

# S&P Dow Jones Indices

A Division of **S&P Global**

## **S&P/B3 Ibovespa VIX** *Methodology*

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# Introduction

## Index Objective and Highlights

The S&P Ibovespa VIX Indices measure the implied volatility of the Brazilian stock market over the next 30 days.

The index is a real-time index that reflects investor sentiment about the expected volatility in the Brazilian benchmark equity index, the Bovespa index (Ibovespa B3). The index reflects expected equity market volatility over the next 30 days by using mid prices for Ibovespa 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' Options Indices Policies & Practices Methodology	<a href="#">Options Indices Policies &amp; Practices Methodology</a>
S&P Dow Jones Indices' Index Mathematics Methodology	<a href="#">Index Mathematics Methodology</a>

This methodology was created by S&P Dow Jones Indices in agreement with B3 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.

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# Index Construction

Derive the index from the near-term and next-term options on Ibovespa. To minimize the pricing anomalies from the heavy trading on the expiring options during the last few trading days, options roll to the next term and third term when the near-term options have fewer than six business days to expire. The interest rates corresponding to the near-term and next-term options expiration dates are obtained directly from the B3 exchange. The index calculates and publishes from 10:30 AM to 4:45 PM Brazilian time (UTC-3) when U.S. daylight savings time is in effect and from 10:30 AM to 5:45 PM Brazilian time (UTC-3) when U.S. standard time is in effect.

B3 established a market maker program to ensure sufficient options series for index calculations.

For more information on market maker requirements, please see the B3 website [here](#).

## 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 30-day calendar period. However, when the near-term options have fewer than six business 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, use put and call options to calculate the implied volatility. The detailed calculation is described in the next section.

Interpolate the near-term volatility  $\sigma_1$  and the next-term volatility  $\sigma_2$  to arrive at a single value  $\sigma^2$  with a constant maturity of 30 days to expiration. Derive VIX by taking  $\sigma$  (the square root of  $\sigma^2$ ) and multiplying by 100.

$$VIX = \sigma \times 100$$
$$\sigma^2 = \frac{N_y}{N_m} \left\{ T_1 \sigma_1^2 \left[ \frac{N_{T_2} - N_m}{N_{T_2} - N_{T_1}} \right] + T_2 \sigma_2^2 \left[ \frac{N_m - N_{T_1}}{N_{T_2} - N_{T_1}} \right] \right\} \quad (1)$$

where:

$\sigma$  = 30-day implied volatility

$\sigma_1$  = Near-term volatility derived from the near-term options (see formula (3))

$\sigma_2$  = Next-term volatility derived from the near-term options (see formula (3))

$N_y$  = Number of days in one year, set to be 365 for the purpose of this calculation

$N_m$  = Number of days in one month, set to be 30 for the purpose of this calculation

$T_1$  = 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 time and the expiration time of the near-term options

$N_{T_2}$  = Number of days between the current time and the expiration time of the next-term options

## Calculate Time to Maturity

The time to maturity ( $T$ ) is measured in years and consists of three parts:

$N_1$  = Fractional number of days remaining from the current calculation time until midnight of the current day =  $\frac{\text{minutes remaining until midnight of the current day}}{24 \times 60}$

$N_2$  = Number of days between the current day and the expiration day

$N_3$  = Fractional number of days from midnight of the day prior to expiry to the settlement time on the expiry date (5:00 PM Brazilian time during U.S. daylight saving time, 6:00 PM Brazilian time during U.S. standard time) =  $\frac{\text{minutes from midnight to settlement time on expiry day}}{24 \times 60}$

$$T = \frac{N_T}{N_y} \quad (2)$$

where:

$N_T$  =  $N_1 + N_2 + N_3$  = Number of days until option expiration

$N_y$  = Number of days in one year

All day count calculations use calendar days.

### Risk-free Rates

Interest rates for the near-term  $R_1$  and next-term  $R_2$  are obtained from the B3 exchange.

### General Formula to Calculate Implied Volatilities

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

$$\sigma^2 = \frac{2}{T} \sum_i \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) - \frac{1}{T} \left[ \frac{F}{K_0} - 1 \right]^2 \quad (3)$$

where:

$\sigma$  = Implied volatility

$T$  = Time to expiration (see formula (2))

$F$  = Forward index level (see formula (4))

$K_i$  = Strike price of the  $i^{th}$  out-of-the-money option

$\Delta K_i$  = Interval between strike prices (see formula (5))

$K_0$  = Strike that is nearest to  $F$ . If there are two equidistant strikes, the lower of them is used.

$R$  = Risk-free interest rate to expiration, which is taken from the interest rate curve in Brazil, as determined by Central Bank Resolution 2399/97 and Circular 2771/97.

$Q(K_i)$  = Mid-price of each option with strike  $K_i$

Calculate the forward index level using the following formula:

$$F = K' + e^{RT} (C_{K'} - P_{K'}) \quad (4)$$

where:

$K'$  = The strike price at which the difference between the call and the put mid-prices is the smallest, also referred to as the at-the-money (ATM) strike. If there are multiple put-call pairs with the same minimum absolute difference, then select the lowest strike among them.

$C_{K'}$  = Mid price of the call at strike  $K'$

$P_{K'}$  = Mid price of the put at strike  $K'$

To select the options in the volatility calculation:

- Sort all the options in ascending order by strike prices.
- Exclude options that have invalid prices. A call (put) option price is considered valid only when the following conditions are satisfied:
  - $0 < bid \leq ask$
  - $bid \leq bid_{K_0}$  where  $bid_{K_0}$  is the bid price of the call (put) option at strike  $K_0$
  - $ask \leq ask_{K_0}$  where  $ask_{K_0}$  is the ask price of the call (put) option at strike  $K_0$
- Select call options that are out-of-the-money. Start with the call having strike  $K$  immediately greater than  $K_0$  and move to successively higher strike prices. After encountering two consecutive calls with a bid price of 0, no calls with higher strikes are considered.
- Select put options that are out-of-the-money. Start with the put having strike  $K$  immediately less than  $K_0$  and move to successively lower strike prices. After encountering two consecutive puts with a bid price of 0, no puts with lower strikes are considered.
- If strike  $K = K_0$ , use the average price of the put and the call.

Generally,  $\Delta K_i$  is half the distance between the strike on either side of  $K_i$  and calculates as

$$\Delta K_i = \frac{K_{i+1} - K_{i-1}}{2} \quad (5)$$

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

### Roll Between Option Contract Months

To calculate the index, when the near-term options have fewer than six business days to expire, the index rolls to the second and third contract months. The new option positions are effective as of the open on the fifth business day prior to nearest expiry. For example, the June 2023 expiration date is 06/14/2023, and 06/08/2023 is a holiday, so the roll is effective as of the open on 06/06/2023.

### Calculations and Pricing Disruptions

Note that the VIX cannot calculate in the following cases:

- Quotes of the  $K_0$  call option or the  $K_0$  put option are null, or  $bid_{K_0} > ask_{K_0}$ .
- All out-of-the-money call options have been excluded, or all out-of-the-money put options have been excluded.

The last valid VIX republishes until a new valid VIX value can be calculated and disseminated.

# Index Governance

## **Index Committee**

The S&P/B3 FIC Index Committee maintains the indices. All members of the Committee are full-time professionals at S&P Dow Jones Indices and the B3. Meetings are held regularly.

The Index Committee oversees the management of the indices, including determinations of intra-rebalancing changes, maintenance and inclusion policies, and other matters affecting the maintenance and calculation of the indices.

In fulfilling its responsibilities, the Index Committee has full and complete discretion to (i) amend, apply, or exempt the application of index rules and policies as circumstances may require and (ii) add, remove, or by-pass any bond in determining the composition of an index.

The Index Committee may rely on any information or documentation submitted to it or gathered by it that the Index Committee believes to be accurate. The Index Committee reserves the right to reinterpret publicly available information and to make changes to the indices based on a new interpretation of that information at its sole discretion. All Index Committee discussions are confidential.

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' Fixed Income Policies & Practices Methodology.*

# Index Policy

## **Announcements**

Announcements of the daily index values are made before the open of the next trading day.

## **Holiday Schedule**

The index calculates daily, throughout the calendar year. The index does not calculate on days when the B3 is officially closed.

A complete holiday schedule for the year is available on the S&P Dow Jones Indices' Web site at [www.spglobal.com/spdji/](http://www.spglobal.com/spdji/). For the B3 trading calendar, see [here](#). For B3 market trading hours, see [here](#).

## **Unexpected Exchange Closures**

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

*For information on Calculations and Pricing Disruptions, Expert Judgment, Data Hierarchy, Unexpected Exchange Closures and Error Corrections, please refer to S&P Dow Jones Indices' Commodities Indices Policies & Practices Methodology.*

## **Contact Information**

For questions regarding an index, please contact: [index\\_services@spglobal.com](mailto:index_services@spglobal.com).



# Index Dissemination

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

## 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	BBG	RIC
S&P/B3 Ibovespa VIX	VXBR	.VXBR

## Index Data

Daily index level data is available via subscription.

For product information, please contact S&P Dow Jones Indices, [www.spglobal.com/spdji/en/contact-us](http://www.spglobal.com/spdji/en/contact-us).

## Web site

For further information, please refer to S&P Dow Jones Indices' Web site at [www.spglobal.com/spdji/](http://www.spglobal.com/spdji/).

# Appendix

## ESG Disclosures

<b>EXPLANATION OF HOW ENVIRONMENTAL, SOCIAL &amp; GOVERNANCE (ESG) FACTORS ARE REFLECTED IN THE KEY ELEMENTS OF THE BENCHMARK METHODOLOGY<sup>1</sup></b>	
1.	<b>Name of the benchmark administrator.</b> S&P Dow Jones Indices LLC.
2.	<b>Underlying asset class of the ESG benchmark.<sup>2</sup></b> N/A
3.	<b>Name of the S&amp;P Dow Jones Indices benchmark or family of benchmarks.</b> <a href="#">S&amp;P DJI Options Indices Benchmark Statement</a>
4.	<b>Do any of the indices maintained by this methodology take into account ESG factors?</b> No
<b>Appendix latest update:</b> N/A	
<b>Appendix first publication:</b> November 2023	

<sup>1</sup> 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 and the retained EU law in the UK [The Benchmarks (amendment and Transitional Provision) (EU Exit) Regulations 2019].

<sup>2</sup> 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

## Performance Disclosure/Back-Tested Data

Where applicable, S&P Dow Jones Indices and its index-related affiliates (“S&P DJI”) defines various dates to assist our clients by providing transparency. The First Value Date is the first day for which there is a calculated value (either live or back-tested) for a given index. The Base Date is the date at which the index is set to a fixed value for calculation purposes. The Launch Date designates the date when the values of an index are first considered live: index values provided for any date or time period prior to the index’s Launch Date are considered back-tested. S&P DJI defines the Launch Date as the date by which the values of an index are known to have been released to the public, for example via the company’s public website or its data feed to external parties. For Dow Jones-branded indices introduced prior to May 31, 2013, the Launch Date (which prior to May 31, 2013, was termed “Date of introduction”) is set at a date upon which no further changes were permitted to be made to the index methodology, but that may have been prior to the Index’s public release date.

Please refer to the methodology for the Index for more details about the index, including the manner in which it is rebalanced, the timing of such rebalancing, criteria for additions and deletions, as well as all index calculations.

Information presented prior to an index’s launch date is hypothetical back-tested performance, not actual performance, and is based on the index methodology in effect on the launch date. However, when creating back-tested history for periods of market anomalies or other periods that do not reflect the general current market environment, index methodology rules may be relaxed to capture a large enough universe of securities to simulate the target market the index is designed to measure or strategy the index is designed to capture. For example, market capitalization and liquidity thresholds may be reduced. In addition, forks have not been factored into the back-test data with respect to the S&P Cryptocurrency Indices. For the S&P Cryptocurrency Top 5 & 10 Equal Weight Indices, the custody element of the methodology was not considered; the back-test history is based on the index constituents that meet the custody element as of the Launch Date. Also, the treatment of corporate actions in back-tested performance may differ from treatment for live indices due to limitations in replicating index management decisions. Back-tested performance reflects application of an index methodology and selection of index constituents with the benefit of hindsight and knowledge of factors that may have positively affected its performance, cannot account for all financial risk that may affect results and may be considered to reflect survivor/look ahead bias. Actual returns may differ significantly from, and be lower than, back-tested returns. Past performance is not an indication or guarantee of future results.

Typically, when S&P DJI creates back-tested index data, S&P DJI uses actual historical constituent-level data (e.g., historical price, market capitalization, and corporate action data) in its calculations. As ESG investing is still in early stages of development, certain datapoints used to calculate certain ESG indices may not be available for the entire desired period of back-tested history. The same data availability issue could be true for other indices as well. In cases when actual data is not available for all relevant historical periods, S&P DJI may employ a process of using “Backward Data Assumption” (or pulling back) of ESG data for the calculation of back-tested historical performance. “Backward Data Assumption” is a process that applies the earliest actual live data point available for an index constituent company to all prior historical instances in the index performance. For example, Backward Data Assumption inherently assumes that companies currently not involved in a specific business activity (also known as “product involvement”) were never involved historically and similarly also assumes that companies currently involved in a specific business activity were involved historically too. The Backward Data Assumption allows the hypothetical back-test to be extended over more historical years than would be feasible using only actual data. For more information on “Backward Data Assumption” please refer to the FAQ. The methodology and factsheets of any index that employs backward assumption in the back-tested history

will explicitly state so. The methodology will include an Appendix with a table setting forth the specific data points and relevant time period for which backward projected data was used. Index returns shown do not represent the results of actual trading of investable assets/securities. S&P DJI maintains the index and calculates the index levels and performance shown or discussed but does not manage any assets.

Index returns do not reflect payment of any sales charges or fees an investor may pay to purchase the securities underlying the Index or investment funds that are intended to track the performance of the Index. The imposition of these fees and charges would cause actual and back-tested performance of the securities/fund to be lower than the Index performance shown. As a simple example, if an index returned 10% on a US \$100,000 investment for a 12-month period (or US \$10,000) and an actual asset-based fee of 1.5% was imposed at the end of the period on the investment plus accrued interest (or US \$1,650), the net return would be 8.35% (or US \$8,350) for the year. Over a three-year period, an annual 1.5% fee taken at year end with an assumed 10% return per year would result in a cumulative gross return of 33.10%, a total fee of US \$5,375, and a cumulative net return of 27.2% (or US \$27,200).

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S&P DJI ESG indices use ESG metrics and scores in the selection and/or weighting of index constituents. ESG scores or ratings seek to measure or evaluate a company's, or an asset's, performance with respect to environmental, social and corporate governance issues.

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objectives. Furthermore, the legal and/or market position on what constitutes an 'ESG', 'sustainable', 'good governance', 'no adverse environmental, social and/or other impacts', or other equivalently labelled objectives may change over time, especially as further regulatory or industry rules and guidance are issued and the ESG sustainable finance framework becomes more sophisticated.

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