# SPY Skew Index Methodology

## August 2022

Define the SPY Skew Index as a linear function of an arithmetic skewness swap rate, denoted *S*. More specifically,

$$\text{Skew Index} = 100 - 10 * S$$

*S* is calculated from a portfolio of SPY options that resembles the fair payoff of a 30-day arithmetic skewness swap. It is derived by interpolation or extrapolation from $S_1$ and $S_2$, the price skewness at adjacent SPY monthly expirations:

$$S = wS_1 + (1-w)S_2 \quad \text{where} \quad w = \frac{t_2 - t_M}{t_2 - t_1}$$

Here $t_1$ and $t_2$ are respectively the time (in seconds) to the near and next-term expiration, while $t_M$ is the number of seconds in 30 days (30 x 86,400 = 2,592,000).

The skewness estimates $S_{1,2}$ are calculated using arithmetic skewness swap approximation:

$$S_{1,2} = \frac{2\left\{3e^{RT}\sum_i (K_i - F)\Delta K_i p_i + \left[e^{RT}\left(p^c_{\text{ATM}} - p^p_{\text{ATM}}\right)\right]^3\right\}}{\left\{2e^{RT}\sum_i \Delta K_i p_i - \left[e^{RT}\left(p^c_{\text{ATM}} - p^p_{\text{ATM}}\right)\right]^2\right\}^{3/2}}$$

Where

| | |
|---|---|
| *R* | Risk-free interest rate to option expiration; |
| *T* | Time to option expiration (in years, with 1-second precision) |
| $K_{\text{ATM}}$ | Strike closest to the point where linearly interpolated SPY call and put prices intersect; |
| $p^c_{\text{ATM}}$ | Price of the at-the-money (ATM) SPY call option; |
| $p^c_{\text{ATM}}$ | Price of the ATM SPY put option; |
| $F$ | Forward price defined as $F = K_{\text{ATM}} + e^{RT}\left(p^c_{\text{ATM}} - p^p_{\text{ATM}}\right)$; |
| $K_i, p_i$ | A list of unique SPY options strikes, ordered from lowest to highest, and the corresponding SPY options prices; of a call if $K_i > K_{\text{ATM}}$; and of a put if $K_i < K_{\text{ATM}}$; if $K_i = K_{\text{ATM}}$ then an average of the ATM SPY put and call prices; |
| $\Delta K_i$ | Half the difference between the strikes on either side of $K_i$: $\Delta K_i = \frac{K_{i+1} - K_{i-1}}{2}$ |

For the last (highest and lowest) selected strikes, $\Delta K_i$ is simply the absolute difference between $K_i$ and the nearest selected option's strike;

Option expiration, strike and price selection for the SPY Skew index is identical to that used for the SPIKES Index. In summary:

1. When the closest monthly expiration is too close to expiry (less than two full days), rolling to the third monthly expiration occurs.
2. SPY option prices (called Cash Reference Prices, or CRPs) are determined using the proprietary "price dragging" technique.
3. When two consecutive options with CRPs of 5 cents or less are reached, exclude all options further away from the money at both tails.

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