
# The Volatility Indices

*Methodology*

*October 2007*

The Volatility Indices are based on the VIX methodology. The methodology, which is described in this paper, extends this definition to make easier the adaptation to the European markets and the possible change in the future.

# I. The calculation

## *The formula*

The Volatility Index (VOLIND) is a rolling index at a fixed 30 days and is determined by linear interpolation of the two sub-indices which are nearest to the remaining time to expiry of 30 days ($T_1$ and $T_2$ are the two expiry dates).

$$VOLIND = 100\sqrt{\left[T_1\sigma_1^2\left(\frac{N_{T_2}-N_T}{N_{T_2}-N_{T_1}}\right)+T_2\sigma_2^2\left(\frac{N_T-N_{T_1}}{N_{T_2}-N_{T_1}}\right)\right]*\frac{N_{365}}{N_T}} \qquad (1)$$

where

$N_{Ti}$ number of seconds to expiry of the i[th] maturity of the index option

$N_T$ number of seconds in NDAYS (NDAYS=30) days

$N_{365}$ number of seconds for a standard year

**Determining the time to expiry** $T_i$

$T_i = \frac{T_{settlement-calculation}}{T_{year}} = \frac{N_{T_i}}{N_{365}}$ is expressed in fraction of year

**Determining the volatility of expiry** $\sigma_i$

$$\sigma_i^2 = \frac{2}{T_i}\sum_j \frac{\Delta K_{i,j}}{K_{i,j}^2} R_i M\left(K_{i,j}\right) - \frac{1}{T_i}\left[\frac{F_i}{K_{i,0}}-1\right]^2 \qquad \text{for i=1,2}$$

where

$T_i$ time to expiry of the $i^{th}$ maturity

$F_i$ Forward price derived from the prices of the $i^{th}$ maturity, for which the absolute difference between call and put prices (C and P) is smallest.

$$F_i = K_{\min|C-P|} + R_i * (C-P) \qquad (3)$$

(Note: If a clear minimum does not exist, the average value of the relevant forward prices will be used instead.)

$K_{i,j}$ Exercise price of the $j^{th}$ out-of-the-money option of the $i^{th}$ expiry month in ascending order

$\Delta K_{i,j}$ Interval between the relevant exercise prices or half the interval between the one higher and one lower exercise price. On the boundaries, the simple interval between the highest and the second

highest exercise price (or lowest and second lowest exercise price) is used:

$$\Delta K_{i,j} = \frac{K_{i,j+1} - K_{i,j-1}}{2}$$

$K_{i,0}$ Highest exercise price below forward price $F_i$

$R_i$ Refinancing factor of the $i^{th}$ expiry, $R_i = E^{r_i * T_i}$

$r^i$ Risk-free interest rate to expiry of the $i^{th}$ maturity

$M(K_{i,j})$ Price of the option (call or put) $K_{i,j}$, where $K_{i,j} \neq K_{i,0}$

$M(K_{i,0})$ Average of the put and call prices at exercise price $K_{i,0}$

$$M(K_{i,j}) = \begin{cases} Put & : \quad K_{i,j} < K_{i,0} \\ \dfrac{Put + Call}{2} & : \quad K_{i,j} = K_{i,0} \\ Call & : \quad K_{i,j} > K_{i,0} \end{cases}$$

Call and Put prices are the Mid price (mid of Bid and Ask). Prices are excluded if:

$$\frac{Ask - Bid}{0.5(Ask + Bid)} > 50\%$$

The sub Volatility indices are calculated for each maturity 1 and 2. The final Volatility index is calculated by the interpolation with the sub volatilities.

### *The rollover*

Eight calendar days before the first maturity expiry date, the second nearest maturity become the first maturity for the calculation, and the third nearest maturity becomes the second maturity.

## II. The dissemination

The volatility indices are calculated every minute between 9:05 am and 5:40 pm (CET)

| ISIN | Full name | Mnemonic |
|---|---|---|
| QS0011052147 | AEX Volatility | VAEX |
| QS0011052154 | BEL20 Volatility | VBEL |
| QS0011052139 | CAC 40 Volatility | VCAC |
| QS0011052162 | FTSE 100 Volatility | VFTSE |

### *Websites*

- www.euronext.com
- http://volatility.euronext.com