

**S&P Dow Jones
Indices**

A Division of **S&P Global**

S&P/BMV IPC VIX Index *Methodology*

August 2021

Table of Contents

Table of Contents	1
Introduction	2
Index Objective	2
Highlights	2
Supporting Documents	2
Collaboration	2
Index Construction	3
Approaches	3
Derive VIX from Near Term and Next Term Options	3
Calculating Time to Maturity	4
Interpolating Risk Free Rates	4
Forward Index Level	5
Option Selection Methodology	5
General Formula to Calculate Implied Volatilities	6
Rolling Between Option Contract Months	7
Currency of Calculation and Additional Index Return Series	7
Index Governance	8
Index Committee	8
Index Policy	9
Announcements	9
Holiday Schedule	9
Rebalancing	9
Unexpected Exchange Closures	9
Contact Information	9
Index Dissemination	10
Tickers	10
Index Data	10
Web site	10
Appendix	11
EU Required ESG Disclosures	11
Disclaimer	12

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. The S&P/BMV IPC VIX Index is maintained by S&P Dow Jones Indices in agreement with the Bolsa Mexicana de Valores (BMV).

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' Options Indices Policies & Practices Methodology	Options Indices Policies & Practices Methodology
S&P Dow Jones Indices' Index Mathematics Methodology	Index Mathematics Methodology

This methodology was created by S&P Dow Jones Indices in agreement with the Bolsa Mexicana de Valores (BMV) 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 and the BMV so that the index continues to achieve its objective.

Collaboration

The S&P/BMV IPC VIX Index is maintained by S&P Dow Jones Indices in agreement with the Bolsa Mexicana de Valores (BMV).

Pursuant to an Index Operation and License Agreement dated May 2015 (the "Agreement") between S&P Dow Jones Indices LLC ("S&P DJI") and Bolsa Mexicana de Valores, S.A.B. DE C.V. ("BMV"), as amended, S&P DJI and BMV have agreed to jointly publish and co-brand a family of indices (the "Indices"). The Indices will be co-branded with the S&P/BMV naming convention on June 5, 2017 in conjunction with S&P Dow Jones Indices' assumption of index calculation and maintenance. Prior to June 5, 2017, the Indices were calculated and maintained by BMV.

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 TIIE rate, TIIE 28-day rate, TIIE 91-day rate and TIIE 182-day rate are used to interpolate the risk free rates of each maturity. 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

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

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

(2)

$$N_T = N_1 + N_2 + N_3$$

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

where:

N_y = Number of days in one year

N_T = Number of days until option expiration

Calendar days are used in all the day count calculations.

Interpolating Risk Free Rates

The TIE rate (R_{on}), TIE 28-day rate (R_{1m}), TIE 91-day rate (R_{3m}) and TIE 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).

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

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

(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 TIE rate interpolation

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

N_{6m} = 182 days, as used in the 182-day TIE 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 TIE 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 TIE rates are used to interpolate the next-term risk free rate, R_2 .

Forward Index Level

For both near-term and next-term, the formula used to calculate the forward index level is:

$$F = K + e^{RT} * (C_K - P_K) \tag{5}$$

where:

F = Forward index level

K = The strike price at which the absolute difference between the mid-price of the call and the put options is the smallest

T = Time to expiration (see formula 2)

R = Risk-free interest rate to expiration (see formula 3)

C_K = Mid price of calls at strike K

P_K = Mid price of puts at strike K

Option Selection Methodology

To select the options in the volatility calculation for both near-term and next-term:

- Sort all the options in ascending order by strike prices.
- Determine at-the-money strike K_0 . It is the strike nearest to the forward index level F .
- Both put and call options at strike K_0 are selected.
- Out-of-the-money call options with strike prices higher than K_0 are selected.

Start with call option with strike price immediately higher than K_0 and move to successively higher strike prices (K). After encountering two consecutive calls with bid price of zero, no calls with higher strikes are considered.

Out-of-the-money put options with strike prices lower than K_0 are selected. Start with put option with strike price immediately lower than K_0 and move to successively lower strike prices (K). After encountering two consecutive puts with bid price of zero, no puts with lower strikes are considered.

Options which are not good quotes will be excluded. A good quote is a quote with a bid price and an ask price available:

where:

- $0 < \text{bid price} \leq \text{ask price}$ (for all options); and
- bid/ask price of selected call options \leq bid/ask price of the call option at K_0 ; and
- bid/ask price of selected put options \leq bid/ask price of the put option at K_0

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:

$$\sigma^2 = \frac{2}{T} \sum_i \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) - \frac{1}{T} \left[\frac{F}{K_0} - 1 \right]^2 \quad (6)$$

where:

- σ = Implied volatility
- T = Time to expiration (see formula 2)
- F = Forward index level (see formula 5)
- 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 (see formula 3)
- $Q(K_i)$ = 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:

$$\Delta K_i = \frac{K_{i+1} - K_{i-1}}{2} \quad (7)$$

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 of Calculation and Additional Index Return Series

In addition to the indices detailed in this methodology, additional return series versions of the indices may be available, including, but not limited to: currency, currency hedged, decrement, fair value, inverse, leveraged, and risk control versions. For a list of available indices, please refer to the [S&P DJI Methodology & Regulatory Status Database](#).

For information on the index calculation, please refer to S&P Dow Jones Indices' Index Mathematics Methodology.

For the inputs necessary to calculate certain types of indices, including decrement, dynamic hedged, fair value, and risk control indices, please refer to the Parameters documents available at www.spdji.com.

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 meets regularly. At each meeting, the Index Committee may review pending corporate actions that may affect index constituents, statistics comparing the composition of the indices to the market, companies that are being considered as candidates for addition to an index, and any significant market events. In addition, the Index Committee may revise index policy covering rules for selecting companies, treatment of dividends, share counts 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 and based on all publicly available information.

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' Options Indices Policies & Practices Methodology.

Index Policy

Announcements

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

Holiday Schedule

The index is calculated daily when BMV is open.

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' Options Indices Policies & Practices Methodology.

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 versions of the below indices that may exist are also covered by this document. Please refer to the [S&P DJI Methodology & Regulatory Status Database](#) for a complete list of indices covered by this document.

Index	Bloomberg	RIC
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.

Appendix

EU Required ESG Disclosures

EXPLANATION OF HOW ENVIRONMENTAL, SOCIAL & GOVERNANCE (ESG) FACTORS ARE REFLECTED IN THE KEY ELEMENTS OF THE BENCHMARK METHODOLOGY¹	
1.	Name of the benchmark administrator. S&P Dow Jones Indices LLC.
2.	Underlying asset class of the ESG benchmark.² N/A
3.	Name of the S&P Dow Jones Indices benchmark or family of benchmarks. S&P DJI Options Indices Benchmark Statement
4.	Do any of the indices maintained by this methodology take into account ESG factors? No
Appendix latest update: January 2021	
Appendix first publication: January 2021	

¹ The information contained in this Appendix is intended to meet the requirements of the European Union Commission Delegated Regulation (EU) 2020/1817 supplementing Regulation (EU) 2016/1011 of the European Parliament and of the Council as regards the minimum content of the explanation of how environmental, social and governance factors are reflected in the benchmark methodology.

² The 'underlying assets' are defined in European Union Commission Delegated Regulation (EU) 2020/1816 supplementing Regulation (EU) 2016/1011 of the European Parliament and of the Council as regards the explanation in the benchmark statement of how environmental, social and governance factors are reflected in each benchmark provided and published.

Disclaimer

© 2021 S&P Dow Jones Indices. All rights reserved. S&P, S&P 500, S&P 500 LOW VOLATILITY INDEX, S&P 100, S&P COMPOSITE 1500, S&P 400, S&P MIDCAP 400, S&P 600, S&P SMALLCAP 600, S&P GIVI, GLOBAL TITANS, DIVIDEND ARISTOCRATS, S&P TARGET DATE INDICES, S&P PRISM, S&P STRIDE, GICS, SPIVA, SPDR and INDEXOLOGY are registered trademarks of S&P Global, Inc. (“S&P Global”) or its affiliates. DOW JONES, DJ, DJIA, THE DOW 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 or reproduction in whole or in part are prohibited without written permission of S&P Dow Jones Indices LLC. This document does not constitute an offer of services in jurisdictions where S&P Dow Jones Indices LLC, S&P Global, Dow Jones or their respective affiliates (collectively “S&P Dow Jones Indices”) do not have the necessary licenses. Except for certain custom index calculation services, 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 and providing custom calculation services. Past performance of an index is not an indication or guarantee of future results.

It is not possible to invest directly in an index. Exposure to an asset class represented by an index may be 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.

BMV is a trademark of Bolsa Mexicana de Valores, S.A.B. de C.V. and has been licensed for use by S&P Dow Jones Indices.

Cboe[®] and VIX[®] are registered trademarks of Cboe Exchange, Inc. and have been licensed for use by S&P Dow Jones Indices.