

S&P/BMV IPC VIX Index *Methodology*

July 2017

Table of Contents

Introduction	2
Highlights	2
Index Construction	3
Approaches	3
Derive VIX from Near Term and Next Term Options	3
Calculating Time to Maturity	4
Risk Free Rates	4
General Formula to Calculate Implied Volatilities	5
Rolling Between Option Contract Months	6
Index Governance	7
Index Committee	7
Index Policy	8
Announcements	8
Holiday Schedule	8
Rebalancing	8
Unscheduled Exchange Closures	8
Index Dissemination	9
Tickers	9
FTP	9
Web site	9
S&P Dow Jones Indices' Contact Information	10
Index Management	10
Product Management	10
Media Relations	10
Client Services	10
Disclaimer	11

Introduction

The S&P/BMV IPC VIX Index uses the VIX^{®1} methodology to measure the market expectations of 90-day volatility conveyed by the prices of the options on IPC Futures.

Highlights

The index is an end-of-day index that reflects investor sentiment about the expected volatility in the Mexican stock index.

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

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.

¹ The S&P/BMV IPC VIX Index is calculated by CBOE.

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.

$$VIX = \sigma * 100$$

$$\sigma^2 = \frac{N_y}{N_m} \left\{ T_1 \sigma_1^2 \left[\frac{N_{T_2} - N_m}{N_{T_2} - N_{T_1}} \right] + T_2 \sigma_2^2 \left[\frac{N_m - N_{T_1}}{N_{T_2} - N_{T_1}} \right] \right\} \quad (1)$$

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_{T_1} = Number of days between the current day and the expiration date of the near term options
- N_{T_2} = 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).

$$R_1 = \frac{N_y}{N_{T_1}} \left\{ T_{on} R_{on} \left[\frac{N_{1m} - N_{T_1}}{N_{1m} - N_{on}} \right] + T_{1m} R_{1m} \left[\frac{N_{T_1} - N_{on}}{N_{1m} - N_{on}} \right] \right\} \quad (3)$$

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

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_{T_1} = Number of days between the current day and the expiration date of the near-term options
- N_{T_2} = Number of days between the current day and the expiration date of the next-term options
- N_y = Number of days in one year

$$\begin{aligned}
T_{on} &= \frac{N_{on}}{N_y} \\
T_{1m} &= \frac{N_{1m}}{N_y} \\
T_{3m} &= \frac{N_{3m}}{N_y} \\
T_{6m} &= \frac{N_{6m}}{N_y}
\end{aligned}
\tag{4}$$

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:

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

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.

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.

For information on Quality Assurance and Internal Reviews of Methodology, please refer to S&P Dow Jones Indices' Equity Indices Policies & Practices document located on our Web site, www.spdji.com.

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.

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.

Unscheduled Exchange Closures

For information on Unexpected Exchange Closures, please refer to S&P Dow Jones Indices' Equity Indices Policies & Practices document located on our Web site, www.spdji.com.

Index Dissemination

Historical index returns are available through Standard & Poor's index data group for subscription via FTP.

Tickers

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

FTP

Index returns and data are available via FTP 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.

S&P Dow Jones Indices' Contact Information

Index Management

David M. Blitzer, Ph.D. – Managing Director & Chairman of the Index Committee
david.blitzer@spglobal.com +1.212.438.3907

Product Management

Joseph Kairen – Senior Director
joseph.kairen@spglobal.com +1.212.438.8213

Media Relations

Soogyung Jordan – Communications
soogyung.jordan@spglobal.com +1.212.438.2297

Client Services

index_services@spglobal.com

Disclaimer

Copyright © 2017 S&P Dow Jones Indices LLC, a division of S&P Global. All rights reserved. STANDARD & POOR'S, S&P, SPDR, S&P 500, S&P EUROPE 350, S&P 100, S&P 1000, S&P COMPOSITE 1500, S&P MIDCAP 400, S&P SMALLCAP 600, GIVI, GLOBAL TITANS, S&P RISK CONTROL INDICES, S&P GLOBAL THEMATIC INDICES, S&P TARGET DATE INDICES, S&P TARGET RISK INDICES, DIVIDEND ARISTOCRATS, STARS, GICS, HOUSINGVIEWS, INDEX ALERT, INDEXOLOGY, MARKET ATTRIBUTES, PRACTICE ESSENTIALS, S&P HEALTHCARE MONITOR, SPICE, and SPIVA are registered trademarks of Standard & Poor's Financial Services LLC, a division of S&P Global ("S&P"). DOW JONES, DJ, DJIA and DOW JONES INDUSTRIAL AVERAGE are registered trademarks of Dow Jones Trademark Holdings LLC ("Dow Jones"). These trademarks together with others have been licensed to S&P Dow Jones Indices LLC. Redistribution, reproduction and/or photocopying in whole or in part are prohibited without written permission. This document does not constitute an offer of services in jurisdictions where S&P Dow Jones Indices LLC, Dow Jones, S&P or their respective affiliates (collectively "S&P Dow Jones Indices") do not have the necessary licenses. All information provided by S&P Dow Jones Indices is impersonal and not tailored to the needs of any person, entity or group of persons. S&P Dow Jones Indices receives compensation in connection with licensing its indices to third parties. Past performance of an index is not a guarantee of future results.

It is not possible to invest directly in an index. Exposure to an asset class represented by an index is available through investable instruments based on that index. S&P Dow Jones Indices does not sponsor, endorse, sell, promote or manage any investment fund or other investment vehicle that is offered by third parties and that seeks to provide an investment return based on the performance of any index. S&P Dow Jones Indices makes no assurance that investment products based on the index will accurately track index performance or provide positive investment returns. S&P Dow Jones Indices LLC is not an investment advisor, and S&P Dow Jones Indices makes no representation regarding the advisability of investing in any such investment fund or other investment vehicle. A decision to invest in any such investment fund or other investment vehicle should not be made in reliance on any of the statements set forth in this document. Prospective investors are advised to make an investment in any such fund or other vehicle only after carefully considering the risks associated with investing in such funds, as detailed in an offering memorandum or similar document that is prepared by or on behalf of the issuer of the investment fund or other investment product or vehicle. S&P Dow Jones Indices LLC is not a tax advisor. A tax advisor should be consulted to evaluate the impact of any tax-exempt securities on portfolios and the tax consequences of making any particular investment decision. Inclusion of a security within an index is not a recommendation by S&P Dow Jones Indices to buy, sell, or hold such security, nor is it considered to be investment advice.

These materials have been prepared solely for informational purposes based upon information generally available to the public and from sources believed to be reliable. No content contained in these materials (including index data, ratings, credit-related analyses and data, research, valuations, model, software or other application or output therefrom) or any part thereof ("Content") may be modified, reverse-engineered, reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written permission of S&P Dow Jones Indices. The Content shall not be used for any unlawful or unauthorized purposes. S&P Dow Jones Indices and its third-party data providers and licensors (collectively "S&P Dow Jones Indices Parties") do not guarantee the accuracy, completeness, timeliness or availability of the Content. S&P Dow Jones Indices Parties are not responsible for any errors or omissions, regardless of the cause, for the results obtained from the use of the Content. THE CONTENT IS PROVIDED ON AN "AS IS" BASIS. S&P DOW JONES INDICES PARTIES DISCLAIM ANY AND ALL EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR USE, FREEDOM FROM BUGS, SOFTWARE ERRORS OR DEFECTS, THAT THE CONTENT'S FUNCTIONING WILL BE UNINTERRUPTED OR THAT THE CONTENT WILL OPERATE WITH ANY

SOFTWARE OR HARDWARE CONFIGURATION. In no event shall S&P Dow Jones Indices Parties be liable to any party for any direct, indirect, incidental, exemplary, compensatory, punitive, special or consequential damages, costs, expenses, legal fees, or losses (including, without limitation, lost income or lost profits and opportunity costs) in connection with any use of the Content even if advised of the possibility of such damages.

S&P Global keeps certain activities of its various divisions and business units separate from each other in order to preserve the independence and objectivity of their respective activities. As a result, certain divisions and business units of S&P Global may have information that is not available to other business units. S&P Global has established policies and procedures to maintain the confidentiality of certain non-public information received in connection with each analytical process.

In addition, S&P Dow Jones Indices provides a wide range of services to, or relating to, many organizations, including issuers of securities, investment advisers, broker-dealers, investment banks, other financial institutions and financial intermediaries, and accordingly may receive fees or other economic benefits from those organizations, including organizations whose securities or services they may recommend, rate, include in model portfolios, evaluate or otherwise address.

VIX is a trademark of Chicago Board Options Exchange, Incorporated and has been licensed for use by S&P Dow Jones Indices.