Cboe® S&P 500 Market-Neutral Volatility Risk Premia Optimized Index

As of April 2018
# Table of Contents

- **Introduction** .................................................................................................................................................. 1
- **Index Design** .................................................................................................................................................. 2
- Roll Date Transactions ......................................................................................................................................... 2
- Number of Options Sold ..................................................................................................................................... 3
- Sale Price of Options .......................................................................................................................................... 3
- Final Settlement Price of Expiring Options ....................................................................................................... 3
- **Index Calculation** .......................................................................................................................................... 3
- **Valuation** ......................................................................................................................................................... 5
- **Index Maintenance** ....................................................................................................................................... 5
  - Index Construction ........................................................................................................................................... 5
  - Valuation and Equations ................................................................................................................................. 5
  - Calculation and Dissemination ......................................................................................................................... 5
- **Index Dissemination** ................................................................................................................................... 6
- **Disclaimer** ...................................................................................................................................................... 6
Introduction

The Cboe S&P 500 Market-Neutral Volatility Risk Premia Optimized Index ("SVRPO") is designed to provide a variable level of monthly premium income that has low correlation (is directionally neutral) to monthly returns of the US large cap stocks and exhibits low correlation to monthly returns of US fixed income markets.

The Index is designed to capture the volatility risk premium in S&P 500 Index options by writing one-month S&P 500 Index call and put options and buying one-month S&P 500 Index call and put options with a lesser value. The "volatility risk premium" in S&P 500 Index options is based on the premise that the expected level of volatility of the S&P 500 Index priced into such options (the options’ “implied volatility”) is, on average, higher than the volatility actually experienced by the S&P 500 Index (the “realized volatility”). The Index has the ticker “SVRPO”.

The Index is a benchmark index designed to track the performance of a hypothetical option trading strategy that is based on a default option portfolio subject to the following conditions:

The default option portfolio (Def-1) consists of the following:

1. Sell a rolling monthly out-of-the-money (OTM) put option with strike closest to 90% of SPX_t-1
2. Purchase a rolling monthly further OTM SPX Put option with strike closest to \( K_{Put(2)} = K_{Put(1)} - (33\% \text{ of the SPX value at roll(SPX_t-1:Roll33)}) \)
3. Sell a rolling monthly out-of-the-money (OTM) put option with strike closest to 110% of SPX_t-1
4. Purchase a rolling monthly further OTM SPX Put option with strike closest to \( K_{call(2)} = K_{call(1)} + \text{SPX_t-1:Roll33} \)

The conditions are as follows:

CONDITION #1:
If \( 0.20\% < \text{(Def-1 / SPX_t-1)} < 1.00\% \), then the Option portfolio is the Default Portfolio

CONDITION #2:
If \( (\text{Def-1 / SPX_t-1}) < 0.20\% \), then the strikes are adjusted such that the value of:

\[
\frac{Put(1) - Put(2)}{SPX} = \frac{Call(1) - Call(2)}{SPX} = 0.1\%
\]

CONDITION #3:
If \( (\text{Def-1 / SPX_t-1}) > 1.00\% \), then the strikes are adjusted such that the value of:

\[
\frac{Put(1) - Put(2)}{SPX} = \frac{Call(1) - Call(2)}{SPX} = 0.5\%
\]

1 The Index is a hypothetical portfolio of options and other assets. As such, the Index cannot actually buy or sell an option or other asset, but the Index reflects the value of such transactions as if the Index could actually engage in them. The Index is described as “buying” and “selling” options to aid investors in understanding how the Fund will act in tracking the Index.
CONDITION #4:

Once a portfolio satisfying Conditions 1-3 has been created

If SPX_{t-1} - K_{Put(1)} < 5% of the SPX Value at Roll \((SPX_{t-1}:Roll33)\), \(K_{Put(1)}\) is set to the strike closest to 95% of \(SPX_{t-1}\)

If \(K_{Call(1)} < SPX_{t-1}:Roll5\), \(K_{Call(1)}\) is set to the strike closest to 105% of \(SPX_{t-1}\)

The index also holds a money market account invested in one-month and three-month Treasury bills, which is rebalanced on the option Roll Day and designed to limit the downside return of the SVRPO Index. All SPX options involved are PM-settled, expire on the last business day of the month and roll on a monthly basis. All option positions are one unit.

Index Design

On December 31, 1999, the initial roll date of the SVRPO Index and on the last business day of each month (the “roll date”), the strikes of the four monthly SPX options are selected before 4:00 pm ET. SPX options satisfying the above conditions are sold and purchased. Each SPX option is purchased or written at the appropriate last bid-ask quote (bid for sold options and ask for purchased options) of the applicable option before 4:00 pm ET.

Given the strike prices of the new SPX options, the maximum possible loss from the new option positions is

\[
\begin{align*}
\text{Max} & \left( K_{call(2)} - K_{call(1)}, K_{Put(1)} - K_{put(2)} \right) = \\
\text{Max} & \left( \left( K_{call(1)} + SPX_{t-1:Roll33} \right) - K_{call(1)}, K_{Put(1)} - \left( K_{Put(1)} - SPX_{t-1:Roll33} \right) \right) = \\
\text{Max} & \left( SPX_{t-1:Roll33}, SPX_{t-1:Roll33} \right) = SPX_{t-1:Roll33}
\end{align*}
\]

To provide a downside limit of negative return to the SVRPO Index, a money market account with initial cash that equals one third the maximum possible loss of the new option positions is set up at 4:00 pm ET. The money market account is designed such that the maximum possible loss from the final settlement of the new option positions is approximately 100% of the total value of the account. The money market account accumulates interest.

Roll Date Transactions

Roll Date coincides with the expiry of the options, which is the last business day of the month. At each roll date, any settlement loss from the expiring SPX options is financed by the Treasury bill accounts and a new batch of options is sold. The revenue from their sales is added to the Treasury bill account. The three-month Treasury bills are deemed to mature when SPX options on the March quarterly cycle months are sold. The total cash available is then reinvested at the three-month Treasury bill rate. In other months, the revenue from the sale of options is invested separately at the one-month Treasury bill rate.
Number of Options Sold

The number of SPX options sold is chosen to ensure full collateralization. This means that at expiration of the options, the total value of the Treasury bill investment(s) must be equal to the maximum possible loss from the final settlement of the options or: $3 \times N \times \text{SPX}_{t-1: \text{Roll33}}$. Where $N$ is the number of puts sold and $\text{SPX}_{t-1: \text{Roll33}}$ is the value of 33% of the value of SPX at the previous roll date.

Sale Price of Options

The SPX options are deemed to be sold at a price equal to the volume-weighted average of the traded prices ("VWAP") of options with that strike during the half-hour period beginning at 3:30 p.m. ET. The Cboe calculates the VWAP in a two-step process: first, the Cboe excludes trades between 3:30 p.m. and 4:00 p.m. ET that are identified as having been executed as part of a "spread", and then the Cboe calculates the weighted average of all remaining transaction prices at that strike between 3:30 p.m. and 4:00 p.m. ET, with weights equal to the fraction of total non-spread volume transacted at each price during this period. The source of the transaction prices used in the calculation of the VWAP is Cboe’s Market Data Retrieval ("MDR") System. If no transactions occur at the new option strike prices between 3:30 p.m. and 4:00 p.m. ET, then the new options are deemed sold at the last bid price reported before 4:00 p.m. ET.

Final Settlement Price of Expiring Options

At expiration, the exercise-settlement value is calculated using the last (closing) reported sales price in the primary market of each component stock. On the last trading day, trading in the expiring options closes at 4:00 pm ET.

Index Calculation

Index0: 1000 as of December 30, 2005

The SVRPO Index value is calculated by Cboe in real-time, every 15 seconds during each trading day. On any given date, the index represents the mark-to-market value of the base date $1000 invested in the SVRPO strategy.

At the close of every business date, the value of the SVRPO is equal to the value of the Treasury bill account less the mark-to-market value of the options.

$$SVRP_t = M_t + N_{last} \times (Put(2)_t + Call(2)_t - Put(1)_t - Call(1)_t)$$

Where $M_t$ is the value of the Treasury bill balance on day $t$, Put(1) stands for the price of the SPX Put option price whose delta is closest to -0.10 at the time of last roll date, Call(1) stands for the price of the SPX Call option price whose delta is closest to 0.10 at the time of last roll date, Put(2) stands for the put option whose strike price is closest to the strike price of Put(1) - SPX_{Roll33}, and Call(2) stands for the call option whose strike price is closest to the strike price of Call(1) + SPX_{Roll33}. Each SPX option price with subscript $t$ is the average of the last bid-ask quote for the applicable option before 4:00 pm EST. Each SPX option price is the average of the last bid-ask quote of the applicable option before 4:00 pm ET on the previous day.

On all but roll dates, the Treasury bill balance is obtained by compounding the one and three-month Treasury balances at the previous business close at their respective daily rates.

$$M^i_t = (1 + \tau^i_{t-1})M^i_{t-1}$$
Cboe® S&P 500 Market-Neutral Volatility Risk Premia Optimized Index

Where \( i = 1 \) and \( 3 \) for the one and three-month Treasury bills, and \( r_{t-1}^i \) is the Treasury bill rate from the previous to current close. The Treasury bill rates between the two roll dates are obtained by compounding the daily rates.

On every third roll date, the Treasury bills are deemed to mature, the cash is used to pay for final settlement of the options and new options are sold. The net cash balanced available for reinvestment is:

\[
M_t = \sum_i (1 + r_{t-1}^i) M_{t-1}^i - N_{last} \times (Option\_Settle) + N_{new} \times (Put(2)_{new_t} + Call(2)_{new_t} - Put(1)_{new_t} - Call(1)_{new_t})
\]

Where:

\[
Option\_Settle = Put(2)_{old\_settle} + Call(2)_{old\_settle} - Put(1)_{old\_settle} - Call(1)_{old\_settle}
\]

And Where:

\[
Put(2)_{old\_settle} = \max(0, K_{Put(2)_{old}} - PS_t)
\]

\[
Call(2)_{old\_settle} = \max(0, PS_t - K_{Call(2)_{old}})
\]

\[
Put(1)_{old\_settle} = \max(0, K_{Put(1)_{old}} - PS_t)
\]

\[
Call(1)_{old\_settle} = \max(0, PS_t - K_{Call(1)_{old}})
\]

Where \( PS_t \) is the final settlement price on roll date \( t \), \( N_{new} \) is the number of new option contracts bought and sold. This balance is reinvested at the three-month Treasury bill rate. Hence in the month following a third roll date, the one-month Treasury balance is zero.

The number of new options sold on any roll date \( t \) is set such that the Treasury balance at the next roll date covers the maximum potential settlement loss:

Third roll date:

\[
N_{new} = \left[ \sum_i (1 + r_{t-1}^i) M_{t-1}^i - N_{last} \times (Option\_Settle) / SPX_{t-1:Roll33} \right]
\]

Other roll dates:

\[
N_{new} = \left[ M_{1,Roll} + M_{3,Roll} / SPX_{t-1:Roll33} \right]
\]

\[
M_{1,Roll} = \max(0, (1 + r_{t-1}^1) M_{t-1}^1 - N_{last} \times (Option\_Settle) * (1 + R_1)
\]
\[ M_{3,\text{Roll}} = \left((1 + r_{t-1}^3)M_{t-1}^3 + \text{Min}[0, (1 + r_{t-1}^1)M_{t-1}^1 - N_{\text{last}} \cdot \text{Option\_Settle}] \right) \cdot (1 + R_3) \]

Where \( R_1 \) and \( R_3 \) are the one- and three-month Treasury bill rates to the next roll date.

**Valuation**

To value the component Options that comprise the Monthly index series, a model based valuation offered by a Cboe affiliate is used.

Model based valuation is used for valuing the options. Cboe constructs an implied volatility surface from listed S&P 500 option prices by applying the SABR model. 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 options on the roll dates and for the official close of Cboe each trading date.

**Index Maintenance**

**Index Construction**

Cboe gathers information for the option components and applies the methodology to create individual index series.

**Valuation and Equations**

Cboe determines an evaluated value for each component option and associated equation in the Indices.

**Calculation and Dissemination**

Cboe compiles, calculates, maintains and disseminates the values of the Indices. Calculation will occur in real-time, every 15 seconds during each trading day.
Cboe® S&P 500 Market-Neutral Volatility Risk Premia Optimized Index

Index Dissemination

Index levels are available through Cboe Global Markets website www.Cboe.com/Index, major quote vendors (see codes below), numerous investment-oriented websites, and various print and electronic media.

<table>
<thead>
<tr>
<th>Index</th>
<th>Bloomberg</th>
<th>Reuters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cboe S&amp;P 500 Market-Neutral Volatility Risk Premia Optimized Index</td>
<td>SVRPO &lt;Index&gt;</td>
<td>.SVRPO</td>
</tr>
</tbody>
</table>

Disclaimer

Options involve risk and are not suitable for all investors. Prior to buying or selling an option, a person must receive a copy of Characteristics and Risks of Standardized Options. Copies are available from your broker or from The Options Clearing Corporation, One North Wacker Drive, Suite 500, Chicago, Illinois 60606 or www.theocc.com The CBOE S&P 500 Market-Neutral Volatility Risk Premia Optimized Index (the “Index”) is designed to represent a proposed yield strategy. Like many passive indexes, the Indices do not take into account significant factors such as transaction costs and taxes and, because of factors such as these, many or most investors should be expected to underperform passive indexes. In the construction of the Indices, the options components of each monthly index series are assumed to be purchased and sold at a certain price on the last business day of the month. However, there is no guarantee that all investors will be able to buy or sell at this price, and investors attempting to replicate the Indices should discuss with their brokers possible timing and liquidity issues. Transaction costs and taxes for a strategy such as the Indices could be significantly higher than transaction costs for a passive strategy of buying-and-holding stocks. Investors should consult their tax advisor as to how taxes affect the outcome of contemplated options transactions. Multiple leg strategies involve multiple commission charges. Past performance does not guarantee future results. It is not possible to invest directly in an index. Chicago Board Options Exchange, Incorporated (Cboe) calculates and disseminates the Indices.

The information in this paper is provided for general education and information purposes only. No statement within this paper should be construed as a recommendation to buy or sell a security or to provide investment advice. Your use of, and access to, this paper is subject to the Terms and Conditions for Use of Cboe Websites located at http://www.Cboe.com/common/termsconditions.aspx.

The methodology of the Indices is the property of Cboe. Cboe®, Chicago Board Options Exchange®, FLEX® and Flexible Exchange® are registered trademarks of Cboe. S&P 500® is a registered trademark of Standard & Poor’s Financial Services, LLC and has been licensed for use by Cboe. Financial products based on S&P indices are not sponsored, endorsed, sold or promoted by Standard & Poor’s, and Standard & Poor’s makes no representation regarding the advisability of investing in such products.

© 2017 Chicago Board Options Exchange, Incorporated. All rights reserved.