread is worth $1.20 at 36 volatility with a vega of .03. So, we can assume that the spread trading at $1.00 must be trading at a volatility lower than 36.

To find out how much lower we first take the difference between the two spread values which is $.20 ($1.20 at 36 volatility minus $1.00 at ? volatility). Then we divide the $.20 by the spread's vega of .03 and we get 6.667 volatility ticks. We then subtract 6.667 volatility ticks from 36 volatility and we get 29.33 volatility for the spread trading at $1.00.

We can also determine the volatility of the spread as the spread's price changes. Let's fix the spread price at $1.30. To calculate this, we must first take the value of the spread ($1.20 at 36 volatility) and find the dollar difference between it and the new price of the spread ($1.30). The difference is $.10. This dollar difference must now be divided by the vega of the spread. The $.10 difference divided by the .03 vega gives you a value of 3.33 volatility ticks. Then add the 3.33 ticks to the 36 volatility and you get 39.33 as the volatility for the spread trading at $1.30.

Let's double-check our work by calculating the volatility the other way.

This time we will do the calculation by moving the August 70 calls up to the equal base volatility of the June 70 calls. As calculated earlier, the August 70 calls will have a value of $3.32 at 40 volatility.

The June 70 calls are worth $2.00 at 40 volatility. Thus the spread is worth $1.32 at 40 volatility.

Now let's again move the spread price to $1.30, $.02 lower than the value of the spread at 40 volatility. As before, we take the difference in the prices of the spread. The result is $.02 ($1.32 - $1.30). Then, divide $.02 by our spread's vega of .03 (remember that the vega of the spread is equal to the difference between the vega of the two individual options). $.02 divided by .03 gives us a value of .67. That .67 must be subtracted from our base volatility of 40. That gives us a 39.33 (40 - .67) volatility for the spread trading at $1.30. This volatility matches our previous calculation perfectly.

At first glance, you might be wondering why we went through all of these calculations. With the June 70 calls at 40 volatility, price $2.00, vega .05 and the August 70 calls at 36 volatility, price $3.00, vega .08 why not just take an average of the volatility? This would give us a 38 volatility for the spread with a price of $1.00 when in actuality $1.00 in the spread represents a 29.33 volatility.

This would be almost a nine tick difference which represents a whopping 30% mistake! Because, as stated earlier, vega is not linear; you can not weigh each month evenly and just take an average of the two months. For argument's sake suppose you did. Let's say you found the difference of the vegas of the options and came up with a spread vega of .03 which is correct. However, when you try to calculate the spread's volatility and price you would have difficulty.

Now, recalculate the spread with the trading price of $1.30, or $.30 higher than your value at 38 volatility. Divide that $.30 higher difference by the spread's vega of .03. You get a 10 tick volatility increase. Add that increase to the base 38 volatility. That would mean you feel the spread is trading at 48 volatility instead of a 39.33 volatility! This type of mistake could be very, very costly. Remember, apples to apples, oranges to oranges. It doesn't matter which option's volatility of the spread you move as long as you get both options to an equal base volatility.

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