Volatility Derivatives

by Larry McMillian

In 1993, the CBOE formally published the Volatility Index, VIX – the first and still the foremost index of volatility in existence. But the mere publication of VIX was just something traders could observe; they could not trade it. Eventually, though, in 2004, listed futures on VIX were introduced. The CBOE created its own futures exchange, the CBOE Futures Exchange (CFE) for this purpose. Futures were listed on both realized volatility (variance futures) and on implied volatility (VIX futures). Variance futures have not proven to be very popular with the populace who trades listed derivatives, but VIX futures have. Listed options on VIX were introduced in 2006. These products allowed listed option traders to address volatility directly for the first time. For those who don't trade derivatives, the volatility Exchange Traded Note (ETN) – VXX – was listed in 2009.

These have been some of the most successful new products ever intro-

duced, and their popularity continues to grow among both speculators and hedgers – those looking to protect stock portfolios.

Historical and Implied Volatility

Most of the time, actual volatility declines in bull markets and increases in bear markets. One reason is that, in bull markets, stocks tend to advance almost every day. But, in bear markets, declines are often punctuated with sharp, short-lived rallies, and so the standard deviation of the daily price changes is much greater. In fact, novice investors and certain members of the media interchange the terms "volatility" and "price decline." They might say "the market is volatile," when what they mean is "the market is down." This is incorrect, of course.

Implied volatility, however, is strictly a component of option pricing, and is a forward-looking measure. It is the volatility that one would have to use in a theoretical model (such as the Black-Scholes model) in order for the model's estimate of "fair value" to be equal to the current market price of the option. There is not a specific formula for calculating implied volatility; rather, it is an iterative process.

Calculation of VIX

The original CBOE Volatility Index calculation was released in 1993. It used the weighted implied volatilities of four series of OEX options, centered about the current OEX price – one strike above the OEX price, one below, in each of the first two expiration months.

By 2003, SPX options had become the most liquid index options, so the CBOE revamped the calculation of VIX. The "old" VIX remains – its symbol was merely changed to VXO. The "new" VIX was based on SPX options, and incorporated nearly all of the strikes trading in the first two expiration months. In the vernacular, it is said that the "new" VIX is based on the "strips" of options expiring in the first two months. The actual formula, which is complicated, can be found on the CBOE web site, along with other papers on the subject.

Both the old and new VIX are 30-day volatility measures. That is very important, for longer term derivatives, expiring many months in the future will not track VIX well, for this very reason. What this 30-day estimate means, in mathematical terms, is that the two strips of SPX options that are used in the VIX calculation have a different weighting each day. As time passes from one month to the next, the strip of SPX options in "near" month gets less weight and the strip in the "far" month gets more.

The VIX calculation is versatile. It can be applied to any set of options where continuous markets (bids and offers) are being made in the two strips of options in the two front months. As a result, a VIX-like calculation of volatility can be made for nearly every listed stock, index, or futures options. In recent years, the CBOE has begun publishing VIX calculations, and in some cases trading futures and options, on gold, crude oil, and the Euro (foreign currency). These used the options of the popular ETF's GLD, USO, and FXE, respectively. Also, VIX calculations are being broadcast on a number of other ETF's and some individual stocks – which, at this time, include Apple (AAPL), Amazon (AMZN), Goldman Sachs (GS), Google (GOOG), and IBM (IBM), and the following ETF's: Emerging Markets (EEM), China (FXI), Brazil (EWZ), Gold Miners (GDX), Silver (SLV), and Energy (XLE).

It will become necessary, if it isn't already, to qualify what VIX one is talking about. For years, VIX meant the calculation based on the SPX options. But, it really is likely to be called "SPX VIX" as time progresses. To differentiate it from "Gold VIX," "Apple VIX," and so forth.

Listed Volatility Futures

In 2004, the CBOE created its futures exchange – the CFE – with only two products in mind: listed futures on historical and implied volatility. Implied volatility futures – or VIX futures, as

they are commonly known – have proven to be the far more popular product.

Do not skip this section if you are planning on trading any derivative

volatility products. Even if you think that you might have no interest in trading VIX futures – only options on VIX – you must understand the futures on VIX in order to understand the options on VIX.

VIX futures are quoted in price terms, much like VIX. For example, if VIX itself is trading near 20, then the various futures will be trading at prices slightly above 20, most likely. A VIX futures contract is worth $1,000 for every one point move it makes. So if one buys one July VIX futures contract at 21 and sells it at 22, he makes $1,000 less commissions.

The margin required by the futures broker can vary, depending on the price of the futures and only general market volatility. The exchanges are always allowed to raise margin prices to curb speculation if they see fit. At this time, the exchange minimum margin for trading one VIX futures contract is $4,000. Thus, this has tremendous leverage, as do most futures contracts. A four-point move in the contract could double your money or wipe out your initial margin equity.

VIX Futures Expiration Date

VIX futures are listed for several months – at least the next seven contiguous months going forward from today's date. Each futures contract has an expiration date. At first glance, VIX expiration dates seem rather arcane, but there is actually a physical reason for the way these expiration dates are determined, as is the case with many futures expiration dates on all kinds of commodities and financial products.

The expiration of VIX futures in any given month is 30 days prior to the SPX option expiration in the next month. This is always a Wednesday. It may sometimes be the Wednesday before "regular" option expiration (which takes place on the third Friday of the month), or the Wednesday after. Those are the only two possibilities.

> Example: July SPX options expire on Friday, the 19th. June VIX futures will thus expire 30 calendar days prior. That means back up 19 days in July, and 11 in June. Since June has 30 days in all, backing up 11 days from the end of the month, puts the expiration date as June 19th. If July 19th is a Friday, June 19th will always be a Wednesday.

This 30-day "look-back" has to do with providing an arbitrage capability for market makers, which is necessary for liquidity in the VIX options. Moreover, VIX futures are based only on the SPX options that expire 30 days hence – not on two "strips" of options, as VIX itself is.

The actual expiration of the VIX futures takes place on the Wednesday morning of expiration, and a VIX calculation is done, using just the SPX options that are trading with an expiration of 30 days hence. There are rules governing exactly what price to use for the SPX options – an average of the bid and offer, or the last sale – that can be found on the CBOE web site.

Once this "expiration-day-only" VIX computation is made, the VIX futures expire and settle for cash at that price.

Example: The VIX settlement price is disseminated by the CBOE under the symbol VRO (quoted as an index). Suppose that an account had bought a single June VIX futures contract at a price of 23.25 and held it until expiration. Furthermore, suppose that at expiration, VRO is determined to be 20.84. Then a realized loss of 2.41 points, or $2,410 dollars, would be booked into his account, and the futures position would be removed from the account. In reality, the futures would have been marked to market daily is his account, so that $2,410 loss would have been accumulating for some time.

Futures Compared to VIX – Premiums or Discounts

If a futures contract is trading at a higher price than VIX, it is said to be trading at a premium. Conversely, if a futures contract is trading a lower price than VIX, it is said to be trading at a discount. In other words – as is the case with S&P futures and many other futures contracts – the terms premium or discount refer to the relationship of the futures with respect to VIX, not the other way around. That is, one would not say "VIX is trading at a discount to the futures contract," but would instead say "the futures contract is trading at a premium to VIX."

When one talks about the collective status of the premiums on all the futures contract, he is said to be referring to the term structure of the futures. It is usually the case that the various futures contracts – extending out seven months in time, or more – trade in a pattern. One pattern that is fairly common is to see larger and larger premiums on the futures, as one looks farther out in time.

Example: this is an example of a positive-sloping term structure:

VIX:	13.45
August VIX futures:	15.09 S
eptember VIX futures:	18.17
October VIX futures:	20.28
November VIX futures:	21.92
December VIX futures:	23.01

January VIX futures:	24.94
February VIX futures:	26.03
March VIX futures:	26.70

See how each futures contract is trading at a slightly higher price than its predecessor?

That is a positive slope to the term structure.

A positive-sloping term structure usually exists during bullish markets

and/or if VIX is quite low-priced. A negative-sloping term structure is possible as well, and that usually exists during the throes of an ongoing bear market, especially if VIX is high-priced.

In these regards, the term structure can sometimes be a good indicator of whether the market is overbought or oversold, for if the term structure slopes "too steeply" in one direction or the other, odds are it will flatten out somewhat, and the stock market will reverse direction – at least temporarily – in order for that to occur. The above sample prices show a very steep term structure, and thus describe an "overbought" stock market.

Novice traders often ask why these futures trade at such different prices than VIX, even the short-term ones. Besides the natural term structure of option pricing, there is another important factor – the way that VIX is computed as compared to what the VIX futures measure. Recall that, in the VIX calculation, one uses the two near-term strips of SPX options, whereas the futures only use the SPX options that expire 30 days hence.

As an example, examine what happened in August 2011, when VIX exploded to 48 as the stock market collapsed, but VIX futures didn't come close to that level. When VIX closed at 48 on August 8th, 2011, the nearterm (front month) August VIX futures settled at a 36.55 – a huge discount of 11.45. The September futures (second month) discount was a rather stupendous 17.80 on that day, for the Sept VIX futures settled at a price of 30.20.

The reason this occurs is that VIX and the futures do not have the same components. VIX and VIX futures prices are based on the implied volatilities of SPX options. On that date, VIX was a weighted calculation of the August and September SPX options. The VIX futures however, are based on just one strip of SPX options – those that expire 30 days after the VIX futures expiration. Hence, on that date of August 8th, August VIX futures were based on the SPX September options. Similarly, September VIX futures were based on SPX October options.

In rough terms, the average implied volatility of SPX August options on that day was about 58%, while the average September SPX option was about 36%, and the average October SPX option was about 30%. VIX was a blend of the 58% and 36% – resulting in VIX being at 48. But

August VIX futures reflect the volatility of September SPX options (36%) and September VIX futures reflect the volatility of October SPX options (30%). Hence the difference in pricing.

It has nothing to do with market makers or other traders trying to make unreasonable volatility predictions for the coming months. It does have to do with the term structure of SPX implied volatilities inverting steeply in a very bearish market.

Volatility ETF's and ETN's

Once the popularity of Volatility futures became evident, other entities tried to copy the product. The CBOE and CFE have certain licensing agreements in place, so the exact same products could not be duplicated. That is, it is not possible to create another futures exchange and then start trading volatility futures in the same way. However, a number of ETF's (Exchange Traded Funds) and ETN's (Exchange Traded Notes), which utilize the VIX futures, have been created.

The first, and the most popular and liquid, of these is the Barclay's Bank creation, VXX. It is formally known as the iPath S&P 500 VIX Short-term Futures Exchange Traded Note. It was launched on January 31, 2009, and has been a way for entities that cannot or will not trade futures and options to trade volatility. The components of this ETN are the two front-month VIX futures that trade on the CFE. Barclays rolls them daily, to keep them in the proper ratio according to the VIX formula.

VXX is, by far, the most active and popular of the volatility ETF's and ETN's. However, others are gaining in popularity and – due to the overall demand for volatility hedging products – there will probably continue to be more of these in the future. VIXY is an ETF, which essentially duplicates VXX. TVIX is double the speed of VXX. XIV is the inverse of VXX. There are many others, as well.

A Potential Problem With ETF's and ETN's

One of the main problems with commodity-based ETFs is they don't necessarily track the underlying commodity very well. This is mainly due to the fact that the ETF is forced to trade the futures contracts, and there are times when it isn't feasible for the ETF managers to roll from one futures contract to the next without making a "losing" trade that puts drag on the performance of the ETF vis-a-vis the spot index or commodity itself. For example, when the term structure has a positive slope (which is most of the time), each daily "roll" costs the long volatility (VXX or VIXY) ETF some money.

It should also be pointed out that an ETN is essentially subordinated debt issued by the underwriter. Hence, if you own VXX and Barclay's were to go out of business, your VXX shares

could be worth only pennies on the dollar. This is a remote possibility, but not impossible.

Listed VIX Options

Some of the ETN's, such as VXX, have listed options. Those options are of the "normal" variety – expiring on the third Friday of the month, and settling into VXX shares if they are exercised or assigned.

But the options on the VIX index itself are cash-based options, settling for cash on their expiration day – ostensibly like OEX or SPX options do. The same "a.m." VIX futures settlement price that was discussed earlier is used for the VIX options settlement.

> Example: a trader owns a VIX July 25 put. He does not exit the contract in the open market, but rather holds it until expiration. The settlement price (VRO) is determined to be 20.84. The July 25 put is thus 4.16 points in the money (25 minus 20.84), and the customer would receive $416 in his account, while the put contract would be removed from the account.

But nearly all other aspects of VIX option trading are different from other listed equity or index options, whether they be cash-based or not.

First, VIX options expiration dates are the same as VIX futures – 30 days prior to the next SPX option expiration. That date is always a Wednesday, often the Wednesday before the third Friday, but occasionally the Wednesday after the third Friday.

But the most important thing to understand about VIX options is they are priced off the VIX futures – not off of VIX itself. As an aside, then, each month's VIX options actually have a different underlying index – the corresponding VIX futures contract. If one is discussing IBM, October IBM and December IBM, say, have the same underlying – IBM's stock price. Same for an index, such as SPX. But not the same for VIX options, since each month's underlying futures contract is a reflection the implied volatility of the SPX options expiring in each separate month.

> Example: On February 24, 2006, on the first day of VIX option trading, VIX was trading at 11.46. The following were the prices of the VIX put options with a striking price of 15:
>
> | | |
> |---|---|
> | VIX Index: | 11.46 |
> | VIX March 15 put: | 3.00 |
> | VIX April 15 put: | 2.55 |
> | VIX May 15 put: | 2.00 |

First of all, this looks rather strange, doesn't it? The longer-term puts sell for a lower price than

the near-term ones? But any option trader will always relate an option's price of parity, first of all. For a normal American-style option, parity of an in-the-money put is the striking price minus the underlying price.

If we (erroneously) assume VIX is the underlying, then we would calculate:

$$\text{Parity} = 15 - 11.46 = 3.54$$

These puts are trading well below parity, it seems. The May 15 put seems to be trading at nearly a point and a half discount to parity.

What is possibly going on here? The answer to that question lies in the fact that, for pricing purposes prior to expiration, the underlying for these VIX options is not VIX itself (at least not until the last instant of their life), but rather the VIX futures. Consider, then, this further piece of information, Table 1:

Table 1: VIX Options and Futures Prices

Option Contract	Option Price	Futures Price
VIX March 15 put	3.00	March: 12.10
VIX April 15 put	2.55	April: 12.76
VIX May 15 put	2.00	May: 13.86

Consider the following general information about a proverbial XYZ option:

If we have XYZ: 13.86
And we have an XYZ May 15 put: 2.00

One would not think there is anything unusual about this. XYZ stock is slightly below the striking price of 15, and it's 1.14 in the money (15 minus 13.86). The put option is trading at 2.00 – well above intrinsic value. Now substitute the data for the May 15 put from Table 1:

May VIX futures: 13.86
VIX May 15 put: 2.00

Now, the option prices in Table 1 make sense – if you consider that the underlying is the futures contract and not VIX itself. In fact, VIX may differ from the futures prices by a substantial amount, as we have seen from earlier examples. Not until the settlement process takes place does VIX have to converge with the near-term futures price. Hence, for nearly all of a VIX option's life, the price of VIX itself is a piece of irrelevant information! True, there may be

strategies we can employ knowing that the near-term futures and VIX will have to eventually converge, but for the purpose of pricing the options, VIX is not needed. VIX options are priced off of the futures contracts.

VIX Option "Calendar" Spreads

Using these same concepts, let's see how what appears to be a rather benign strategy – the call calendar spread – can actually have some unexpected results. The following examples closely replicate what actually happened in the fall of 2008, much to the chagrin of both customers and their brokerage firms.

Date: September 8, 2008
VIX: 22.64
VIX Oct 25 call: 1.75
VIX Nov 25 call: 2.15

Most brokerage option platforms at that time – and, sad to say, most still today – do not calculate option Greeks and implied volatility correctly, because they are not "smart enough" to use the futures prices as the underlying. Rather they just use VIX, which we know is wrong. That contributed to the problem. Using VIX (incorrectly) as the underlying, it appears that the implied volatilities of these two options are out of line – that the Oct 25 call is trading with a much higher implied than the Nov 25 call. Thus, traders thought that a call calendar spread might make sense.

VIX Call Calendar:
Buy Nov 25 call and Sell Oct 25 call for 0.40 debit

Now, if this were IBM or an index, or anything besides the equivalent of a futures option, you know that a "regular" calendar spread risks the initial debit (0.40 in this case) and can make a limited profit, depending on where the underlying is at the time of near-term (October) expiration and what the implied volatility of the long-term (November) call is at that time. There isn't any such thing as "November IBM" and "October IBM." IBM is just IBM.

But these are not IBM options, and what happened was devastating to some.

Date: October 10, 2008

VIX Oct 25 call:	31.60	Oct VIX futures:	56.60
VIX Nov 25 call:	13.70	Nov VIX futures:	38.30

This VIX call calendar spread is now trading at minus 17.90 points. Thus, to exit the spread

costs another $1,790! You would have to buy back the Oct 25 call for 17.90 more than you get from selling out your long Nov 25 call. Since you already paid $40 to enter the spread, your total loss is $1,830 plus commissions.

Traders who used this strategy lost a lot of money, and in many cases their brokerage firms did too, because those brokerage firms had not properly margined the position – thinking it was a "normal" calendar spread. Now, most experienced brokerage firms are asking for naked margin for any short options in a VIX calendar spread or diagonal spread; only vertical spreads receive the usual reduced margin requirement.

Using VIX Derivatives

Trading VIX options as a speculative vehicle can be quite interesting, for VIX can be very explosive. If VIX is very low-priced, it can rise tremendously if a bearish market takes place. Essentially, VIX trends opposite to the stock market.

Almost any strategy that one would employ with "regular" stock or index options can be constructed with VIX options, but be aware that VIX rarely falls below 10 or rises above 50 (although it did reach 93 in the financial crisis of 2008, and theoretically would have reached 150 in the Crash of '87, according to the CBOE).

Another use is as protection. If one owns a portfolio of stocks behaving in a manner similar to the broad stock market, then an effective hedge against some downside risk would be to own VIX futures or options (or the volatility ETNs or their options).

Volatility has become an asset class. Volatility derivatives are going to be a major factor in portfolio strategy in the coming years, and they already are for the more sophisticated traders. Furthermore, more and more individual stocks and ETFs will have volatility derivatives as well. Hopefully, this article will get the reader interested enough to search out further information on the topic.

About Lawrence G. McMillan

Lawrence G. McMillan is the author of "Options as a Strategic Investment", the best-selling work on stock and index options strategies, which has sold over 300,000 copies. The fifth edition of this work was released, in August, 2012. He also edits and publishes several option-oriented newsletters as President of McMillan Analysis Corporation, which he founded in 1991. He writes about volatility derivatives daily and in feature articles in The Option Strategist newsletter.

For anyone who is interested in sampling that newsletter, please go to www.optionstrategist.com, and order any subscription to The Option Strategist. Receive 50% off, if you enter the Coupon Code SSTBOOK when subscribing.

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