EXTERNAL

# Cboe S&P 500 5% Put Protection Index

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 5% Put Protection Index ("PPUT Index"), ticker symbol 'PPUT'.

## Description of the Market or Economic Reality Measure

The Cboe S&P 500 5% Put Protection Index (PPUT) is a benchmark index designed to track the performance of a hypothetical risk-management strategy that consists of a long position indexed to the S&P 500 Index (SPX Index) and a long position in the monthly 5% Out-of-the-Money (OTM) SPX Put options. The PPUT Index does not use contributed input data, and all the input data is readily available via public sources. The PPUT 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 PPUT Index, including applicable formulas and input data. Under the PPUT Index methodology, the roll date is the third Friday of each month. Should the third Friday fall on an exchange holiday, the roll date is the preceding business day.

PPUT is a total return index that is rebalanced monthly. Dividends paid on the component stocks underlying the S&P 500 Index are functionally "re-invested" in the PPUT Index portfolio.

On June 20, 1986, the initial roll date of the PPUT Index, a unit of the SPX Index is purchased and a unit of a 5% OTM monthly SPX Put option is purchased simultaneously. The strike of the SPX Put option selected is the first available strike below 95% of the last disseminated value of the SPX Index before 11:00 a.m. ET. The SPX Put option is purchased at a volume weighted average trade price between 11:30 a.m. and 12:00 p.m. ET (VWAP).

Cboe calculates the VWAP in two steps: first, Cboe excludes trades in the new SPX put option between 11:30 a.m. and 12:00 p.m. ET that are identified as uppercase A – H and lowercase f – t. This will remove all forms of late, cancel and spread orders; and second, Cboe calculates the weighted average of all remaining transaction prices of the new SPX put option between 11:30 a.m. and 12:00 p.m. ET, with weights equal to the fraction of total remaining volume transacted at each price during this period. The source of the transaction prices used in the calculation of the VWAP is OPRA. If no transactions occur at the new put strike between 11:30 a.m. and 12:00 p.m. ET, then the new put options are deemed purchased at the last ask price reported before 12:00 p.m. ET. As the long SPX Index position is assumed to be entered into simultaneously with the long SPX Put option position, the weighted average price of the SPX Index is calculated using disseminated values of the SPX Index based on the same time and weights used to calculate the SPX Put option VWAP. Similarly, if there is no trade of the SPX Put option during the VWAP period, the last disseminated value of the SPX Index before 12:00 p.m. ET is used.

Typically, on the third Friday (Roll Day) of every month since the initial roll date, the old SPX Put option settles at 9:30 a.m. ET against the Special Opening Quotation of the S&P 500 Index (SOQ). The option settlement value is determined as $\text{Put\_old}_{\text{settle}} = \text{Max}\ (0, \text{K}_{\text{old}} - \text{SOQ}_{\text{t}})$. A new 5% OTM monthly SPX Put option will be subsequently purchased. The new SPX Put option is determined by selecting the first available strike below 95% of the last disseminated value of the SPX Index before 11:00 a.m. ET. The price of the new SPX Put option is determined as the VWAP. If there is no trade of the SPX Put option during the VWAP period, the last ask quote of the SPX Put option before 12:00 p.m. ET is used. The long SPX Index position remains unchanged.

The PPUT Index is calculated every 15 seconds according to the following formula:

$$PPUT_t = PPUT_{t-1} * (1 + R_t) \qquad (1)$$

where:

- $PPUT_t$ is the level of the PPUT Index;
- $PPUT_{t-1}$ is the level of the PPUT Index on the previous day; and
- $R_t$ is the return of the PPUT Index.

**<u>Non-Roll Date Calculations</u>**

The non-roll date return of the index is calculated as:

$$(1 + R_t) = (SPX_t + DIV_t + Put_5\%_t) / (SPX_{t-1} + Put\_5\%_{t-1}) \qquad (2)$$

where:

- $SPX_t$ is the SPX Index close price on day *t*. For intraday calculations, the current reported value of the S&P 500 Index is used;
- $SPX_{t-1}$ is the SPX Index close price on day *t-1*;
- $Div_t$ represents the ordinary cash dividends payable on the component stocks underlying the S&P 500 Index that trade “ex-dividend” at date t expressed in S&P 500 Index points;
- $Put\_5\%_t$ is the average of the last bid-ask quote of the 5% OTM SPX Put option before 4:00 p.m. ET. For intraday calculations, the average of the current reported bid and ask prices of the put option is used; and
- $Put\_5\%_{t-1}$ is the average of the last bid-ask quote of the SPX Put option before 4:00 p.m. ET on the previous day.

**<u>Roll Date Calculations</u>**

The roll date return of the index is calculated in three steps using formulas (3), (4) and (5). Formula (3) is used to calculate the return from the previous day’s market close to present day’s morning settlement:

$$(1 + R_1) = (SOQ_t + DIV_t + Put\_5\%\_old_{settle}) / (SPX_{t-1} + Put\_5\%\_old_{t-1}) \qquad (3)$$

where:

- $SPX_t$ is the SPX Index close price on day *t*;
- $SPX_{t-1}$ is the SPX Index close price on day *t-1*;
- $DIV_t$ is the SPX dividend;
- $Put\_5\%\_old_{settle} = \text{Max}\ (0, K_{old} - SOQ_t)$ is the settlement value of the expiring SPX Put option; and
- $Put\_5\%\_old_{t-1}$ is the average of the last bid-ask quote of the expiring SPX Put option before 4:00 p.m. ET on the previous day.

Formula (4) is used to calculate the return from morning settlement to the moment the new SPX Put option is deemed purchased:

$$(1 + R_2) = SOQ_t \,/\, SPX_{vwap} \qquad (4)$$

where:

- $SOQ_t$ is the Special Opening Quotation of the SPX Index on the roll day; and
- $SPX_{vwap}$ is the volume weighted average price of the SPX Index, calculated using disseminated values of the SPX Index based on the same time and weights used to calculate the new SPX Put option VWAP.

Formula (5) is used to calculate the return from the time the new SPX Put option position is deemed purchased to the market close:

$$(1 + R_3) = (SPX_t + Put\_5\%\_new_t) \,/\, (SPX_{vwap} + Put\_5\%\_new_{vwap}) \qquad (5)$$

where:

- $SPX_t$ is the SPX Index close price on day *t*;
- $SPX_{vwap}$ is the volume weighted average value of the SPX Index, calculated using disseminated values of the SPX Index based on the same time and weights used to calculate the new SPX Put option VWAP;
- $Put\_5\%\_new_t$ is the average of the last bid-ask quote of the new SPX Put option before 4:00 p.m. ET on the roll day; and
- $Put\_5\%new_{vwap}$ is the VWAP of the new SPX Put option between 11:30 a.m. and 12:00 p.m. ET.

The product of the three parts (i.e., $1 + R_t = (1 + R_1) * (1 + R_2) * (1 + R_3)$) is the total return of the roll day:

## Calculation and Dissemination

Cboe compiles, calculates, maintains, and disseminates all PPUT Index values. The PPUT Index is calculated and disseminated every 15 seconds during U.S. trading hours, with a daily closing index value disseminated 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 PPUT 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 PPUT Index value will not be able to be calculated, and
- where the underlying option contract data is not available, the PPUT Index value will not be able to be calculated.

## Document Information <DO NOT EDIT>

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