

# Index Methodology

VSPIKES™ (Symbol: VSPKE)

## 1. Index Calculation Formula

The VSPIKES™ index is constructed using SPIKES® Index option and future prices, by interpolating between the variances of two monthly expirations (near- and next- term) to the 30-day time point, as follows:

$$(1) \quad \text{VSPIKES} = 100 \times \sqrt{\left( \frac{t_1}{t_M} \frac{t_2 - t_M}{t_2 - t_1} \sigma_1^2 + \frac{t_2}{t_M} \frac{t_M - t_1}{t_2 - t_1} \sigma_2^2 \right)}$$

Here  $t_1$  and  $t_2$  are times to near- and next-term option contract settlements (in seconds), and  $t_M$  is the number of seconds in 30 days.

Near- and next- term volatilities are calculated using a simple variance swap approximation:

$$(2) \quad \sigma^2 = \frac{1}{TF^2} \left[ 2e^{rT} \Sigma \Delta K p_i - (F - K_{ATM})^2 \right]$$

where  $F$  is the corresponding futures price,  $T$  is time to options settlement (in years, within 1 second precision);  $r$  is risk-free interest rate to expiration;  $K_{ATM}$  is at-the-money strike (see details in calculation outline);  $K_i$  and  $p_i$  are selected options' strikes and prices (puts with strikes below  $K_{ATM}$ , calls with strikes above  $K_{ATM}$  and ATM strike, for which an average between put and call prices is used);  $\Delta K_i$  is the average distance from the strike  $K_i$  to the two nearest selected options' strikes (or, in the case of the highest and the lowest strikes, the distance to the nearest selected strike).

## 2. Options and Futures Reference Prices

VSPIKES uses a proprietary "price dragging" technique to capture live options and futures prices as inputs for the index calculation. The price inputs that result from price dragging are called Cash Reference Prices (CRPs), and determined as follows:

- Set all CRPs to 0 at SPIKES Options market opening;
- For trades, only consider standard simple trades (conditions space, I, or J). For quotes, only consider NBBO eligible bids and offers (conditions A, B, C, O or space). Block trades, out of sequence prints, as well as trades resulting from complex transactions and stopped orders are ignored.
- On the opening quote, the opening bid is used as the CRP;
- When there is a trade, the CRP is set to trade price;
- For newly-placed ask (bid) quotes, if the ask (bid) is lower (higher) than current CRP, the CRP is set to ask (bid).

This method should materially reduce erratic movements of the index value as quotations on out-of-the-money (OTM) options are rapidly altered during times of low liquidity and/or high volatility.

### 3. Data Selection

The options expirations to be used in the calculation are selected as the two closest subsequent monthly cycle expirations, at least two full days ahead in time (as observed at the opening of market on the considered date).

For each of the expirations, the options to be used in the calculation are then selected, by removing in-the-money and far out-of-the-money options. The procedure is as follows:

- Find the at-the-money strike  $K_{ATM}$  as the strike with non-zero CRPs for both call and put, closest to the current future price  $F$  with the corresponding expiration date. If  $F$  falls exactly in the middle between two such strikes, use the lower strike.
- Select call options with strikes above or equal to  $K_{ATM}$  and put options with strikes below or equal to  $K_{ATM}$ .
- Remove all the call (put) options with strikes higher (lower) than the point, when two options on consecutive strikes with prices below or equal to 10 cents are first encountered (when moving up (down) from  $K_{ATM}$ ).

The options, selected this way, are then used in formula (2) then (1) for the final index calculation.

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