

S&P Dow Jones Indices

A Division of **S&P Global**

S&P/ASX 200 VIX *Methodology*

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Introduction

Index Objective and Highlights

The S&P/ASX 200 VIX seeks to measure the 30-day implied volatility in the Australian stock market.

The index is a real-time index that reflects investor sentiment about the expected volatility in the Australian benchmark equity index, the S&P/ASX 200. The index reflects expected equity market volatility over the next 30 days by using mid prices for S&P/ASX 200 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.

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Index Construction

Approaches

The index is derived from the near-term and next-term options on the S&P/ASX 200. 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 less than a week to expire. The overnight RBA rate, 1-month, 2-month and 3-month BBSW rates are used to interpolate the risk-free rates of each maturity. The index is calculated and published between 10:10 am and 4:15 pm local time.

Deriving 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 less than a week 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.

We interpolate the near-term volatility σ_1 and the next-term volatility σ_2 to arrive at a single value σ with a constant maturity of 30 days to expiration. VIX is derived by taking σ (the square root of σ^2) and multiplying by 100.

$$\begin{aligned}
 VIX &= \sigma * 100 \\
 \sigma^2 &= \frac{N_y}{N_m} \left\{ T_1 \sigma_1^2 \left[\frac{N_{T_2} - N_m}{N_{T_2} - N_{T_1}} \right] + T_2 \sigma_2^2 \left[\frac{N_m - N_{T_1}}{N_{T_2} - N_{T_1}} \right] \right\} \tag{1}
 \end{aligned}$$

where:

- σ = 30-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 one month
- 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

Calculating Time to Maturity

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

N_1 = Fractional number of days remaining from the current 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 (12:00 noon) on the expiry date

$$\begin{aligned}
 N_1 &= \frac{\text{minutes remaining until midnight of the current day}}{24 * 60} \\
 N_3 &= \frac{\text{minutes from midnight to settlement time on expiry}}{24 * 60} \\
 N_T &= N_1 + N_2 + N_3 \\
 T &= \frac{N_T}{N_y}
 \end{aligned} \tag{2}$$

where:

N_y = Number of days in one year

N_T = Number of days until option expiration

Calendar days are used in all day count calculations.

Interpolating Risk Free Rates

We use the RBA overnight rate (R_{on}), BBSW 1-month rate (R_{1m}), and BBSW 2-month rate (R_{2m}) to interpolate the risk free rates used in near term (R_1) and next term (R_2).

$$\begin{aligned}
 R_1 &= \frac{N_y}{N_{T_1}} \left\{ T_{on} R_{on} \left[\frac{N_{1m} - N_{T_1}}{N_{1m} - N_{on}} \right] + T_{1m} R_{1m} \left[\frac{N_{T_1} - N_{on}}{N_{1m} - N_{on}} \right] \right\} \\
 R_2 &= \frac{N_y}{N_{T_2}} \left\{ T_{1m} R_{1m} \left[\frac{N_{2m} - N_{T_2}}{N_{2m} - N_{1m}} \right] + T_{2m} R_{2m} \left[\frac{N_{T_2} - N_{1m}}{N_{2m} - N_{1m}} \right] \right\}
 \end{aligned} \tag{3}$$

where:

R_1 = Near-term risk-free rate

R_2 = Next-term risk-free rate

R_{on} = RBA overnight rate

R_{1m} = BBSW 1-month rate

R_{2m} = BBSW 2-month rate

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

N_{1m} = 30 days, as we are using a one-month BBSW rate in the interpolation

N_{2m} = 60 days, as we are using a two-month BBSW rate in the interpolation

N_{T_1} = Number of days between the calculation time on the current day and 12:00 noon on the expiration date of the near-term options

N_{T2} = Number of days between the calculation time on the current day and 12:00 noon on the expiration date of the next-term options

N_y = Number of days in one year

$$\begin{aligned} T_{on} &= \frac{N_{on}}{N_y} \\ T_{1m} &= \frac{N_{1m}}{N_y} \\ T_{2m} &= \frac{N_{2m}}{N_y} \end{aligned} \quad (4)$$

Note that the interpolation works when the near-term and next-term expirations are bracketed by the overnight - 1 month and 1 month - 2 month maturities of interest rates, respectively. When the option expirations fall outside of the corresponding interest rate expirations, which will most likely happen during the roll period, we need to pick the correct BBSW rates. For example, if the near-term expiration is between 1 and 2 months, we use the 1-month and 2-month BBSW rates to interpolate the near-term risk free rate R_1 ; if the next term expiration is between 2 and 3 months, we use the 2- and 3-month BBSW rates to interpolate the next-term risk-free rate R_2 .

General Formula to Calculate 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 (see formula 6)
- K_i = Strike price of the i^{th} out-of-the-money option
- ΔK_i = Interval between strike prices (see formula 7)
- K_0 = Strike that is nearest to F = At-the-money strike
- R = Risk-free interest rate to expiration (see formula 3)
- $Q(K_i)$ = Strike mid-price of each option with strike K_i

The at-the-money strike, K , is the strike price at which the difference between the call and the put prices is the smallest. The formula used to calculate the forward index level is:

$$F = K + e^{RT} * (C_K - P_K) \quad (6)$$

where:

- F = Forward index level
- K = The strike price at which the difference between the call and the put prices 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

To select the options in the volatility calculation,

- Sort all the options in ascending order by strike prices.
- Select call options that have strike prices greater than F and a non-zero bid price. Start with the call strike immediately greater than K_0 and move to successively higher strike prices (K). Compare the option price at K to the one immediately greater than K and already validated. The option price is only valid when it is less than or equal to the price for the last validated K . After encountering two consecutive puts with a bad price or zero, do not select any other calls.
- Select put options that have strike prices less than F and a non-zero bid price. Start with the put strike immediately less than K_0 and move to successively lower strike prices (K). Compare the option price at K to the one immediately greater than K and already validated. The option price is only valid when it is less than or equal to the price for the last validated K . After encountering two consecutive puts with a bad price or zero, do not select any other puts.
- If strike $K = K_0$, use the average price of the put and the call.

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 less than a week to expire, the index rolls to the second and third contract months. When the options expire on a Thursday, the index usually rolls on the prior Friday if the Australian Securities Exchange is open. If Friday is a holiday, the index rolls on the next business day when the Australian Securities Exchange is open.

Start Date

The index start date is January 2, 2008.

Index Governance

Index Committee

Each of S&P Dow Jones Indices' global indices is the responsibility of an Index Committee that monitors overall policy guidelines and methodologies, as well as additions to and deletions from these indices. S&P Dow Jones Indices chairs the S&P/ASX Index Committee, which is comprised of five voting members representing both S&P Dow Jones Indices and the Australian Securities Exchange.

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' Commodities Indices 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 is calculated daily, throughout the calendar year. The only days the index is not calculated is on days when the ASX 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/.

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.

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	RIC	BBG
S&P/ASX 200 VIX	.AXVI	AS51VIX

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.

Web site

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

Appendix I

Methodology Changes

Methodology changes since January 1, 2015 are as follows:

Change	Effective Date (After Close)	Methodology	
		Previous	Updated
Definition of the at-the-money strike, K_0	01-Dec-17	K_0 is set equal to F, the forward index level.	K_0 is defined as the strike that is nearest to F, the forward index level.
Options selected in the volatility calculation.	01-Dec-17	If strike $K < K_0$, use put prices; if strike $K \geq K_0$, use call prices.	If strike $K < K_0$, use put prices; if strike $K > K_0$, use call prices; if strike $K = K_0$, use the average price of the put and the call.
		After encountering two consecutive puts with a bid price of zero, do not select any other puts; after encountering two consecutive calls with a bid price of zero, do not select any other calls.	Start with the put strike immediately less than K_0 and move to successively lower strike prices (K). Compare the option price at K to the one immediately greater than K and already validated. The option price is only valid when it is less than or equal to the price for the last validated K. After encountering two consecutive puts with a bad price or zero, do not select any other puts.
			Start with the call strike immediately greater than K_0 and move to successively higher strike prices (K). Compare the option price at K to the one immediately greater than K and already validated. The option price is only valid when it is less than or equal to the price for the last validated K. After encountering two consecutive puts with a bad price or zero, do not select any other calls.

Appendix II

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: February 2021	
Appendix first publication: February 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 and the retained EU law in the UK [The Benchmarks (amendment and Transitional Provision) (EU Exit) Regulations 2019].

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

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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