

EXTERNAL

Cboe S&P 500 Enhanced Growth Index Series

This document details the calculation methodology of the titled index/benchmark. This document, in conjunction with the Cboe Index Rules and Governance document (available on Cboe's Governance website), provides a transparent and easily accessible view of the methodology used to calculate The Cboe S&P 500 Enhanced Growth Index Series ("SPEN Index"), ticker symbol 'SPEN'.

Description of the Market or Economic Reality Measure

The Cboe S&P 500 Enhanced Growth Index Series (the "Indices") is part of a family of Target Outcome Indices. The Indices are designed to provide target outcome returns linked to the US domestic stock market. The options prices used in the calculation of this index are theoretical values generated using a volatility surface constructed in accordance with the Cboe European-Style Options Implied Volatility Calculation Methodology, which is available on Cboe's Governance website. To value the component options that comprise the Monthly index series, a model-based valuation is used. The Cboe Model is constructed using an implied volatility surface from listed S&P 500 option prices by applying the spline method for interpolation and the SABR model for extrapolation. The spline interpolation is a form of interpolation where the interpolant is a piecewise-defined function by polynomials. The SABR model is a stochastic volatility model, which attempts to capture the volatility smile in derivatives markets. The name stands for "stochastic alpha, beta, rho", referring to the parameters of the model, introduced by Hagan et.al., as an attempt to model the volatility surface and capture the empirically observed dynamic behavior of the smile. Valuations are then calculated for the FLEX options on the roll dates and at 4:15 p.m. ET each trading date.

The Indices measure the performance of a portfolio of hypothetical exchange traded Flexible Exchange Options ("FLEX Options") that are based on the S&P 500 Index. Each index in the series is designed to track the returns of a hypothetical investment that over a period of approximately one year seeks to provide 2x leveraged returns on the appreciation of the S&P 500 Index up to a capped level while providing one-to-one exposure to any losses due to a decline in the index. The capped level is determined on each annual roll date such that there is no premium or discount to enter into the hypothetical investment compared to an investment in the Index. The SPEN Index does not use contributed input data, and all of the input data is readily available via Cboe's Index website. The SPEN Index is non-significant, as defined by EU Regulation 2016/1011 ("EU Benchmark Regulation" or "EU BMR").

Index Calculations

The following describes the methodology for calculating the SPEN Index, including applicable formulas and input data. Under the SPEN Index methodology, roll date is the third Wednesday of each month. Should the third Wednesday fall on an exchange holiday, the roll date is the preceding day.

The Index Series comprises 13 series. There are 12 monthly series that roll on the third Wednesday of each month:

- Cboe S&P 500 Enhanced Growth Index January Series (Ticker: SPEN01)
- Cboe S&P 500 Enhanced Growth Index February Series (Ticker: SPEN02)
- Cboe S&P 500 Enhanced Growth Index March Series (Ticker: SPEN03)
- Cboe S&P 500 Enhanced Growth Index April Series (Ticker: SPEN04)
- Cboe S&P 500 Enhanced Growth Index May Series (Ticker: SPEN05)
- Cboe S&P 500 Enhanced Growth Index June Series (Ticker: SPEN06)
- Cboe S&P 500 Enhanced Growth Index July Series (Ticker: SPEN07)
- Cboe S&P 500 Enhanced Growth Index August Series (Ticker: SPEN08)
- Cboe S&P 500 Enhanced Growth Index September Series (Ticker: SPEN09)
- Cboe S&P 500 Enhanced Growth Index October Series (Ticker: SPEN10)
- Cboe S&P 500 Enhanced Growth Index November Series (Ticker: SPEN11)
- Cboe S&P 500 Enhanced Growth Index December Series (Ticker: SPEN12)

In addition, there is one balanced index that is a composite of the 12-monthly series, where each monthly series is allocated an equal weight at each monthly roll date:

- Cboe S&P 500 Enhanced Growth Balanced Series (Ticker: SPEN)

Each monthly index series will consist of four FLEX Option components whose strike price and expiration date will be set on the Roll Date(i) relative to the closing level of S&P 500 Index on the roll date:

- Purchased 2 Call Options with strike = 50% of S&P 500 Index closing price
- Written 2 Put Options with strike = 50% of S&P 500 Index closing price
- Purchased 1 Put Option with strike = 100% of S&P 500 Index closing price
- Written 2 Call Options with strike = $CapStrike_{RollDate(i)}$

All FLEX Options are European-Style Options based on the S&P 500 Index and have an expiration date that is the next roll date for the respective monthly series.

Non-Roll Date Calculations

The value of the monthly index series will be calculated as follows for $t = 1$ (i.e. one day after the roll date) until $t = RollDate(i+1)$ (i.e. until the next roll date):

$$Index_t = Index_{RollDate(i)} \times \left[\frac{OptionPortfolioValue_t}{OptionPortfolioValue_{RollDate(i)}} \right] \quad (1)$$

The value of the Balanced Index will be a composite of each monthly index series, $Index_m$ ($m = 1$ for January series, $m = 2$ for February series, ..., $m = 12$ for December series) and will be calculated as follows for $t = 1$ and until $t = RollDate(i+1)$ (i.e. until the next Roll Date):

$$BalancedIndex_t = BalancedIndex_{RollDate(i)} \times \frac{\sum_{m=1}^{m=12} \left[\frac{Index_t^m}{Index_{RollDate(i)}^m} \right]}{12} \quad (2)$$

$$OptionPortfolioValue_{RollDate(i)} = 2 \times PurchasedCallOption_{RollDate(i)} - 2 \times WrittenPutOption_{RollDate(i)} + PurchasedPutOption_{RollDate(i)} - 2 \times WrittenCallOption_{RollDate(i)} \quad (3)$$

$$OptionPortfolioValue_t = 2 \times PurchasedCallOption_t - 2 \times WrittenPutOption_t + PurchasedPutOption_t - 2 \times WrittenCallOption_t \quad (4)$$

where:

- RollDate_(i) is the value on the last roll date
- PurchasedCallOption_t is the closing value of the Purchased Call Option on day t;
- WrittenPutOption_t is the closing value of the Written Put Option on day t;
- PurchasedPutOption_t is the closing value of the Purchased Put Option on day t; and
- WrittenCallOption_t is the closing value of the Written Call Option on day t.

Roll Date Calculations

On the subsequent roll date of each monthly series, the FLEX Option components expire and the index series simultaneously rolls to a new set of FLEX Options with the expiration of the Options as of the close on the next roll date.

On the roll date the Index value is calculated as follows:

$$Index_{RollDate(i+1)} = Index_{RollDate(i)} \times \left[\text{Min} \left(0, \frac{SPX_{RollDate(i+1)}}{SPX_{RollDate(i)}} - 1 \right) + 2 \times \text{Min} \left(\frac{CapStrike_{RollDate(i)}}{SPX_{RollDate(i)}} - 1, \text{Max} \left(0, \frac{SPX_{RollDate(i+1)}}{SPX_{RollDate(i)}} - 1 \right) \right) + 1 \right] \quad (5)$$

On Roll Dates of each monthly series, the Balanced Index will be rebalanced and calculated as a composite of each monthly index series, Index_m (m = 1 for January series, m = 2 for February series, ... m = 12 for December series) as follows:

$$BalancedIndex_{RollDate(i+1)} = BalancedIndex_{RollDate(i)} \times \frac{\sum_{m=1}^{m=12} \left[\frac{Index_{RollDate(i+1)}^m}{Index_{RollDate(i)}^m} \right]}{12} \quad (6)$$

CapStrikeRollDate(i) is the strike of the Written Call Option such that the following holds true on the roll date:

$$WrittenCallOption_{RollDate(i)} = \frac{1}{2} \left(2 \times PurchasedCallOption_{RollDate(i)} - 2 \times WrittenPutOption_{RollDate(i)} + PurchasedPutOption_{RollDate(i)} - SPX_{RollDate(i)} \right) \quad (7)$$

To determine the value and CapStrike of the Written Call Option, Cboe uses an interpolation methodology that it deems is most appropriate for the market conditions at the time. To do so, Cboe values at least two written call options. The value of these options is then used to estimate the value and strike of the Written Call Option.

The following is an illustration of the possible methodology that Cboe may use to interpolate using two option prices:

The value of two additional options is determined on the roll date:

Written Call Option 1

Written Call Option 2

Denote the weights as: $W1$ and $W2$ for the Written Call Option 1 and Written Call Option 2 with Strike 1 = 105% of the S&P500 Index closing price and Strike 2 = 115% of the S&P500 Index closing price, respectively. The value and strike of the Written Call Option is interpolated such that the following equalities hold true:

$$\text{Written Call Option} = W1 \times \text{Written Call Option 1} + W2 \times \text{Written Call Option 2} \quad (8)$$

$$\text{Strike} = W1 \times \text{Strike 1} + W2 \times \text{Strike 2} \quad (9)$$

$$W1 + W2 = 1 \quad (10)$$

While Cboe will use at least two options, as a matter of practice it will generally use three option prices, namely, Written Call Option 0, Written Call Option 1 and Written Call Option 2 to estimate the value of the Written Call Option. However, to determine the value and Strike of the Written Call Option, Cboe may use just two or more than two option prices if it deems it appropriate for the market conditions at the time.

Calculation and Dissemination

Cboe compiles, calculates, maintains, and disseminates all SPEN Index values. The SPEN Index is calculated and disseminated as a daily closing index value following the close of U.S. trading hours.

Judgement and Potential Limitations in Calculation

No expert judgement or discretion is used by Cboe in performing the calculation of the SPEN Index. Potential limitations for this index (i.e., situations where the index may not reflect the above described market or economic reality) include:

- where underlying index input data is unavailable, the SPEN Index value will not be able to be calculated, and
- where the underlying option contract data is not available, the SPEN Index value will not be able to be calculated.

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