Volatile times

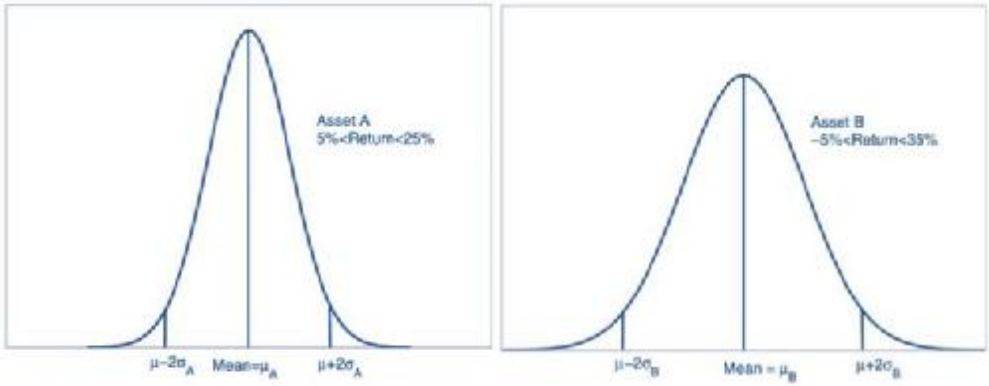
The financial markets have recently endured a flock of geopolitical "black swans" including the devasting earthquake and nuclear crisis in Japan. But other critical events like the European sovereign debt crisis with Greece, Portugal, Ireland and Spain have left a significant footprint in the financial markets. Although volatility trading for many years used to be a domain of an elite group of sophisticated investors, in the last couple of years, pension funds, traditional fund managers and retail investors alike have seen the benefits of incorporating volatility into their investment portfolio and now volatility has become widely recognized as an asset class in its own right[1].

What is volatility?

Volatility, expressed notionally as σ, is a measure of the uncertainty of the returns provided by an asset. Statistically, it is the *standard deviation* of the returns provided by the asset (*variance*, another measure of dispersion, is the square of volatility i.e. σ^2). Volatility gives a measure of the probability distribution of the future returns of an asset. For example, two assets, A and B, both give the same *average* return of 15 percent, yet asset A has a standard deviation (i.e. volatility) of 5 percent and asset B has a standard deviation of 10 percent – asset B is a more *volatile* asset than A despite both assets giving the same average return. Assuming a normal distribution, statistical theory says that over time there is a 95 percent probability of an assets' return falling within two standard deviations (i.e. 2σ) of the mean, μ (i.e. the average). The higher the standard deviation (i.e. the higher the volatility) the greater the probability/expectation of higher and lower returns of the asset.

Diagram 1 below looks at the probability distribution of the return of the two assets, A and B, based on their differing volatilities/standard deviations:

Diagram 1: Expected returns and volatility



With a probability of 95 percent asset B is expected to have a much higher range of possible returns (i.e. -5 percent to 35 percent) with a standard deviation of 10 percent to that of asset A with a standard deviation of 5 percent and with expected returns of between 5 percent and 25 percent

[1] Already since 2006, the Committee for European Securities Regulators (CESR) has recognized volatility derivatives as UCITS compliant.

Volatility types

There are three types of volatility:

- Historical volatility measures what volatility *has been* over a given time period.
- Implied volatility is the volatility *implied* in the option price given the other variables that is time, exercise price, underlying asset price, etc.
- Realized volatility is the *subsequent movement* in the assets' volatility following the options trade. It is not possible to calculate implied volatility using the Black-Scholes model but it is calculated *iteratively* using the *Newton-Raphson technique*.

Implied volatility has the characteristic that options for different exercise prices but identical expiration dates trade at different implied volatilities. This is known as the *implied volatility smile* (or skew). Implied volatility will also have a *term structure* in that for the same strike price but different expiration dates options will have different implied volatilities. Volatility and the shape of the volatility smile/skew has always been regarded as reflecting market participants' expectations and being a "lead indicator" of impending moves in the underlying asset. The Eurex VSTOXX® Mini Futures contract can be used as a barometer of the state of the European financial market - a "fear gauge".

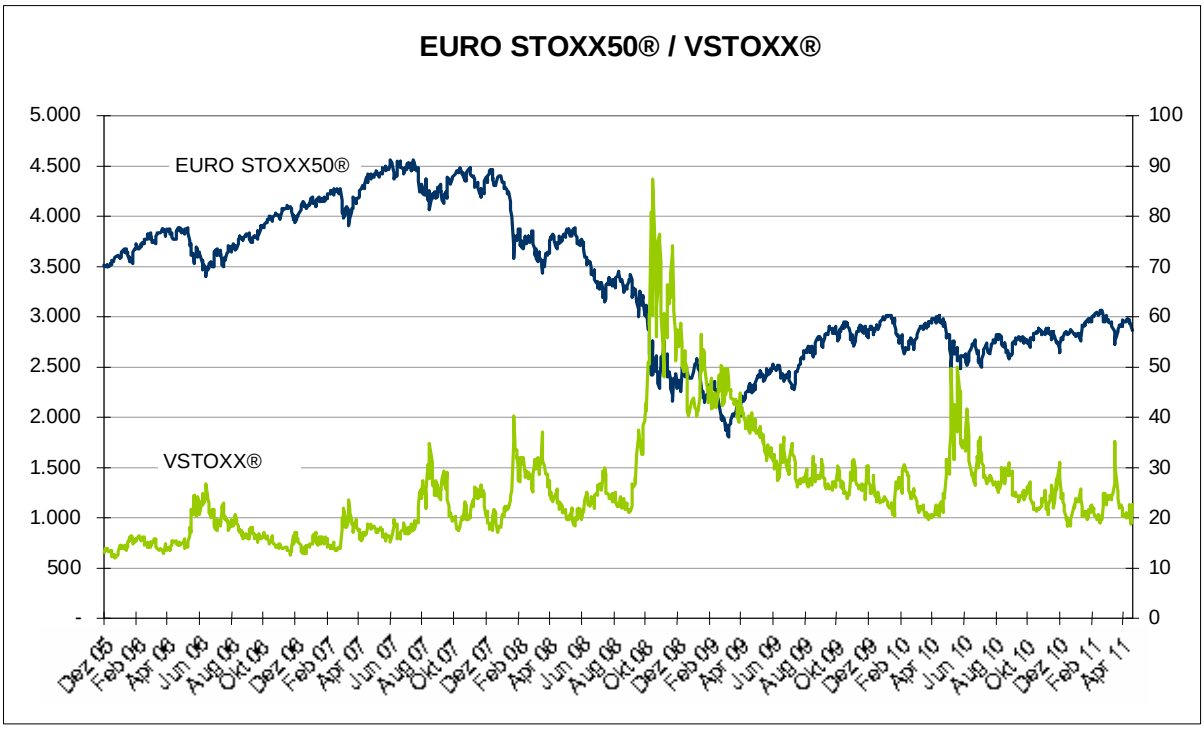
The relationship between equity volatility and equity markets

The basis of the attraction of the VSTOXX® to the equity fund manager lies in the negative correlation of equity volatility to the equity market offering increased portfolio diversification and reduced portfolio risk. The causality between equity market and equity volatility can be attributed to *"the leverage effect"* – a fall in equity prices increases a company's leverage, thereby increasing the risk to equity holders, and increasing equity volatility.

John C. Hull in "Options, Futures & Other Derivatives", outlined the causality as follows: *"As a company's equity declines in value, the company's leverage increases. This means that the equity becomes more risky and its volatility increases. As a company's equity increases in value, leverage decreases. The equity then becomes less risky and its volatility decreases. This argument shows that we can expect the volatility of equity to be a decreasing function of price."*

Diagram 2 below looks at the historical statistical relationship between (daily) changes in the spot volatility index of the VSTOXX®, and (daily) changes in its respective equity index that is the EURO STOXX 50® Index between December 2005 and April 2011:

Diagram 2: Correlation between the VSTOXX® Index and the EURO STOXX 50® Index



Eurex VSTOXX® Mini Futures

The Eurex volatility futures contract on the VSTOXX® Index represents an implied volatility level on the underlying equity index options of the EURO STOXX 50® Index. The implied volatility level of the Eurex VSTOXX® Mini Futures contract takes into consideration the volatility skew and corresponds to the square root of implied variance that is $\sqrt{\square^2}$ to bring the quotation close to that used to evaluate variance in the OTC variance swap market. In fact Eurex VSTOXX® Mini Futures are 100. $\sqrt{\square^2}$ for the quote to reflect volatility in percentage terms. The formula for the computation of the volatility index is not based on a particular options pricing model like Black-Scholes and thus makes volatility more tradable as an asset with changes in the value of the contract due to changes in volatility and not due to any changes in the underlying equity market. If one VSTOXX® Mini Futures was bought at 18.00 (percent) and sold at 20.00 (percent), then the payoff would be the index multiplier times the difference between the two volatilities, that is EUR 100 x (20-18) = EUR 200 – a straightforward linear payoff to a change in volatility.

The payoff to volatility and variance are different. In a variance swap the payoff is expressed as:

Payoff (Variance Swap) = notional x (realized implied volatility^2 – implied volatility^2)

For example, a EUR 5 million variance swap struck at an implied volatility (squared) of 30 percent with an eventual realized volatility of 50 percent would have a payoff, to the buyer of the swap, of EUR 5 million x (50%^{2} – 30%^{2}) = EUR 800,000. Alternatively, if at the end of the swap period implied volatility had fallen to 15 percent the loss would have been EUR 5 million x (15 percent^2 – 30 percent^2) = - EUR 337,500. The payoff profile in a variance swap is not symmetrical but convex. The payoff is similar to a long call

option profile. Conversely, for the seller of the variance swap there is a larger loss when realized variance exceeds implied variance in relation to the gains of the short variance position.

With regards to the Eurex VSTOXX® Mini Futures, the payoff of a futures contract held can be described as:

Payoff (VSTOXX® Mini Futures) =

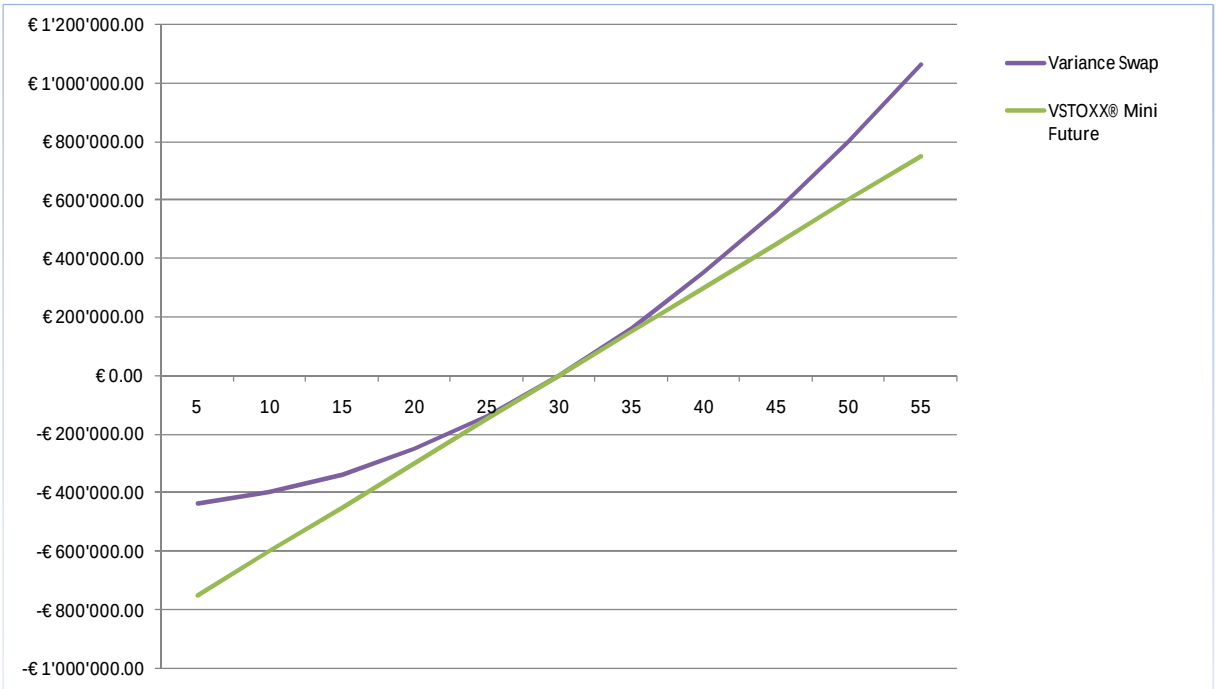
index multiplier (i.e. EUR 100) x (realized 30-day implied volatility level at expiration - expected 30-day implied volatility at trade initiation) X number of contracts

In contrast to the variance swap example above a notional EUR 5 Mio position equals approximately the same vega exposure as 300 contracts in VSTOXX® Mini Futures struck at an expected implied volatility of 30 percent. If the level of implied 30day forward volatility at expiration increased to 50 percent, the calculation shows the following results: the payoff to the buyer would be EUR 100 x (50 percent – 30 percent) * 300 = EUR 600,000. Alternatively, if implied volatility fell to 15 percent the loss would be EUR 100 X (15 percent – 30 percent) x 300 = - EUR 450,000. The payoff is linear – a Eurex VSTOXX® Mini Future can be likened to that of a forward on 30-day (implied) volatility and it can be compared to that of a volatility swap whose payoff profile can be expressed as follows:

Payoff (Volatility Swap) = notional X (realized volatility – implied volatility)

Diagram 3 below compares the two different payoff profiles with the equivalent vega exposure of being long variance through a variance swap and long volatility through a long position in VSTOXX® Mini Futures

Diagram 3: Volatility versus variance – long payoff profile - same vega

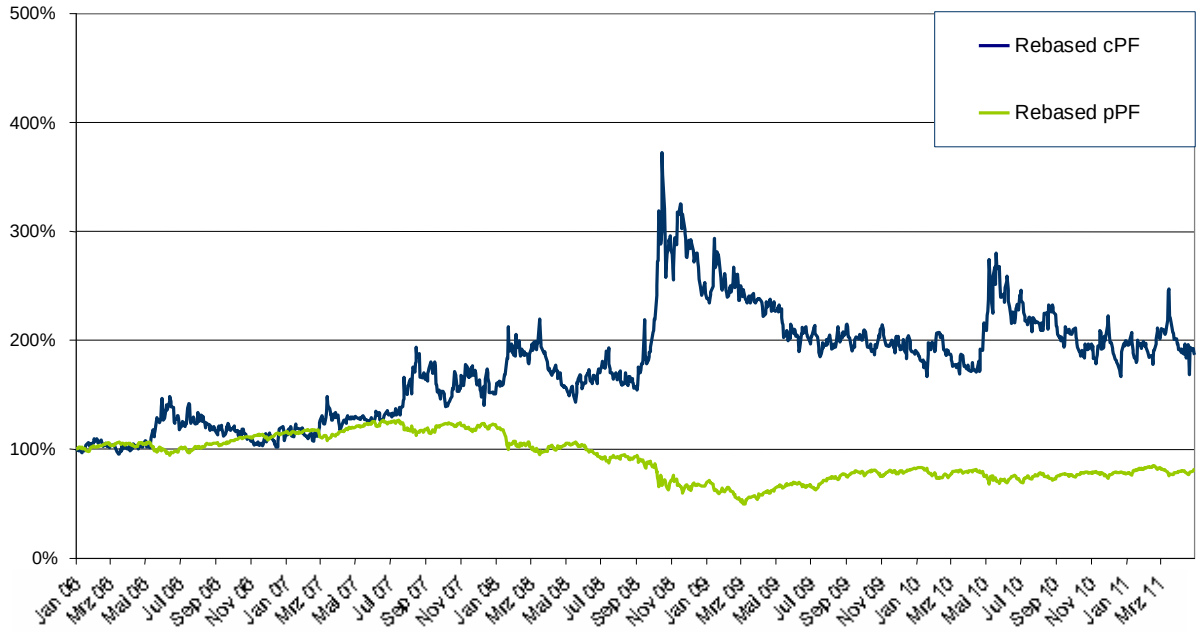


Fund management applications of Eurex VSTOXX® Mini Futures

Increased portfolio diversification and enhanced portfolio returns

The negative correlation of equity volatility to its respective equity market makes equity volatility an attractive asset to incorporate within an equity portfolio to increase portfolio diversification and potentially enhance portfolio returns. An analysis was carried out to determine the effects of incorporating equity volatility into an equity portfolio by taking the respective equity index, the EURO STOXX 50®, as the "core" equity index portfolio and combining it with the respective volatility index of VSTOXX®, in a 70/30 percent weighting (weighted in terms of monetary value, adjusted weekly) over a period from January 2006 until April 2011 The results are shown in diagram 4 below:

Diagram 4: EURO STOXX 50® Index portfolio versus combined EURO STOXX 50®/VSTOXX® Index portfolio



As the above diagram shows, in the analysis period, the combined 70/30 percent equity/volatility index portfolio outperformed the underlying equity index as represented by the Euro STOXX 50® equity index. Because of its negative correlation to equities the inclusion of VSTOXX® Mini Futures to an equity portfolio changes the efficient frontier to the further left, and delivers significant diversification benefits.

Managing tracking error and rebalancing costs

Benchmark/passive equity index fund managers are in essence, *short volatility*. As equity markets become more volatile, tracking error and rebalancing costs increase. Equity fund managers can go long Eurex VSTOXX® Mini Futures to hedge against increases in portfolio tracking error and rebalancing costs of their benchmark/passive index funds. Similarly, convertible bond arbitrage fund managers can use Eurex VSTOXX® Mini Futures to hedge their imbedded volatility exposure. Periods of low dispersion/high correlation across equities make it difficult for fund managers to extract alpha in stock selection, buying Eurex VSTOXX® Mini Futures could be used to hedge low dispersion/high correlation.

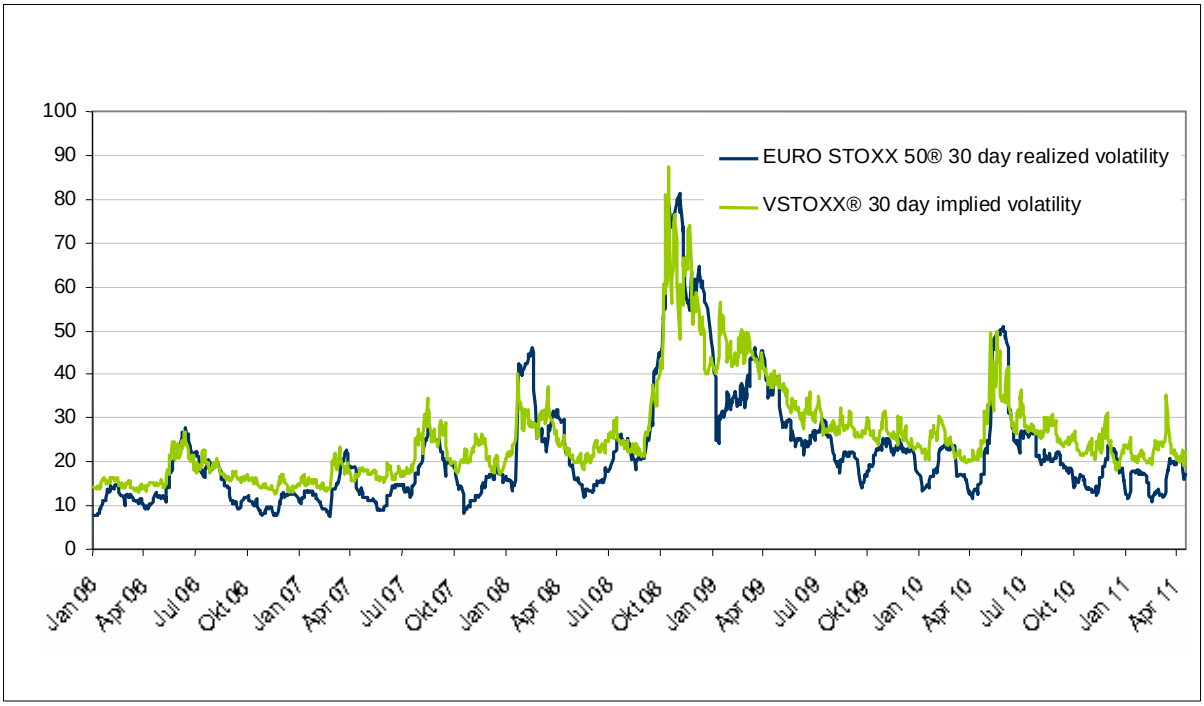
Realized volatility versus implied volatility

Another possible application for portfolio managers is using the different statistical properties of variance and volatility elaborated in the section outlining the differences between the payoff profiles. The financial market trades realized volatility through OTC variance swaps. Variance swaps reflect the daily price changes measured by the daily log normal returns of the underlying instrument and these prices changes can differ substantially from the implied volatility, as reflected by the option premiums used to calculate the VSTOXX® Index. As shown below in diagram 5 realized volatility usually trades below implied volatility. Even without having a fundamental insight into the development of volatility, institutional investors can benefit from the different statistical properties of both tradable instruments. Especially the property of variance being volatility squared represents a good basis for a "volatility neutral trade", of being long variance versus shorting the equivalent vega exposure using the VSTOXX® Mini Futures. Such a vega neutral trade would then especially react and turn profitable, if market volatility spikes on the basis of an exogenous shock and turbulences in the equity markets.

Firstly, we consider the previous variance swap with a notional of EUR 5 Mio, and determine the sensitivity of the position for a 1 percent move in volatility. For a move from a level of 30 percent to 31 percent, the variance swap shows a profit of EUR 30,500. Next, with this vega sensitivity, we determine the "hedge ratio" to neutralize the position in vega terms: We therefore require EUR 30'500/ Contract Multiplier (VSTOXX® = 100 EUR) = 305 VSTOXX® Mini Futures short. The remaining net position consists of the difference between the exponential payoff of the variance swap and the linear exposure of the VSTOXX® Mini Futures to moves in volatility. This position is purely long "convexity", and provides upside to exogenous shocks to the equity markets, while reducing risk to strong setbacks in volatility. Periods of a widening spreads between realized and implied volatility as shown in the graph below are beneficiary for such a trade application.

As recently announced, Eurex Clearing will soon expand its clearing services to OTC equity derivatives extending the benefits of trading with a central counterparty also to the OTC variance swap space. This will reduce the counterparty risk of the current variance swap aspect of this relative value volatility trade structure.

Diagram 5: Difference between EURO STOXX 50® realized volatility and VSTOXX® implied volatility:



Generating alpha

Efficient vega positioning and volatility spreads

Eurex VSTOXX® Mini Futures offer a very *cheap* and *leveraged* way to initiate directional strategies in volatility, because there is no requirement to delta hedge for movement in the underlying asset, as it is the case when trading volatility with straddles and strangles in equity index options. The Eurex VSTOXX® Mini Futures contract is 'pure vega', a 1 percent increase or decrease in implied volatility increases or decreases the value of the contract by EUR 100 i.e. the index multiplier.

VSTOXX® Mini Futures provide the fund manager with a cheaper vehicle to attain pure European equity volatility vega exposure than through using EURO STOXX® Index Options. A one month at-the-money option has a vega of approximately EUR 34[2] and a two month at the money EURO STOXX® Index Option would have approximately a EUR 46 vega – a third and a half that of the vega value of a VSTOXX® Mini Future respectively. Moreover, the Eurex VSTOXX® Mini Futures contract allows for *leveraged relative value* implied volatility spread strategies trading European equity implied volatility against. U.S. equity implied volatility by initiating spread trades with its equivalent in the U.S. market, the VIX® volatility index futures contract traded at the CBOE.

How can a VSTOXX® volatility index spread versus the CBOE VIX® be structured? One method is to structure the position in terms of the monetary value of a given change in volatility of each contract that is the monetary value of a 1 percent change in volatility. Obviously, based on this approach the ratio for the **VIX®/VSTOXX®** spread would be **1:6.90** as a 1 percent change in volatility for both contracts is USD 1'000 versus EUR 100 at a prevailing exchange rates of EUR/USD 1.45. However it is noteworthy to recognize that both underlying indexes the S&P 500® as well as the EURO STOXX 50® differ in the absolute number of constituents, as well as within the structure of the underlying sectors. Therefore, irrespective of their benchmark status in the respective equity landscape, these two factors are relevant for individual movements not necessarily explainable through global equity shocks.

Conclusion

Because of the negative correlation to equity markets, the Eurex VSTOXX® Mini Futures contracts is a very attractive product for the equity fund manager. They can facilitate an increase in portfolio diversification and potentially enhance portfolio returns.

VSTOXX® Mini Futures offer a very cost-efficient (i.e. no transaction costs in managing deltas) and leveraged (i.e. initial margin) way to buy and sell volatility and generate alpha returns by initiating a variety of relative value/cross asset class strategies.

Moreover, as exchange-traded derivative products, Eurex VSTOXX® Mini Futures offer the *additional benefit* to fund management companies in terms of mark-to-market, independent valuation and substantially reduced counterparty risk due to central counterparty clearing via Eurex Clearing.

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[2] EUR vega can be approximateted to: M.S. (√T / 2.5 / / 100) where M is the EURO STOXX 50® Index multiplier, T is the annualized time to maturity and S is the underlying EURO STOXX 50® Index.

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