June 2016

Colin Bennett on volatility trading: The evolution of volatility products

This introductory report describes the evolution of the volatility product landscape over time, and the different methods of calculating volatility indexes. Example trades for both volatility futures and options on volatility futures are shown.

Colin Bennett, the Head of Equity and Index Product Development at Eurex Exchange, is the author of "Trading Volatility", the top ranked book on Amazon for volatility.

Previously Colin was a Managing Director and Head of Quantitative and Derivative Strategy at Banco Santander, Head of Delta 1 Research at Barclays Capital, and Head of Convertible and Derivative Research at Dresdner Kleinwort.

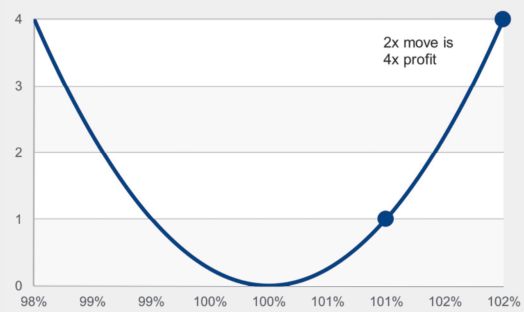
Original VIX was based on ATM volatility

The first volatility index was the original S&P100 VIX, which was created by Professor Robert Whaley on behalf of CBOE in 1993 (and back calculated from 1986). Before this date a volatility index was simply an academic concept that had been discussed since 1987. The original VIX was based on S&P100 ATM volatility of: calls and puts; strikes above and below spot; expiry before and after the 22 trading day (c30 calendar days or c1 month) maturity of the index. The calculation methodology therefore uses as an input 8 different ATM implied volatilities, which is reduced to a single VIX value using the below process:

- Average the call and the put implied volatility for options of same strike and expiry. This reduces the 8 original data points to 4.
- Linearly interpolate between the two strikes of options of same expiry to get spot ATM volatility. The 4 data points are therefore reduced to 2.
- Linearly interpolate (or extrapolate if the nearest maturity is within 8 calendar days, as near dated implies, suffer from data quality issues) to get a 22 trading day implied volatility.

Original VIX suffered from launch of variance swaps at the same time

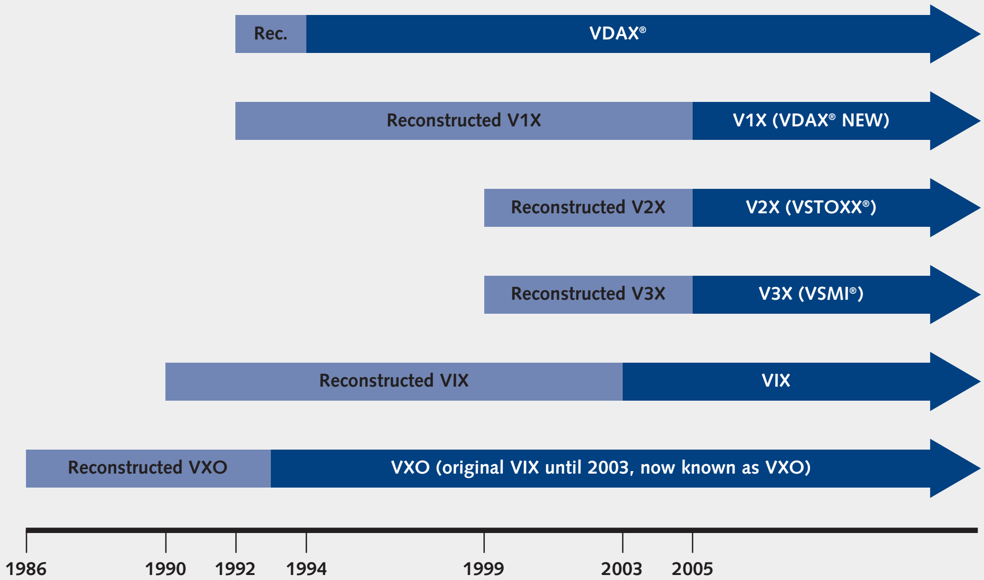
While the original S&P100 VIX was a significant innovation in 1993, the product became almost immediately out-dated as variance swaps were also launched at a similar time. Variance is the square of volatility, which makes variance a difficult concept to understand. However as the pay-out of a delta hedged option is variance, not volatility, variance is mathematically the correct measure of deviation. This can be seen in the diagram below, which shows that a delta hedged option makes 4x the profit when you double the stock price movement. If the payoff of an option was based on volatility, not variance, then a delta hedged option would make 2x the profit when you double the stock price movement.



Volatility Indexes are now usually based on variance

As variance swaps became increasingly popular post-1998 due to the LTCM crisis, it became clear that a volatility index should be based on a variance swap calculation (which uses the implied volatility of all strikes) not an ATM volatility calculation (which only uses the implied volatility of 8 options). A new VIX was therefore launched in 2003 with a variance based calculation, and the underlying changed from the S&P100 to the S&P500. The original S&P100 VIX was renamed VXO. While the majority of volatility indexes use a variance based calculation, there are a few volatility indexes on less liquid indexes (which only have reliable data for ATM options) that continue to use an ATM volatility calculation.

Old VIX, new VIX, VDAX®, New VDAX® and VSTOXX® launch date and first data point



Different index providers use different variants of variance calculation

The major drawback of a variance based calculation is the fact this requires perfectly liquid options for every strike (zero to infinity). To insure the volatility index has a sufficiently high data quality, less liquid OTM options need to be excluded from the calculation. While the calculation of a variance swap is purely mathematical, and therefore impossible to copy-write, each index provider has their own bespoke method of removing illiquid options which is subject to copy-write. For this reason the calculation method of volatility indexes of different providers is slightly different.

Volatiliy indexes are not tradable

The calculation of a volatility index is based on the implied volatility for a fixed number of days, normally 30 calendar days. As listed options are only available for monthly or weekly expiries, for the majority of days a volatility index has to use as an input the implied volatility for two expiries (normally the expiry just before and just after the theoretical expiry of the index). A volatility index is therefore only useful as an indicator of how volatile the market expects the underlying to be. If an investor wants to trade volatility, they have to use an instrument with a fixed expiry such as a volatility future (or an ETN/ETF whose payout is based on volatility futures, like the VSXX[1]).

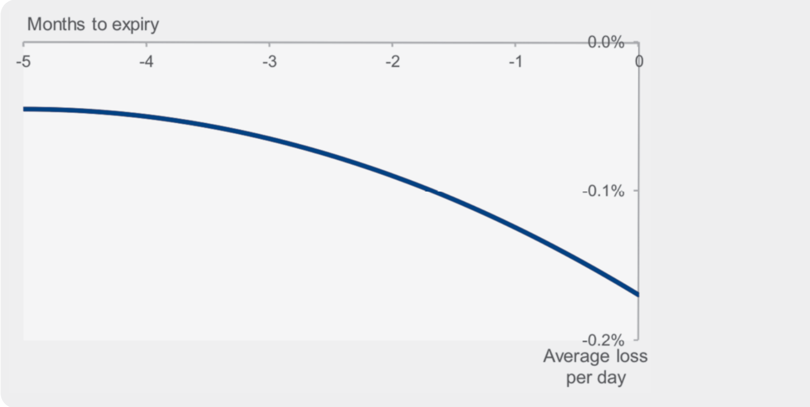
Can trade volatility through futures

As a future has a fixed expiration, it can be hedged with a portfolio of options which also have a fixed expiration. This means that market makers are able to offer liquidity on futures on volatility indexes, as they can hedge their risk with ordinary option on the underlying equity (or equity index). The expiration of volatility futures is chosen so at maturity they are 30 days from the ordinary options expiration, as 30 days is the market standard expiration for volatility indexes. Having this non-standard expiration means that market makers only need to hedge most of their volatility risk with one expiry[2]. This reduces hedging costs which allows them to narrow their bid offer spreads.

Volatility futures as a hedge should have maturity between 2 and 5 months

As put options are typically used to buy protection, investors typically buy (rather than sell) them. This usually lifts the value of implied volatility above fair value. As a future on a volatility index is based on the implied volatility of options, they are on average expensive. This can be seen from the diagram below, which shows the average daily return for VSTOXX® Futures in the 3 months approaching expiry. As the average daily loss for VSTOXX® Futures between 2 and 5 months or more to expiry is relatively small, this is the optimum maturity for long VSTOXX® strategies.

As volatility means reverts over a period of a few months, the sensitivity of VSTOXX® Futures to the VSTOXX® decreases as maturity increases. For this reason, it is not usually wise to trade VSTOXX® Futures of maturity 6 months or more.



Volatility futures can offer cheaper protection than puts when volatility is low

When equity markets plummet, this normally happens with high volatility. Conversely, when equity markets rise they tend to do so gradually with low volatility. This means volatility is negatively correlated to the equity market. A long volatility future position can therefore be used to hedge a long equity position. A portfolio of long volatility futures and long equity should therefore have a low volatility, and hence lower risk of significant negative returns. As volatility is on average expensive, this reduction in risk comes at the expense of a lower average return. However using volatility futures can be a cheaper hedge than buying put options. This is because a put option expires worthless if equities do not decline, while implied volatility is floored and never declines to zero.

Selling volatility earns small profits on average, so needs to be done regularly and with short maturity (1 month)

Investors can therefore profit from selling volatility futures. The disadvantage of this strategy is that while on average small returns are earned, occasionally a large loss is suffered. This strategy could be seen to be similar to selling insurance.

[1] The VSXX is the VSTOXX® equivalent of the VIX based VXX.

[2] As a volatility future is similar to a forward start on volatility (or variance), the position will need to be hedged with two expiries (the main risk from the farthest maturity at the end of the forward start, but also a smaller amount of risk from a nearer dated expiry at the beginning of the forward start).

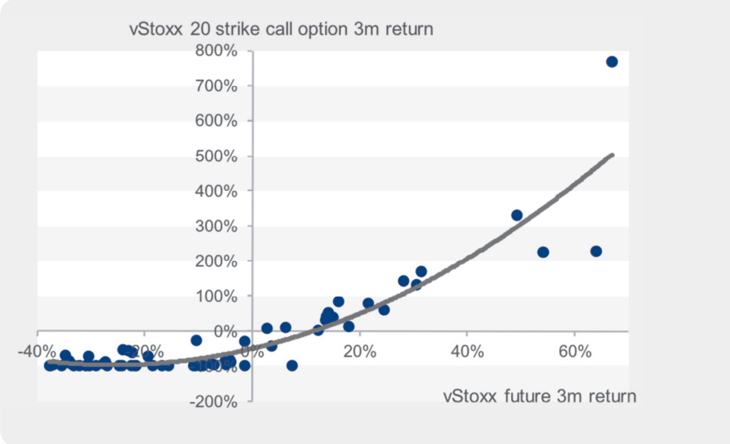
Most of the time a small premium is earned, but in the event of an accident a large loss has to be covered. Given the asymmetric risk reward profile of selling volatility futures, it is only seen to be worthwhile if done regularly (in the same way an insurance company sells lots of insurance, and does not do it as a one off). As VSTOXX® Futures suffer on average the largest loss in the final month to expiry (see diagram on page 3), this is the optimum maturity for a short volatility strategy.

Volatility futures can offer higher returns than equity futures

While it is rare for equities to double or halve over periods less than 1 year, it is possible for volatility to double in a few days or halve in periods as short as a month. Investors who have high conviction regarding the direction of markets can consider volatility futures to be a more profitable way of expressing that view. We would caution that with the higher potential reward, there is higher potential risk.

Options on volatility futures also offer volatility exposure

Investors who wish to be long volatility are normally expecting a volatility spike. While volatility futures will be profitable in the event of a volatility spike, call options on volatility could be significantly more profitable as they offer geared exposure to any volatility upside. The chart above shows the 3 months return for VSTOXX® 20 strike (i.e. roughly ATM) call options against the 3 month return for the identical maturity VSTOXX® Future. As can be seen, the profits on a long VSTOXX® call option can be up to 10 times larger than profits on VSTOXX® Futures.



This additional exposure to volatility spikes comes at the cost of a far larger average loss (24%) than the average loss on VSTOXX® Futures (6%) over the 3 month period.

Buying puts on volatility futures profits from expensive implied volatility

Options on equity indexes are normally overpriced, and the greater the maturity the more expensive they are on average. Because of this, investors can on average profit through buying put options on volatility futures, particularly when volatility is high (as volatility tends to mean revert, hence if it is high it is likely to decline).

Volatility Futures as an alternative to equity and puts

In part 2 of our 3 part series on volatility, Volatility Futures are examined in depth both as an alternative to equity and as an alternative to puts. The key characteristics of trading volatility in practice are demonstrated, and the differences between Volatility Futures and Variance Swaps analyzed.

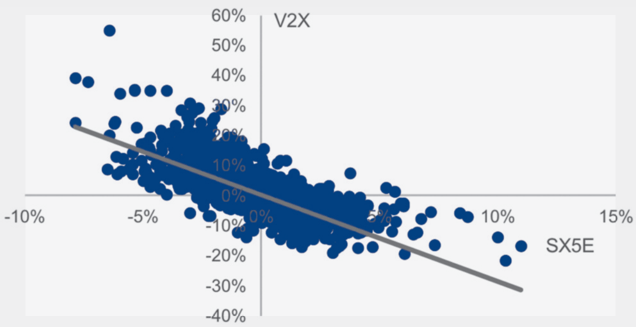
Volatility Futures were first listed in Europe

The DTB (now Eurex) was the first exchange to list Volatility Futures. These VOLAX® Futures were based on ATM 3 month implied on the DAX®, and they were listed in 1998 (and subsequently delisted later the same year). Six years later in 2004 Volatility Futures were listed on the VIX, which was swiftly followed a year later by the launch of VSTOXX® (and VDAX® and VSMI®) futures in 2005.

Volatility has negative correlation to equity

As volatility tends to rise when equities decline, a long Volatility Futures position can be taken as a hedge. For short periods of time (e.g. over 1 day or 1 week) there appears to be a linear negative relationship between volatility and equity returns, as can be seen in the chart below (we note this hedge has a certain amount of noise).

Daily returns of V2X versus SX5E



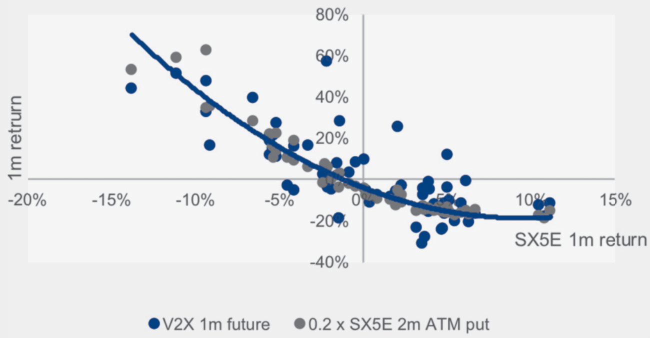
Volatility can have convex profile versus equities, just like a put

Returns over relatively short periods of time hide the fact that volatility is floored at a certain level, for example the VSTOXX® never trades below c12%. This means that the loss from a long VSTOXX® Future is floored, hence returns over a longer time period (e.g. 3 months) show a more convex profile than daily returns. A long Volatility Future can therefore be compared against puts, particularly when volatility is low and the impact of the volatility floor is greatest.

Long ATM SX5E put has similar payout to 5 VSTOXX® Volatility Futures

As a Volatility Future is a future on a 1 month Volatility Index, the implied volatility of a 3 month Volatility Future trades in line with that of a 4 month put. The return of Volatility Future of 3 month expiry until maturity should therefore be compared to the 3 month return of a 4 month put (i.e. the return of a put with 4 month maturity up until it has only 1 month left to expiry). Similarly, the return of a Volatility Future with 1 month until expiry should be compared to the 1 month return of a 2 month put (i.e. return of a put with 2 month maturity until it has only 1 month left to expiry). For both 3 month Volatility Futures (vs 4 month ATM put) and 1 month Volatility Futures (vs 2 month ATM put) the payout of an ATM put is very similar to the payout of 5 VSTOXX® Volatility Futures. Hence 5 VSTOXX® Volatility Futures could be considered an alternative to one SX5E ATM put. It should be remembered that the payout of a Volatility Future is less reliable than that of a put.

V2X Futures versus SX5E put



Volatility futures could outperform puts

While the performance of a SX5E ATM put and 5 VSTOXX® Volatility Futures appears similar, the payout of 5 VSTOXX® Volatility Futures has historically been higher than for SX5E ATM puts. This means using VSTOXX® Volatility Futures for protection could outperform using SX5E ATM puts.

Volatility Futures trading in practice

Trading Volatility Futures allow a volatility position to be taken without the overhead of delta hedging an option. Before trading Volatility Futures it is important to take into account the key differences between volatility trading via options, and Volatility Futures.

Volatility Futures are a forward on volatility

Upon expiration of a Volatility Futures, the pay-out is based on the underlying Volatility Index. Hence when trading a Volatility Futures, the profit and loss is based on a future on volatility (which is the same as a forward on volatility, as a future is simply a listed forward). While trading a forward on volatility has many similarities with trading volatility itself, there are also important differences.

Volatility Futures expiration is 30 days prior to normal expiry

To make it easier for traders to hedge their Volatility Futures position, a Volatility Futures expires 30 days (the maturity of the underlying volatility index) prior to a normal option expiration. As expiration is normally on the 3rd Friday of a month, a Volatility Futures expiration will be on the 3rd or 4th Wednesday of a month (as normal option expirations can be 4–5 weeks apart, i.e. 28–35 days).

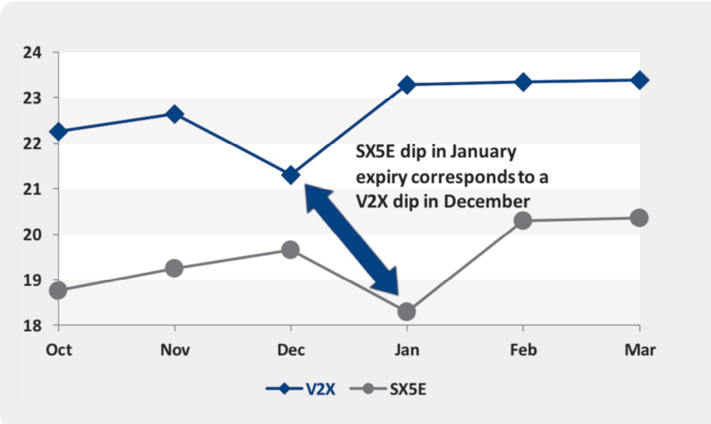
Non-standard expiry (3rd or 4th Wednesday) makes Volatility Futures easier to hedge

While having a non-standard expiry could be seen to be confusing, it does mean that on the date of expiration, the underlying Volatility Index is calculated using the implied volatility for only one maturity (no interpolation or extrapolation between two expiries is needed). A Volatility Futures that expires in November, will therefore be hedged by trading a strip of options for the December expiry one month later.

Volatility Futures implied should be compared with underlying index implied one month later

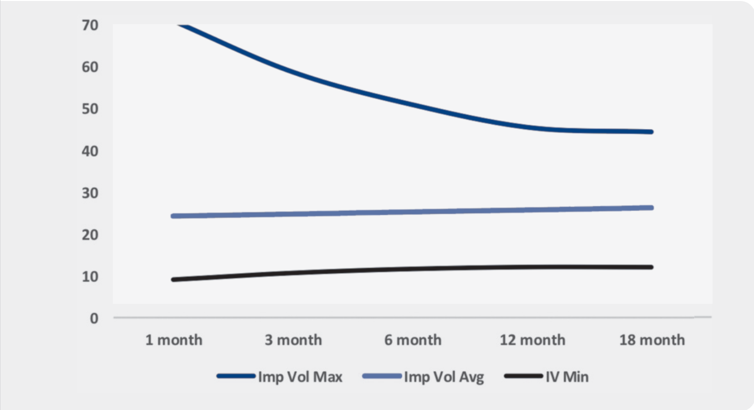
As Volatility Futures are a based on 1 month forward volatility, they should be compared with the volatility of the underlying index 1 month later than the Volatility Futures expiration. The term structure of Volatility Futures therefore has a 1 month offset to the term structure of the underlying index.

For example, the Volatility Futures for VSTOXX® December expiry should be compared with the SX5E January expiry the following year. This is because the December expiration of the VSTOXX® is based on what the VSTOXX® is on the (3rd or 4th Wednesday) Volatility Futures expiration in December. On the December Volatility Futures expiration, the VSTOXX® 30 day volatility is based on the index (3rd Friday) January expiry (of the following year) of the SX5E options. Due to the large number of public holidays between December and January expirations (Christmas and new year) the SX5E volatility term structure normally has a dip in January. Therefore VSTOXX® volatility term structure normally has a dip in December (due to the 1 month offset).



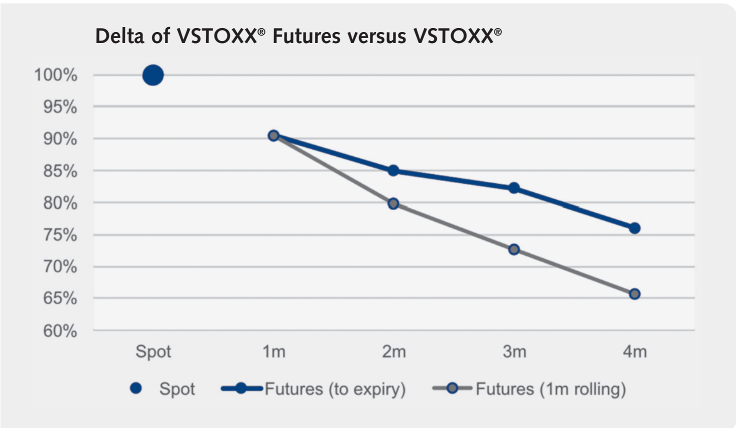
Volatility mean reversion dampens returns of far dated futures

When an unexpected event occurs, volatility normally jumps. As markets digest the news, volatility tends to soften and mean revert over a period of up to 10 months. This mean reversion can be seen by plotting the minimum and maximum implied volatility per maturity (a volatility cone) as can be seen in the chart below. As near dated implieds have a wider min-max range than far dated implieds, this means that when a volatility index spikes near dated Volatility Futures rise more than far dated volatility futures. Far dated Volatility Futures could be seen as a more stable (or less levered) way of gaining volatility exposure.



Near dated Volatility Futures have highest sesitivity to index, but need to be rolled more frequently

While near dated Volatility Futures are more sensitive to the underlying Volatility Index, the position needs to be rolled frequently. Before deciding on the maturity of a Volatility Futures, an investor needs to decide how much overhead (i.e. rolling frequency) they are willing to take, and how sensitive to moves in volatility they want the position to be. For example, while the front month Volatility Futures has a very high delta (90%) with the Volatility Index this would require rolling every month.

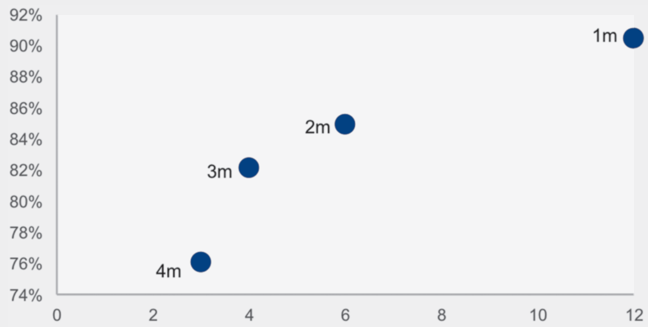


Volatility mean reversion reduces delta of far dated futures

Volatility tends to jump, and then mean revert over a period of time just under 1 year. Near dated Volatility Futures will therefore have a delta (or exposure/sensitivity) to the underlying Volatility Index of nearly 100% (e.g. c90% for 1 month volatility futures). The delta (or exposure/sensitivity) of Volatility Futures will fall as maturity increases, as mean reversion makes it unlikely that the current levels of volatility will remain over the entire life of the Volatility Futures.

A plot of the sensitivity (i.e. delta) of Volatility Futures to the underlying Volatility Index is shown above both for rolling every month, and for rolling at expiry. For example, the 3 month data point can either always have a 3 month maturity (i.e. it is rolled when the maturity reduces to 2 months) or can have a maturity between 0 and 3 months (i.e. it is rolled at expiry). The delta when rolling at expiration can be considered a blend of the deltas when 1 month rolling. For example, the delta of a 3 month future rolled at expiry is a blend of the deltas of the 3, 2 and 1 month future rolled after 1 month.

Futures delta versus number of times roll per year

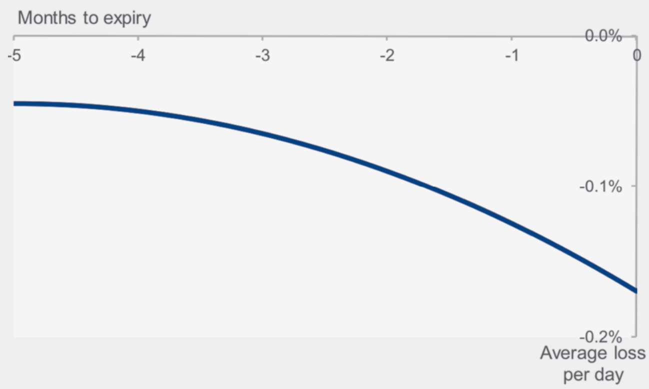


Using 1 month or 3 month futures is best (when rolled at expiry)

The diagram above shows the delta of a Volatility Futures rolled at expiry vs the number of times in a year you have to roll the position. Investors seeking the highest delta should always use 1 month futures and roll 12 times per year. Investors seeking a balance between the delta, and the overhead of rolling the position should use 3 month futures and roll at expiry (i.e. roll 4 times a year). While using 2 month futures has a higher delta than 3 month futures, it is not very significantly for the additional overhead of rolling 6 times a year rather than 4. Using 4 month futures only saves 1 roll per year (as you roll 3 times not 4) and has a significantly reduced delta compared to 3 month futures.

While near dated Volatility Futures are most sensitive to index, they also suffer from being most expensive

In addition to considering the sensitivity of a Volatility Futures to the underlying index, and the number of times the position has to be rolled, and investor should also consider how expensive the position is to hold. As term structure is on average upward sloping, this means a Volatility Futures should on average decline as maturity approaches. As the slope of term structure is relatively flat at the far end, longer dated Volatility Futures suffer less from time decay than near dated Volatility Futures. This can be seen in the diagram below. To reduce the impact of time decay an investor can use far dated futures, potentially rolling when the position is 2 months or less. This strategy would have a lower delta than using near dated futures. There is in effect a trade-off between the cost of holding the position, and the effectiveness of the position. Should an investor be using Volatility Futures tactically (i.e. not all the time, but only in advance of key events likely to cause high volatility) near dated Volatility Futures are likely to be preferred. If an investor is using volatility strategically (i.e. continuously as part of a diversified portfolio) far dated Volatility Futures (potentially rolled before expiry) is likely to be preferred.



Volatility Indexes overestimate future volatility

A variance based estimate includes not only information about future volatility, but also includes a volatility risk premium. As a volatility risk premium lifts the value of a variance based Volatility Index, Volatility Indexes usually overestimate future volatility. This means that selling Volatility Futures is a viable way of earning alpha.

Volatility Futures settlement can suffer from imbalances

A Volatility Futures will be hedged with a strip of options of all strikes. As OTM options are typically less liquid than ATM options, Volatility Index providers have rules to exclude

OTM options if they are too far OTM or are illiquid. While this improves the reliability of the Volatility Index calculation, it makes it harder for traders to hedge as they are not certain if they need to trade an OTM option or not (a sudden change in spot or liquidity approaching expiry could cause the option to be included or excluded from the calculation). In deciding the methodology, there is a trade-off between how easy it is for liquidity providers (i.e. market makers and traders) to hedge and data reliability. Typically end clients are reluctant to trade an instrument that could expire at a significantly different value to the prints just before and just after expiration. Just as there have been issues with the settlement price of equity indexes (e.g. the FTSE June 2005 expiration) there can be issues with the settlement price of Volatility Futures.

Appendix

For all the examples in the appendix we shall for simplicity assume that the calculation of the volatility index is identical to a variance swap. This means the difference between forward volatility, Volatility Futures and forward variance is not related to any chopping of OTM tails or any other practicalities of Volatility Futures.

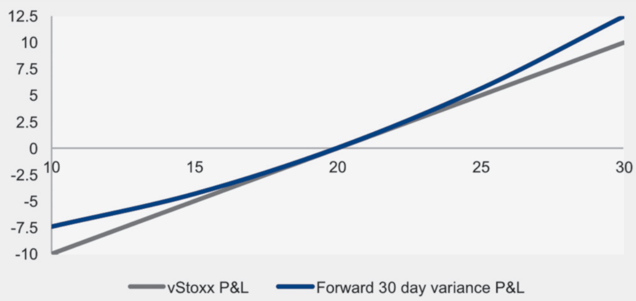
Volatility Futures fair price is not equal to forward variance

Despite the fact Volatility Futures use a variance swap based calculation, the fair price of a Volatility Futures is not equal to forward variance. In fact the fair price of a volatility future is below that of forward variance. As maturity (and volatility of volatility) increases the difference between the price of a variance swap and Volatility Futures widens. This can be seen by comparing a Volatility Index such as the VSTOXX® with a forward variance swap. We note that volatility of volatility can be seen in an index such as the VV2X, which is the volatility of options on VSTOXX® Futures.

Fair price of Volatility Futures is below forward variance

Volatility Futures tend to trade just below the levels of forward variance. If a Volatility Futures traded at the same level as forward variance an arbitrageur could simply go long forward variance and short Volatility Futures to construct a portfolio that can only earn profits. This can be seen by looking at the pay-out of a VSTOXX® Volatility Futures and a forward 30 day (to match VSTOXX®) variance swap for identical vega. We shall assume the strike of both the VSTOXX® and forward variance is 20. As vega gives the P&L sensitivity to volatility, having identical vega means the pay-out should be identical for small deviations of volatility about the level 20 (i.e. the gradient of the two lines are identical for volatility at 20). The diagram below shows the pay-out of forward variance is always equal to or above the pay-out of the VSTOXX® (if they are the same price), hence a long forward variance short VSTOXX® portfolio only has a positive pay-out.

VSTOXX® with same price as forward var

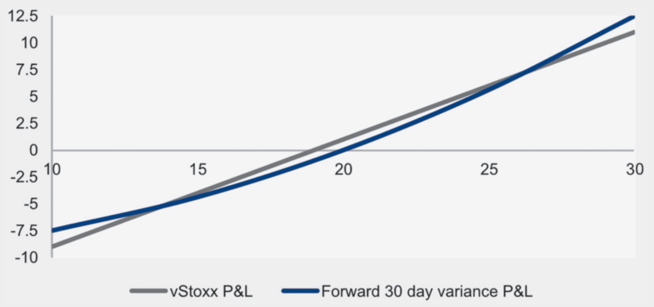


Volatility Futures discount to forward variance increases as maturity and volatility of volatility increases

For reasonable prices (i.e. volatility future price less than forward variance) the profile of a long Volatility Futures and short forward variance swap is similar to short straddle on volatility of volatility. This means the difference between a volatility and forward variance should increase as the maturity increases, and as volatility of volatility increases (just as the premium of a short straddle increases as time increases and volatility increases). While we have used Volatility Futures in this example, volatility swaps (which can be approximated by ATMf volatility) can be substituted for Volatility Futures.

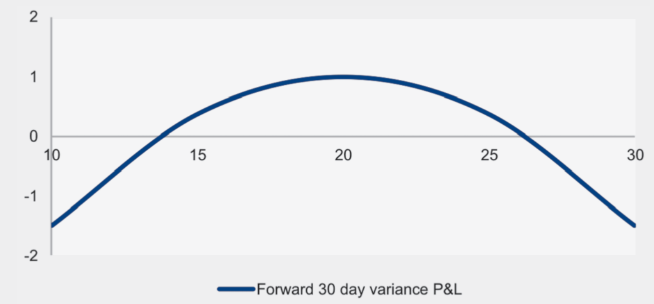
To see this effect graphically we shall first examine the pay-out of a long Volatility Futures and short forward variance swap. We shall assume the forward variance swap is trading at 20 (as before) but this time the VSTOXX® volatility future trades 1 point lower at 19.

VSTOXX® with same price as forward var



The pay-out of a long Volatility Futures short forward variance is then similar to a short straddle on volatility (as can be seen from the below diagram).

VSTOXX® – Forward 30 day variance



Volatility Futures is short volatility of volatility

As the volatility (or variance) exposure of a variance swap can be hedged with a static portfolio of options, a variance swap has no volatility of volatility risk. As the pay-out of a Volatility Futures is linear in volatility, this means it is short volatility of volatility.

This can be seen in the diagram above, if volatility remains near 20 (i.e. low volatility of volatility) a Volatility Futures is more profitable than a forward variance swap. If volatility suddenly changes to be very high or very low (i.e. high volatility of volatility) then a Volatility Futures is less profitable than a forward variance swap. As a (forward) variance swap is neither long nor short volatility of volatility risk, this means a Volatility Futures is short volatility of volatility risk (as it profits when vol of vol is low, and suffers when vol of vol is high).

Options on Volatility Futures can hedge volatility of volatility position

As Typically Volatility Futures are expensive, which is why many trading desks put on a short Volatility Futures long forward variance position. As a short Volatility Futures position is long volatility of volatility, this means a short Volatility Futures long forward variance position is also long volatility of volatility (an uncapped variance swap has zero volatility of volatility exposure). The value from this position can be extracted by selling (a strip of) options on Volatility Futures, as options on Volatility Futures (like most options) are on average expensive.

Post credit crunch, many banks prefer to trade Volatility Futures / swaps rather than variance swaps

By some measures the levels of volatility seen post Lehman bankruptcy were higher than during the great depression. As there was a long low volatility bull market between 2003 and 2007, risk departments were not prepared for the extreme pay-outs of convex instruments such as variance swaps. Now there is a preference for non-convex instruments, such as Volatility Futures or volatility swaps, as many banks prefer to take (small) vol of vol risk than (high) convexity risk.

Focus on Options on Volatility Futures

In our final part of our 3 part series on volatility, we focus on options on Volatility Futures and the trading of volatility of volatility. The key differences between options on equity and options on volatility are established. How traders arbitrage the imbalances between options on volatility, Variance Swaps and Volatility Futures is revealed.

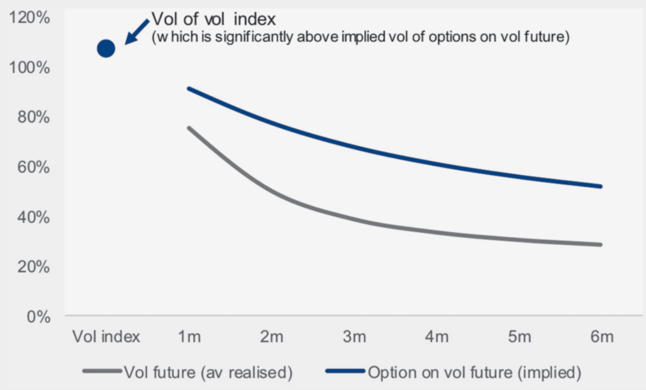
Underlying of options is not spot, but the forward

In order to value options, it is standard practice to look at the implied volatility and compare to realised volatility. One of the most common mistakes people make when attempting to value options on Volatility Futures is to assume that the underlying is spot (i.e. the Volatility Index) rather than the Volatility Future. In fact, the underlying for all options is the forward but for equity underlyings (or any other underlying that follows a random walk) the volatility of the forward and the volatility of spot are virtually identical. For an underlying such as Volatility Futures which mean reverts, the volatility of spot is far greater than the volatility of the volatility forward. If the implied volatility of an option (on volatility forward) is compared to the volatility of the Volatility Index, the option appears very cheap indeed. In order to accurately value options on volatility forwards, we first need to examine how volatility mean reverts.

Volatility jumps only last c10 months

It can be shown (see Appendix on page 13) that volatility jumps mean reverts in a period of time 10 months or less (the higher the volatility jump, the quicker the mean reversion). This means that even if there has been a significant volatility jump, a Volatility Index should have returned to previous lower levels in less than a year. Far dated options (year or more) on a Volatility Index should therefore trade with an implied volatility that is relatively stable. As an option on a Volatility Index approaches expiry, its sensitivity to current levels of volatility increases and the implied volatility should converge with the volatility of the underlying index (see chart above).

Options on VSTOXX® Futures term structure (is negative)



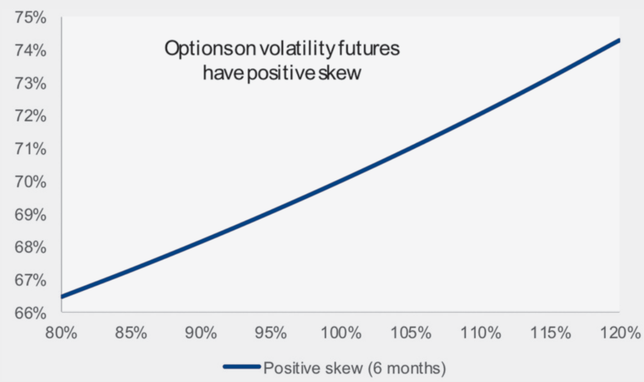
Mean reversion of volatility causes negative term structure

As volatility should be modelled as a process with high volatility of volatility and high mean reversion, there is a significant difference between the volatility of spot and the forward (as can be seen in the chart above). Having a high volatility of volatility means near dated options on a Volatility Index have a high implied volatility. Similarly having a high mean reversion depresses the implied volatility of far dated options on volatility, causing a negative term structure (the opposite to the average term structure of equities).

Volatility is stable at low levels, and volatile at high levels

It can be shown (see Appendix) that volatility is relatively stable when it is low (as markets can be calm for several years). Conversely as volatility spikes last only a few weeks or months, volatility cannot be stable at high levels. This feature causes options on volatility indices to have positive upward sloping skew, the opposite direction to options on equity.

Options on VSTOXX® Futures skew (is positive)



Far dated Volatility Futures are normally higher than near dated

The term structure of Volatility Futures is normally upward sloping due to the demand for long dated hedges. As far dated implied is, on average, higher than near dated implied this means the value of a Volatility Future should (on average) decline as expiry approaches. This means buying puts on Volatility Futures is on average a profitable strategy, while buying calls is an unprofitable strategy. An investor could therefore benefit from selling calls or buying puts.

It is easier to determine the risks and rewards for puts on Volatility Futures than calls

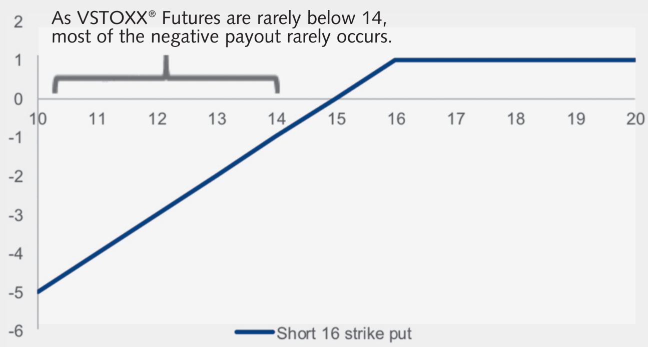
As volatility jumps are rare, but a gradual softening of implied volatility is common, there is far more reliable data about the profitability of puts on Volatility Futures than calls on Volatility Futures. This is because the payout of an ATM put is indifferent to volatility remaining constant or spiking, while the payout of an ATM call is very sensitive to the degree of a volatility spike (and as significant volatility spikes are rare it is difficult to model them).

Put buying is most effective when volatility is high

While on average buying puts on Volatility Futures is a profitable strategy, the amount of profit earned is correlated to the initial level of volatility. If volatility is high, the average profit earned is also high. This makes sense as volatility for the SX5E is floored at c12 and there is therefore greater potential profit if volatility is 30 (maximum 18 points of profit) than if volatility is 15 (maximum 3 points of profit). When looking at the trendline for profit earned against initial level of the VSTOXX® (we note the data is very noisy) it can be shown that buying puts is on average profitable when the VSTOXX® is 19 or above, and unprofitable when the VSTOXX® is 16 or less. As a percentage of premium paid, the profits for OTM and ITM options are similar to that of an ATM option.

Selling puts on Volatility Futures makes sense when volatility is low

Implied volatility has a floor, which limits the downside to a short put strategy. If volatility is low, the maximum loss of a short put is similarly low. If volatility is very low, selling puts on Volatility Futures is therefore a viable strategy as this benefits from having a breakeven around the level of the historical floor of volatility.



Selling calls is a profitable carry strategy, but suffers from tail risk

A short call on volatility future strategy is on average profitable. However while a carry is earned most of the time, there are rare occasions when a volatility spike causes substantial losses. As implied volatility spikes are usually unforeseeable (if future realised volatility is expected foreseeable, implied volatility would have risen beforehand), the profits from call selling appear to have weak correlation to the initial level of volatility. We note however that the rarity of significant volatility spikes makes drawing a reliable conclusion about call selling difficult. As with all call overwriting strategies, the downside of spikes can be reduced by selling call spreads rather than calls (however this will reduce the average carry earned).

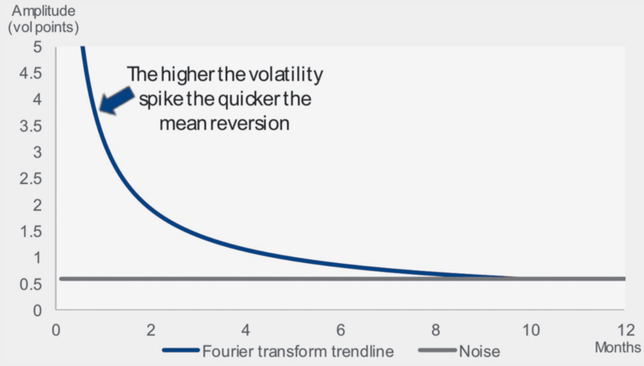
Volatility of volatility is often mispriced in different markets

In the option on volatility future market, volatility of volatility is usually expensive (as is the case for most options). However volatility of volatility is underpriced in the Volatility Futures market, as Volatility Futures are on average expensive (and Volatility Futures are short volatility of volatility). Trader can arbitrage this anomaly by shorting both Volatility Futures and (as strip of) options on Volatility Futures, both of which are on average expensive. The resulting (unwanted) short volatility position (from shorting Volatility Futures) can be hedged with a long forward variance. The final position is short Volatility Future, short (strip of) option on Volatility Future and long forward variance.

The higher the volatility spike, the shorter it lasts

The Fourier transform of 20 day realised volatility for the S&P500 shows that the higher a volatility spike, the quicker the mean reversion (see chart below). For example, if there is a 3 volatility point spike it tends to last c1 month. However a 2 volatility point spike lasts twice as long (c2 months). Conversely when volatility is low, it can remain low for several years (as it did in 1994–6, 2004–6 and 2012–14). This feature is what gives options on a Volatility Index a positive upward sloping skew, as a Volatility Index is more volatile the higher volatility is.

Fourier transform of 20 day realised volatility



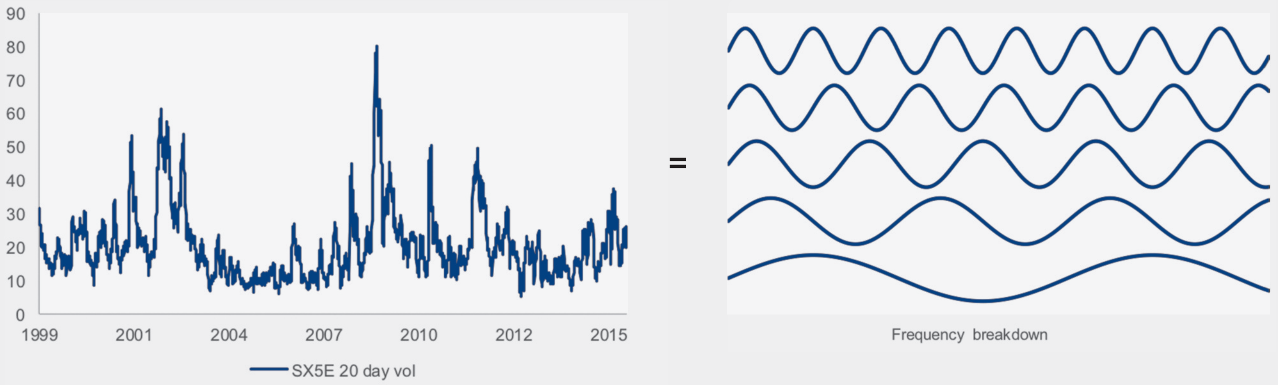
Spikes in volatility last a maximum of 10 months

The transform also shows that for frequencies over 10 months the amplitude of volatility is simply background noise. Hence volatility should mean revert in a period of time not greater than 10 months. This figure is in line with the fact that it takes approximately 8 months for EURO STOXX 50® 3 month volatility to return to levels seen before a spike in volatility. ◀

Appendix

Fourier transform can show how long volatility can last

A Fourier transform can decompose any time series (e.g. 20 day realised volatility vs time) into a sum of sine waves of different amplitude and frequency (e.g. volatility amplitude vs frequency). If we use this analysis on 20 day realised volatility of a major index such as the S&P500, we can determine how long a volatility spike can last.



For further information please contact

Sales Europe
Vincenzo Zinnà **T** +41-43-430-71 25
vincenzo.zinna@eurexchange.com

Sales United Kingdom
Murat Baygeldi **T** +44-20-78 62-72 30
murat.baygeldi@eurexchange.com

Sales U.S.
Megan Morgan **T** +1-312-544-10 83
megan.morgan@eurexchange.com

Sales Buy Side U.S.
Laurent Partouche **T** +1-212-309-93 02
laurent.partouche@eurexchange.com

Sales Asia & Middle East
Jan Thorwirth **T** +852-25 30-78 07
jan.thorwirth@eurexchange.com

Published by
Eurex Frankfurt AG
Mergenthaleralle 61
65760 Eschborn
Germany

Eurex Zürich AG
Löwenstrasse 3
8021 Zurich
Switzerland

Deutsche Börse AG
London Representative Office
11 Westferry Circus, 2nd Floor
Canary Wharf
London E14 4HE

www.eurexchange.com

ARBN Number
Eurex Frankfurt AG ARBN 100 999 764