S&P Dow Jones Indices:
S&P 500 VIX Futures Indices
Methodology

July 2012
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>3</td>
</tr>
<tr>
<td>Highlights</td>
<td>3</td>
</tr>
<tr>
<td>Family</td>
<td>3</td>
</tr>
<tr>
<td>Index Construction</td>
<td>5</td>
</tr>
<tr>
<td>Approaches</td>
<td>5</td>
</tr>
<tr>
<td>Calculation of the VIX Futures Index Excess Return (ER)</td>
<td>6</td>
</tr>
<tr>
<td>Contract Rebalancing</td>
<td>7</td>
</tr>
<tr>
<td>Calculation of the VIX Futures Index Total Return (TR)</td>
<td>9</td>
</tr>
<tr>
<td>Calculation of the VIX Futures Term-Structure Excess Return (ER)</td>
<td>10</td>
</tr>
<tr>
<td>Calculation of the VIX Futures Term-Structure Total Return (TR)</td>
<td>10</td>
</tr>
<tr>
<td>Calculation of the VIX Short Term Futures Daily Inverse Excess Return (ER)</td>
<td>10</td>
</tr>
<tr>
<td>Calculation of the VIX Short Term Futures Daily Inverse Total Return (TR)</td>
<td>11</td>
</tr>
<tr>
<td>Base Date</td>
<td>11</td>
</tr>
<tr>
<td>Historical Assumptions</td>
<td>11</td>
</tr>
<tr>
<td>Index Governance</td>
<td>13</td>
</tr>
<tr>
<td>Index Committee</td>
<td>13</td>
</tr>
<tr>
<td>Index Policy</td>
<td>14</td>
</tr>
<tr>
<td>Announcements</td>
<td>14</td>
</tr>
<tr>
<td>Holiday Schedule</td>
<td>14</td>
</tr>
<tr>
<td>Unscheduled Market Closures and New Holidays</td>
<td>14</td>
</tr>
<tr>
<td>Index Dissemination</td>
<td>15</td>
</tr>
<tr>
<td>Tickers</td>
<td>15</td>
</tr>
<tr>
<td>S&amp;P Contact Information</td>
<td>16</td>
</tr>
<tr>
<td>Index Management</td>
<td>16</td>
</tr>
<tr>
<td>Media Relations</td>
<td>16</td>
</tr>
</tbody>
</table>
Introduction

The S&P 500® VIX® Futures Index Series seeks to model the outcome of holding long and/or short positions in VIX futures contracts or other VIX indices, as defined below.

Highlights

Historically, the VIX Index has a negative correlation to the S&P 500 and is considered a useful tool to hedge against the potential downside of the broad equity market. While the spot VIX is difficult to replicate as a practical matter, there is a market in VIX futures and options, and investors trade them to express their view on the S&P 500’s implied volatility.

Family

The S&P 500 VIX Futures Index Series is comprised of the S&P 500 VIX Short-Term Futures Index, the S&P 500 VIX 2M Futures Index, the S&P 500 VIX 3M Futures Index, the S&P 500 VIX 4M Futures Index, the S&P 500 VIX Mid-Term Futures Index, the S&P 500 VIX 6M Futures Index, the S&P 500 VIX Futures Term-Structure Index and the S&P 500 VIX Short Term Futures Daily Inverse Index.

The S&P 500 VIX Short-Term Futures Index measures the return from a daily rolling long position in the first and second month VIX futures contracts.

The S&P 500 VIX 2M Futures Index measures the return from a daily rolling long position in the second and third month VIX futures contracts.

The S&P 500 VIX 3M Futures Index measures the return from a daily rolling long position in the third and fourth month VIX futures contracts.

The S&P 500 VIX 4M Futures Index measures the return from a daily rolling long position in the fourth and fifth month VIX futures contracts.

The S&P 500 VIX Mid-Term Futures Index measures the return from a daily rolling long position in the fourth, fifth, sixth and seventh month VIX futures contracts.

The S&P 500 VIX 6M Futures Index measures the return from a daily rolling long position in the fifth, sixth, seventh and eighth month VIX futures contracts.

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1 The VIX® methodology is the property of the Chicago Board Options Exchange ("CBOE"). CBOE has granted Standard & Poor’s Financial Services LLC ("S&P"), a license to use the VIX methodology to create the S&P 500 VIX Futures Index.
The S&P 500 VIX Futures Term-Structure Index measures the return from a long position, with 100% weight, in the S&P 500 VIX Mid-Term Futures Index and a short position, with 50% weight, in the S&P 500 VIX Short-Term Futures Index. The weights are rebalanced daily.

The S&P 500 VIX Short Term Futures Daily Inverse Index measures the performance of the inverse of the S&P 500 VIX Short-Term Futures Index.

A total return version of each index is calculated, which includes interest accrual on the notional value of the index based on the 3-month US Treasury rate and reinvestment into the index.
Index Construction

Approaches

The Indices model returns from long VIX futures position (and/or short positions in other indices, as described in the Introduction) that is rolled continuously throughout the period between futures expiration dates. The total return version of the Indices incorporates interest accrual on the notional value of the Indices and reinvestment into the Indices. Interest accrues based on the 3-month US Treasury rate.

The S&P 500 VIX Short-Term Futures Index, the S&P 500 VIX 2M Futures Index, the S&P 500 VIX 3M Futures Index and the S&P 500 VIX 4M Futures Index measure the return from a rolling long position in two VIX futures contracts with adjacent maturities. The index rolls continuously throughout each month from the shorter-term VIX futures contract into the longer-term VIX futures contract. Please refer to Table 1 below.

The S&P 500 VIX Mid-Term Futures Index and the S&P 500 VIX 6M Futures Index measure the return from a rolling long position in four VIX futures contracts with adjacent maturities. The index rolls continuously throughout each month from the shortest-term contract into the longest-term contract while maintaining positions in the other two contracts.

Table 1: Underlying contracts and rolling contracts

<table>
<thead>
<tr>
<th>Index Name</th>
<th>Underlying Contracts</th>
<th>Roll Out (m)</th>
<th>Roll In (n)</th>
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<tr>
<td>S&amp;P 500 VIX Short-Term Futures Index</td>
<td>1st, 2nd</td>
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<tr>
<td>S&amp;P 500 VIX 2M Futures Index</td>
<td>2nd, 3rd</td>
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<tr>
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<td>3rd, 4th</td>
<td>3rd</td>
<td>4th</td>
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<tr>
<td>S&amp;P 500 VIX 4M Futures Index</td>
<td>4th, 5th</td>
<td>4th</td>
<td>5th</td>
</tr>
<tr>
<td>S&amp;P 500 VIX Mid-Term Futures Index</td>
<td>4th, 5th, 6th, 7th</td>
<td>4th</td>
<td>7th</td>
</tr>
<tr>
<td>S&amp;P 500 VIX 6M Futures Index</td>
<td>5th, 6th, 7th, 8th</td>
<td>5th</td>
<td>8th</td>
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</tbody>
</table>
The S&P 500 VIX Futures Term-Structure Index measures the return from taking a 100% long position in the S&P 500 VIX Mid-Term Futures Index, and a 50% short position in the S&P 500 VIX Short-Term Futures Index. The weights of long and short positions are rebalanced daily.

The S&P 500 VIX Short Term Futures Daily Inverse Index measures the performance of the inverse of the S&P 500 VIX Short-Term Futures Index.

**Calculation of the VIX Futures Index Excess Return (ER)**

On any S&P 500 VIX Futures Business Day, \( t \), the index ER is calculated as follows:

\[
IndexER_t = IndexER_{t-1} \times (1 + CDR_t)
\]

(1)

where:

- \( IndexER_{t-1} \) = The Index Excess Return on the preceding business day, defined as any date on which the index is calculated.
- \( CDR_t \) = Contract Daily Return, as determined by the following formula:

\[
CDR_t = \frac{TDWO_t}{TDWI_{t-1}} - 1
\]

(2)

where:

- \( t-1 \) = the preceding business day.
- \( TDWO_t \) = Total Dollar Weight Obtained on \( t \), as determined by the following formula for each of the Indices:

\[
TDWO_t = \sum_{i=m}^{n} CRW_{i,t-1} \times DCRP_{i,t}
\]

(3)

\( TDWI_{t-1} \) = Total Dollar Weight Invested on \( t-1 \), as determined by the following formula for each of the Indices:

\[
TDWI_{t-1} = \sum_{i=m}^{n} CRW_{i,t-1} \times DCRP_{i,t-1}
\]

(4)

where:

- \( CRW_{i,t} \) = Contract Roll Weight of the \( i^{th} \) VIX Futures Contract on date \( t \).
$DCRP_{i,t} =$ Daily Contract Reference Price of the $i^{\text{th}}$ VIX Futures Contract on date $t$.

$m =$ The term of the futures contract that is rolled out on date $t$. Please refer to Table 1.

$n =$ The term of the futures contract that is rolled in on date $t$. Please refer to Table 1.

**Contract Rebalancing**

The Roll Period starts on the Tuesday prior to the monthly CBOE VIX Futures Settlement Date (the Wednesday falling 30 calendar days before the S&P 500 option expiration for the following month), and runs through the Tuesday prior to the subsequent month’s CBOE VIX Futures Settlement Date. Thus, the Indices are rolling on a continual basis. On the business date after the current Roll Period ends the following Roll Period will begin.

In calculating the Excess Return of each of the Indices, the Contract Roll Weights ($CRW_{i,t}$) of each of the contracts in the index, on a given day, $t$, are determined as follows:

**S&P 500 VIX Short-Term / 2M / 3M / 4M Futures Index**

$$CRW_{m,t} = 100 \frac{dr}{dt}$$

$$CRW_{n,t} = 100 \frac{dt - dr}{dt}$$

where:

$dt =$ The total number of business days in the current Roll Period beginning with, and including, the starting CBOE VIX Futures Settlement Date and ending with, but excluding, the following CBOE VIX Futures Settlement Date. The number of business days stays constant in cases of a new holiday introduced intra-month or an unscheduled market closure.

$dr =$ The total number of business days within a Roll Period beginning with, and including, the following business day and ending with, but excluding, the following CBOE VIX Futures Settlement Date. The number of business days includes a new holiday introduced intra-month up to the business day preceding such a holiday.
At the close on the Tuesday, corresponding to the start of the Roll Period, all of the weight is allocated to the shorter-term (i.e. m\textsuperscript{th} month) contract. Then on each subsequent business day a fraction of the m\textsuperscript{th} month VIX futures holding is sold and an equal notional amount of the longer-term (n\textsuperscript{th} month) VIX futures is bought. The fraction, or quantity, is proportional to the number of m\textsuperscript{th} month VIX futures contracts as of the previous index roll day, and inversely proportional to the length of the current Roll Period. In this way the initial position in the m\textsuperscript{th} month contract is progressively moved to the n\textsuperscript{th} month one over the course of the month, until the following Roll Period starts when the old n\textsuperscript{th} month VIX futures contract becomes the new m\textsuperscript{th} month VIX futures contract and gets sold every day afterward as the process begins again.

In addition to the transactions described above, the weight of each index component is also adjusted every day to ensure that the change in total dollar exposure for the index is only due to the price change of each contract and not due to using a different weight for a contract trading at a higher price.

\textit{S&P 500 VIX Mid-Term / 6M Futures Index}

\begin{align*}
CRW_{m,i} &= 100 \times \frac{dr}{dt} \\
CRW_{i,j} &= 100 \\
CRW_{j,n} &= 100 \\
CRW_{n,m} &= 100 \times \frac{dt - dr}{dt}
\end{align*}

At the close on the Tuesday, corresponding to the start of the Roll Period, an equal weight is allocated to the m\textsuperscript{th}, i\textsuperscript{th}, j\textsuperscript{th} and n\textsuperscript{th} month contracts. Then on each subsequent business day a fraction of the shortest term (i.e. m\textsuperscript{th} month) VIX futures holding is sold and an equal notional amount of the longest-term (i.e. n\textsuperscript{th} month) VIX futures is bought. The fraction, or quantity, is proportional to the number of m\textsuperscript{th} month VIX futures contracts as of the previous index roll day, and inversely proportional to the length of the current Roll Period. In this way the initial position in the m\textsuperscript{th} month contract is progressively moved to the n\textsuperscript{th} month contract over the course of the month, until the following Roll Period start when the old i\textsuperscript{th} month VIX futures contract becomes the new m\textsuperscript{th} month VIX futures contract and gets sold every day afterwards as the process begins again.

In addition to the transactions described above, the weight of each index component is also adjusted every day to ensure that the change in total dollar exposure for the index is only due to the price change of each contract and not due to using a different weight for a contract trading at a higher price.
Calculation of the VIX Futures Index Total Return (TR)

A total return version of each of the Indices is calculated, which includes interest accrual on the notional value of the index based on the 3-month US Treasury rate, as follows:

\[
\text{IndexTR}_t = \text{IndexTR}_{t-1} \times (1 + CDR_t + TBR_t)
\]  

where:

- \(\text{IndexTR}_{t-1}\) = The index TR on the preceding business day.
- \(CDR_t\) = Contract Daily Return as defined in equation (2).
- \(TBR_t\) = Treasury Bill Return, as determined by the following formula:

\[
TBR_t = \left[ \frac{1}{1 - \frac{91}{360} \times TBAR_{t-1}} \right]^{\frac{\Delta t}{90}} - 1
\]

\(\Delta t\) = the number of calendar days between the current and previous business days.
- \(TBAR_{t-1}\) = the most recent weekly high discount rate for 91-day US Treasury bills effective on the preceding business day. Generally the rates are announced by the US Treasury on each Monday. On Mondays that are bank holidays, Friday’s rates will apply.
Calculation of the VIX Futures Term-Structure Excess Return (ER)

The Term-Structure Index is a composite index that consists of taking a long position on the S&P 500 VIX Mid-Term Futures Index with 100% weight, and a short position on the S&P 500 VIX Short-Term Futures Index with 50% weight. On any S&P 500 VIX Futures Business Day, \( t \), the index ER is calculated as follows:

\[
IndexER_t = IndexER_{t-1} \times (1 + \text{Excess~Return}_t) 
\]

(7)

where:

\( IndexER_{t-1} \) = The Index Excess Return on the preceding business day, defined as any date on which the index is calculated,

and

\[
\text{Excess~Return}_t = (W_{\text{Long}} \times \text{Excess~Return}_{\text{Long}} - W_{\text{Short}} \times \text{Excess~Return}_{\text{Short}}) 
\]

(8)

where:

\( W_{\text{Long}} = 100\% \), is the weight of the long position,

\( \text{Excess~Return}_{\text{Long}} \) = Excess Return of the long position in S&P 500 VIX Mid-term Futures Index,

\( W_{\text{Short}} = 50\% \), is the weight of the short position,

\( \text{Excess~Return}_{\text{Short}} \) = Excess Return of the short position in S&P 500 VIX Short-term Futures Index.

Calculation of the VIX Futures Term-Structure Total Return (TR)

A total return version of the Index is calculated, which includes interest accrual on the notional value of the index based on the 3-month US Treasury rate, as follows:

\[
IndexTR_t = IndexTR_{t-1} \times (1 + \text{Excess~Return}_t + TBR_t) 
\]

(9)

where:

\( IndexTR_{t-1} \) = The index’s total return on the preceding business day.

\( \text{Excess~Return}_t \) = Excess Return, as defined in equation (8).

\( TBR_t \) = Treasury Bill Return, as defined in equation (6).

Calculation of the VIX Short Term Futures Daily Inverse Excess Return (ER)

The S&P 500 VIX Short Term Futures Daily Inverse Index measures the performance of the inverse of the S&P 500 VIX Short-Term Futures Index. On any S&P 500 VIX Futures Business Day, \( t \), the index ER is calculated as follows:

\[
IndexER_t = IndexER_{t-1} \times (1 + \text{Excess~Return}_t) 
\]

(10)

where:
IndexER_{t-1} = \text{The Index Excess Return on the preceding business day, defined as any date on which the index is calculated,}

and

\begin{equation}
\text{Excess Return}_t = -1 \times \text{VIXShortTermFuturesCDR}_t
\end{equation}

where:

\begin{equation}
\text{VIXShortTermFuturesCDR}_t = \text{Excess Return of the long position on the S&P 500 VIX Short-term Futures Index, as calculated in (2).}
\end{equation}

**Calculation of the VIX Short Term Futures Daily Inverse Total Return (TR)**

A total return version of the Index is calculated, which includes interest accrual on the notional value of the index based on the 3-month US Treasury rate, as follows:

\begin{equation}
\text{IndexTR}_t = \text{IndexTR}_{t-1} \times (1 + \text{Excess Return}_t + \text{TBR}_t)
\end{equation}

where:

\begin{equation}
\text{IndexTR}_{t-1} = \text{The index’s total return on the preceding business day.}
\end{equation}

\begin{equation}
\text{ExcessReturn}_t = \text{Excess Return, as defined in equation (11).}
\end{equation}

\begin{equation}
\text{TBR}_t = \text{Treasury Bill Return, as defined in equation (6).}
\end{equation}

**Base Date**

The base dates of the indices are December 20, 2005 at base values of 100,000.

**Historical Assumptions**

Prior to April 2008, not all consecutive first to seventh month VIX futures were listed. For the purpose of the historical S&P 500 VIX Futures Index series calculations, the following assumptions have been made in interpolating VIX futures contract prices from near-by listed contracts.

When the \(i^{th}\) future was not listed, but \(i^{th}+1\) and \(i^{th}-1\) futures were listed, the following interpolation has been assumed:

\begin{equation}
\text{DCRP}_{i,t} = \text{DCRP}_{i-1,t}^2 + \frac{\text{BDays}(T_i - T_{i-1})}{\text{BDays}(T_{i+1} - T_{i-1})}(\text{DCRP}_{i+1,t}^2 - \text{DCRP}_{i-1,t}^2)
\end{equation}

When \(i^{th}\) and \(i^{th}+1\) futures were not listed, but \(i^{th}+2\) and \(i^{th}-1\) futures were listed, the following interpolation has been assumed:

\begin{equation}
\text{DCRP}_{i,t} = \text{DCRP}_{i-1,t}^2 + \frac{\text{BDays}(T_i - T_{i-1})}{\text{BDays}(T_{i+2} - T_{i-1})}(\text{DCRP}_{i+2,t}^2 - \text{DCRP}_{i-1,t}^2)
\end{equation}
When $i^{th}$, $i^{th}+1$ and $i^{th}+2$ futures were not listed, the following interpolation has been assumed:

$$DCRP_{i,t} = DCRP_{i-1,t}^2 + \frac{BDays(T_i - T_{i-1})}{BDays(T_{i-1} - T_{i-2})}(DCRP_{i-1,t}^2 - DCRP_{i-2,t}^2)$$

where:

- $T_i$ = Expiration Day of the $i^{th}$ VIX Futures contract
- $BDays$ = Number of Business days between VIX Futures Expiration Days
Index Governance

Index Committee

The S&P Dow Jones Indices’ Commodities Index Committee maintains the S&P 500 VIX Futures Indices. The Index Committee meets regularly. At each meeting, the Index Committee reviews any significant market events. In addition, the Index Committee may revise index policy for timing of rebalancings or other matters.

S&P Dow Jones Indices considers information about changes to its Indices and related matters to be potentially market moving and material. Therefore, all Index Committee discussions are confidential.
Index Policy

Announcements

Announcements of the daily index values are made after the market close each day.

Holiday Schedule

The index is calculated daily when the CBOE Futures Exchange is open, excluding holidays and weekends.

Unscheduled Market Closures and New Holidays

In situations where an exchange is forced to close early due to unforeseen events, such as computer or electric power failures, weather conditions or other events, S&P Dow Jones Indices will calculate the value of the index based on the most recent prior closing futures price published by the CBOE Futures Exchange and the roll for that day will be carried to the next CBOE business day as described in the Contract Rebalancing section. If an exchange fails to open due to unforeseen circumstances, S&P Dow Jones Indices may determine not to publish the index for that day.

In situations where an exchange introduces a holiday during the month of the index calculation the index will not be published and the roll for that day will be carried to the next CBOE business day as described in the Contract Rebalancing section.

Delisting of Futures Contracts

If one or more futures contracts included in one of the Indices is no longer listed, S&P Dow Jones Indices may choose to cease publication of the effected index at that time.
Index Dissemination

Historical index returns are available through S&P Dow Jones Indices’ index data group for subscription via FTP.

**Tickers**

<table>
<thead>
<tr>
<th>Index Description</th>
<th>Bloomberg</th>
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