S&P Dow Jones Indices

A Division of S&P Global

S&P/BMV IPC VIX Index
Methodology

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Introduction

Index Objective

The S&P/BMV IPC VIX Index measures the implied volatility of the S&P/BMV IPC Futures over the next 90 days.

Highlights

The index uses settlement prices for S&P/BMV IPC Index Futures put and call options to calculate a weighted average of the implied volatility of the options.

Supporting Documents

This methodology is meant to be read in conjunction with supporting documents providing greater detail with respect to the policies, procedures and calculations described herein. References throughout the methodology direct the reader to the relevant supporting document for further information on a specific topic. The list of the main supplemental documents for this methodology and the hyperlinks to those documents is as follows:

Supporting Document	URL
S&P Dow Jones Indices' Equity Indices Policies & Practices Methodology	Equity Indices Policies & Practices
S&P Dow Jones Indices' Index Mathematics Methodology	Index Mathematics Methodology

This methodology was created by S&P Dow Jones Indices to achieve the aforementioned objective of measuring the underlying interest of each index governed by this methodology document. Any changes to or deviations from this methodology are made in the sole judgment and discretion of S&P Dow Jones Indices so that the index continues to achieve its objective.

Index Construction

Approaches

The index is derived from the near term and next term options on the S&P/BMV IPC Index Futures. To minimize pricing anomalies from the heavy trading on expiring options during the last few trading days, options roll to the next term and third term when the near-term options have 10 calendar days to expire. The index is calculated and published daily.

Derive VIX from Near Term and Next Term Options

The index generally uses put and call options in the two nearest-term expiration months in order to bracket a 90-day calendar period.

However, when the near-term options have less than 10 calendar days to expire, the index rolls to the second and third contract months in order to minimize pricing anomalies that might occur close to expiration.

For each maturity, put and call options are used to calculate the implied volatility. The detailed calculation is described in the next section.

The near term volatility σ_1 and the next term volatility σ_2 are interpolated to arrive at a single value σ with a constant maturity of 90 days to expiration. The index is derived by taking σ (the square root of σ^2) and multiplying by 100.

$$VIX = \sigma * 100$$

(1)

$$\sigma^2 = \frac{N_y}{N_m}\left\{T_1\sigma_1^{\,2}\left[\frac{N_{T_2} - N_m}{N_{T_2} - N_{T_1}}\right] + T_2\sigma_2^{\,2}\left[\frac{N_m - N_{T_1}}{N_{T_2} - N_{T_1}}\right]\right\}$$

where:

σ	= 90-day implied volatility
σ_1	= Near-term volatility derived from the near term options (see formula 5)
σ_2	= Next-term volatility derived from the next term options (see formula 5)
N_y	= Number of days in one year
N_m	= Number of days in three months = 90
T_1	= Time to expiration (in years) of the near term options
T_2	= Time to expiration (in years) of the next term options
N_{T1}	= Number of days between the current day and the expiration date of the near term options
N_{T2}	= Number of days between the current day and the expiration date of the next term options

Calculating Time to Maturity

The time to maturity (*T*) is measured in years. The calculation consists of three parts:

N_1 = Fractional number of days remaining from the calculation time until midnight of the current day

N_2 = Number of days between the current day and the settlement day

N_3 = Fractional number of days from midnight of the day prior to expiry to the settlement time on the expiry date

$$N_1 = \frac{\text{minutes remaining until midnight of the current day}}{24 * 60}$$

$$N_3 = \frac{\text{minutes from midnight to settlement time on expiry}}{24 * 60} \quad (2)$$

$$N_T = N_1 + N_2 + N_3$$

$$T = \frac{N_T}{N_y}$$

where:

N_y = Number of days in one year

Calendar days are used in all the day count calculation.

Risk Free Rates

The TIIE (R_{on}), TIIE 28-day rate (R_{1m}), TIIE 91-day rate (R_{3m}) and TIIE 182-day rate (R_{6m}) are used to interpolate the risk free rates used in the near-term (R_1) and next-term (R_2).

$$R_1 = \frac{N_y}{N_{T_1}}\left\{T_{on}R_{on}\left[\frac{N_{1m} - N_{T_1}}{N_{1m} - N_{on}}\right] + T_{1m}R_{1m}\left[\frac{N_{T_1} - N_{on}}{N_{1m} - N_{on}}\right]\right\}$$

$$R_2 = \frac{N_y}{N_{T_2}}\left\{T_{3m}R_{3m}\left[\frac{N_{6m} - N_{T_2}}{N_{6m} - N_{3m}}\right] + T_{6m}R_{6m}\left[\frac{N_{T_2} - N_{3m}}{N_{6m} - N_{3m}}\right]\right\} \quad (3)$$

where:

R_1 = Near-term risk free rate

R_2 = Next-term risk free rate

N_{on} = Number of days remaining until the midnight of the next business day

N_{1m} = 28 days, as used in the 28-day TIIE rate interpolation

N_{3m} = 91 days, as used in the 91-day TIIE rate interpolation

N_{6m} = 182 days, as used in the 182-day TIIE rate interpolation

N_{T1} = Number of days between the current day and the expiration date of the near-term options

N_{T2} = Number of days between the current day and the expiration date of the next-term options

N_y = Number of days in one year

$$T_{on} = \frac{N_{on}}{N_y}$$
$$T_{1m} = \frac{N_{1m}}{N_y}$$
$$T_{3m} = \frac{N_{3m}}{N_y}$$
$$T_{6m} = \frac{N_{6m}}{N_y} \quad (4)$$

Note that the interpolation works when the near-term and next-term expirations are bracketed by the overnight-28 day and the 91-182 day maturities of interest rates, respectively. When the option expirations fall outside of the corresponding interest rate expirations, the correct interest rate must be selected. For example, if the near-term expiration is between 28 days and 91 days, the 28-day and 91-day TIIE rates are used to interpolate the near-term risk free rate, R_1; if the next-term expiration is beyond 182 days, the 91-day and 182-day TIIE rates are used to interpolate the next-term risk free rate, R_2.

General Formula to Calculate Implied Volatilities

The index uses the settlement prices of options to calculate the implied volatilities.

For the near term and the next term, respectively, implied volatilities are calculated using both puts and calls. The general formula is:

$$\sigma^2 = \frac{2}{T}\sum_i \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) - \frac{1}{T}\left[\frac{F}{K_0} - 1\right]^2 \quad (5)$$

where:

σ = Implied volatility
T = Time to expiration (see formula 2)
F = Forward index level
K_i = Strike price of the i^{th} out-of-the-money option
ΔK_i = Interval between strike prices (see formula 7)
K_0 = At-the-money strike R = Risk-free interest rate to expiration
$Q(K_i)$ = Settlement price of each option with strike K_i

The index uses the S&P/BMV IPC Index futures price as the proxy for forward index level F. Define K_0 as the strike that is closest to F.

The index uses both puts and calls in the volatility calculation:

- Select call options that have strike prices greater than K_0 and a non-zero settlement price.
- Select put options that have strike prices less than K_0 and a non-zero settlement price.
- Select both the put and call at strike K_0 and a non-zero settlement price. Use the average of put and call settlement prices as $Q(K_0)$ in the calculation.

Generally, ΔK_i is half the distance between the strike on either side of K_i and is calculated as:

$$\Delta K_i = \frac{K_{i+1} - K_{i-1}}{2} \quad (6)$$

At the upper and lower edges of any given strip of options, ΔK_i is simply the difference between K_i and the adjacent strike price.

Rolling Between Option Contract Months

In calculating the index, when the near-term options have 10 days to expire, the index rolls to the second and third contract months.

Currency, Currency Hedged, and Risk Control Indices

Currency, currency hedged, and risk control versions of the index may be available. For a list of available currency, currency hedged, and risk control indices, please contact Client Services at index_services@spglobal.com.

For more information on currency, currency hedged, and risk control indices, please refer to S&P Dow Jones Indices' Index Mathematics Methodology.

Index Governance

Index Committee

The S&P/BMV Index Committee maintains the index. The Index Committee is composed of full-time employees of S&P Dow Jones Indices and the BMV. The Index Committee is responsible for monitoring overall policy guidelines and methodology, as well as additions to and deletions from the index. Decisions made by the Index Committee include all matters relating to index construction and maintenance. The Index Committee meets regularly to review market developments and convenes as needed to address major corporate actions.

It is the sole responsibility of the Index Committee to decide on all matters relating to methodology, maintenance, constituent selection and index procedures. The Index Committee makes decisions based on all publicly available information and discussions are kept confidential to avoid any unnecessary impact on market trading.

S&P Dow Jones Indices' Index Committees reserve the right to make exceptions when applying the methodology if the need arises. In any scenario where the treatment differs from the general rules stated in this document or supplemental documents, clients will receive sufficient notice, whenever possible.

In addition to the daily governance of indices and maintenance of index methodologies, at least once within any 12-month period, the Index Committee reviews the methodology to ensure the indices continue to achieve the stated objectives, and that the data and methodology remain effective. In certain instances, S&P Dow Jones Indices may publish a consultation inviting comments from external parties.

For information on Quality Assurance and Internal Reviews of Methodology, please refer to S&P Dow Jones Indices' Equity Indices Policies & Practices document.

Index Policy

Announcements

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

Holiday Schedule

The index is calculated daily when the Mexico Stock Exchange is open, excluding holidays and weekends.

A complete holiday schedule for the year is available at www.spdji.com.

Rebalancing

The Index Committee may change the date of a given rebalancing for reasons including market holidays occurring on or around the scheduled rebalancing date. Any such change will be announced with proper advance notice where possible.

Unexpected Exchange Closures

For information on Unexpected Exchange Closures, please refer to S&P Dow Jones Indices' Equity Indices Policies & Practices document.

Recalculation Policy

For information on the recalculation policy, please refer to S&P Dow Jones Indices' Equity Indices Policies & Practices document.

For information on Calculations and Pricing Disruptions, Expert Judgment and Data Hierarchy, please refer to S&P Dow Jones Indices' Equity Indices Policies & Practices document located.

Contact Information

For questions regarding an index, please contact: index_services@spglobal.com.

Index Dissemination

Index levels are available through S&P Dow Jones Indices' Web site at *www.spdji.com,* major quote vendors, numerous investment-oriented Web sites, and various print and electronic media.

Tickers

The table below lists headline indices covered by this document. All currency, currency hedged, risk control, and return type versions of the below indices that may exist are also covered by this document. Please contact index_services@spglobal.com for a complete list of indices covered by this document.

Index	Bloomberg	Reuters
S&P/BMV IPC VIX	SPBMVVIX	.SPBMVVIX

Index Data

Daily index level data are available via subscription.

For product information, please contact S&P Dow Jones Indices, www.spdji.com/contact-us.

Web site

For further information, please refer to S&P Dow Jones Indices' Web site at www.spdji.com.

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