

**S&P Dow Jones
Indices**

A Division of **S&P Global**

**S&P Dow Jones Indices' Options
Indices Policies & Practices**
Methodology

November 2019

Table of Contents

Introduction	2
Overview	2
Index Policy	3
Announcements	3
Calculations and Pricing Disruptions	3
Real-time Pricing Disruptions	3
Negative/Zero Index Values	4
Data Discrepancy Validations	5
Time Value Price Adjustments	6
Error Correction	7
Error Correction Policy for S&P Dow Jones Indices' Option Indices	7
Types of Errors	7
Unexpected Exchange Closures	8
Full Day Exchange Closure	8
Partial Day or Early Exchange Closure	8
Rebalancing	8
Pricing Types	9
Unavailable Pricing	9
Theoretical Options Calculation	9
Index Governance	10
Index Committee	10
Quality Assurance	10
Internal Reviews of Methodology	10
Expert Judgment	11
Discretion	11
Appendix I: The Black-Scholes Formula	12
Appendix II: The Black Model	14
Disclaimer	16

Introduction

Overview

This document covers constituent and index actions, per S&P Dow Jones Indices' Options Indices policies and practices. To understand and successfully use indices for investment analysis, it is important to know how adjustments are made, when different kinds of index actions occur, and S&P Dow Jones Indices' treatment of these events. The goal is to provide consistent and transparent global treatment of index actions, to the greatest extent possible. However, please note that local market and sector practices may dominate major decisions. Thus, S&P Dow Jones Indices (S&P DJI) has general approaches applicable to the majority of options indices but it is imperative to review each specific index methodology, as certain indices may differ from the general approaches.

S&P DJI uses a variety of processes for dealing with the pricing and events of option indices. This document aims to provide a general outline of key factors that influence index performance and production process.

This document does not aim to be a substitute for the various policies and procedures outlined in each respective index's methodology. Please refer to each index's methodology for further policies and procedures applicable to each particular index.

Index Policy

Announcements

S&P DJI notifies clients either via email or, in certain instances, via Index Announcements, which are also posted on our Web site, www.spdji.com.

Announcement Type	Notification	Frequency
Policy or methodology change	At least two weeks' notice	As needed
Product Enhancements	Five-to-seven business days	As needed
Rebalancing and Index Holiday Calendars	December for the following year	Annual

Calculations and Pricing Disruptions

Depending on the index methodology, S&P DJI leverages prices provided by external providers for end-of-day index calculations. In situations where this data, based on expert judgement, is incomplete or incorrect, S&P DJI will correct or amend this data. **Please refer to the Error Correction Policy section of this document.**

For information on indices that include commodities or futures contracts, or for the treatment of commodity pricing disruptions, please refer to S&P Dow Jones Indices' Commodities Indices Policies & Practices Methodology available at www.spdji.com.

In extreme circumstances, S&P DJI may decide to delay index adjustments or not publish an index.

Real-time Pricing Disruptions

For certain indices, S&P Dow Jones Indices calculates intraday index calculations using real-time exchange traded prices. S&P Dow Jones Indices does not calculate with each traded price, but rather, calculates on a pre-determined fixed interval (e.g. every 5 seconds). At each fixed interval, the index is computed with the latest real-time pricing for each underlying security included in the index. If a new price is not available since the last real-time calculation, the calculation will leverage the last available traded price provided by the exchange. In the absence of a real-time traded price for a given security, the calculation will leverage the prior days' closing price adjusted for corporate actions.

S&P DJI also maintains price thresholds for real-time securities and indices to prevent unusually large price movements or incorrect price adjustments to adversely impact index calculations.

- **Security Level:** In the event a security price breaches a threshold, the system will generate alerts and temporarily hold the last price prior to the breach. For index calculations, a held security will continue to be included in the calculation but the calculation will use the last accepted price prior to the breach. Once the held price is confirmed or falls back within the acceptable tolerance, the latest real-time price for this security will be used for index calculations.
- **Index Level:** In the event an index calculation breaches a threshold, the system will generate alerts and temporarily hold the last index value prior to the breach. While the index is held, the last held index value will be distributed as defined by the set dissemination frequency. Once the held index value is confirmed or falls back within the acceptable tolerance, index calculations will resume with the latest market data.

S&P Dow Jones Indices seeks to minimize any disruptions to its index calculations. In the event there is a disruption in intraday calculations, S&P Dow Jones Indices will not recalculate the impacted period.

Negative/Zero Index Values

A negative, or zero, index level is possible for some indices. In the event that this situation occurs, S&P Dow Jones Indices will publish an official close index value of zero on the impacted trading day. At the discretion of the Index Committee and with sufficient notice to clients, the index will either be discontinued or the index level will be rebased to a new level.

Data Discrepancy Validations

In some indices, depending on the index methodology, third party data will be used to price and publish index values. This includes options data, as well as other index components such as other indices, futures contracts, currencies, or stock data.

S&P DJI has a robust data validation process to ensure the quality of underlying data, as well as the precision of index values.

Time Value Price Adjustments

Due to differences in the time of the closing prices of underlying securities and contracts, across different asset classes, as compared to vendor data capture times, occasional mismatches can occur in options data. These are most easily visible in options where recorded prices are lower than their intrinsic value. An option's intrinsic value is determined as follows:

For Index or Single Stock Options:

For Calls:

$$\text{Intrinsic Value} = (\text{Underlying closing level or price} * e^{(r-q)*t} - \text{Strike Price})$$

For Puts:

$$\text{Intrinsic Value} = \text{Strike Price} - (\text{Underlying closing level or price} * e^{(r-q)*t})$$

For Options on Futures:

For Calls:

$$\text{Intrinsic Value} = \text{Maturity matched futures price} - \text{Strike Price}$$

For Puts:

$$\text{Intrinsic Value} = \text{Strike Price} - \text{Maturity matched futures price}$$

where:

q = Annual dividend yield of underlying

r = annual interest rate, continuously compounded

t = days to expiry/365

e = the base of the natural log

For any option with a negative time value, S&P DJI makes the following adjustment:

The option's price is adjusted to its intrinsic value, with an additional \$.05 added to the price to account for time value. In the case of options expiring on that day, the price will be equal to intrinsic value.

Error Correction

Error Correction Policy for S&P Dow Jones Indices' Option Indices

This section addresses our reposting guidelines due to late announcements or other errors.

Types of Errors

1. Closing input prices are amended
2. Missed index methodology event (deviation from what is stated in the methodology document)

Type of Error	Treatment in S&P Dow Jones Indices' Option Indices
Amended Input Price	Amended input prices due to vendor errors, if this resulted in material differences in index value based on expert judgement, are corrected. Indices are recalculated and files are reposted.
Deviation from Treatment Stated in the Index Methodology	Errors identified prior to the next day open are corrected and the indices are reposted. Other errors are reviewed by the Index Committee, which is responsible for determining what actions should be taken.

- Errors due to an S&P DJI mistake (data entry, methodology misapplication, etc.) are reviewed by the Index Committee. The Index Committee then determines whether an index or indices impacted by such an error/s should be recalculated and reposted.
- Clients are notified of files being reposted.
- Clients are informed when the Index Committee decides not to recalculate or restate an index.

Unexpected Exchange Closures

Full Day Exchange Closure

If an exchange fails to open due to unforeseen circumstances, such as natural disasters, inclement weather, outages, or other events, the index uses the prior day's closing prices for calculation purposes.

Partial Day or Early Exchange Closure

In situations where an exchange is forced to close early due to unforeseen events, such as computer or electric power failures, weather conditions, or other events, S&P DJI calculates the closing price of the indices based on (1) the end of day prices provided, or (2) if no end of days prices are available, the Index Committee determines the course of action and notifies clients accordingly.

Rebalancing

If the rebalancing of an index takes place over a period of time, and during this period an exchange is fully or partially closed on one or more days, and S&P DJI cannot obtain official end of day prices, the Index Committee will review the situation on a case-by-case basis with the appropriate treatment announced to clients.

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.

Pricing Types

S&P Dow Jones options indices will make use of different pricing types based on index methodology. Some of these pricing types include, but are not limited to:

1. End of day (EOD) prices from vendors
2. EOD prices collected at a predetermined time by S&P Dow Jones Indices from vendors
3. Volume Weighted Average Price (VWAP) calculated from vendors
4. Time Weighted Average Price (TWAP), calculated from vendors
5. Theoretical Pricing

For more information on VWAP and TWAP pricing, see refer to S&P Dow Jones Indices' Index Mathematics Methodology available on our Web site, www.spdji.com.

Unavailable Pricing

In the case that an index uses VWAP or TWAP pricing, and the particular price was unable to be captured during that index day (such as VWAP pricing with no recorded trades), the EOD price, depending on index strategy, is used for index calculation.

The order of used price is as follows:

1. EOD Snap Prices, if available
2. EOD Vendor Prices

In the case that the EOD Snap price is unavailable, the EOD vendor prices will be use.

Theoretical Options Calculation

Some S&P DJI indices involve the use of theoretical options. Such options calculated using a formulaic approach rather than an observable, market-based price. Any index utilizing theoretical options will detail the use of these options, and the process for calculating these theoretical values in the relevant index methodology.

S&P DJI maintains a quality control process to insure that the process for calculating a theoretical option's value remains accurate and in -accordance with the index methodology.

Index Governance

Index Committee

Indices are maintained by an Index Committee. Most committees are comprised of full-time professional members of S&P Dow Jones Indices' staff, with the exception of some co-branded indices, which may include committee members from external companies or exchanges. Please refer to individual index methodology documents for information on index committees with external index committee members. 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.

Questions of interpretation or possible exceptions to rules are considered by the Index Committee responsible for the indices in question.

S&P DJI considers information about changes to its indices and related matters to be potentially market moving and material. Therefore, all Index Committee discussions are confidential.

S&P DJI's Index Committees reserve the right to make exceptions in the treatment if the need arises. In any scenario where the treatment differs from the general rules stated in this document, clients will receive sufficient notice, whenever possible.

Quality Assurance

S&P DJI maintains quality assurance processes and procedures for the calculation and maintenance of its indices that include a regularly scheduled meeting to review incidents or errors, if any, that occurred during the previous week and identify causes, determine repetitive issues and evaluate whether any long-term changes are necessary (e.g. a change in process). Incidents and errors are tracked through S&P DJI's internal system and significant matters are escalated, requiring, at times, an ad hoc meeting of the same group.

Internal Reviews of Methodology

Annual Review Process. In addition to its daily governance of indices and maintenance of index methodologies, at least once within any 12-month period, the Index Committee reviews each index methodology to ensure the indices continue to achieve the stated objectives, and that the data and methodology remain effective. The annual review process includes the gathering of information on the appropriateness, representativeness, and effectiveness of the index methodology from colleagues responsible for commercializing the indices. In the case that an index methodology is reviewed off cycle from the annual review, the Index Committee reserves the right to cancel the annual review if the requested review covers all the relevant issues.

Communication with Stakeholders and Consultations. S&P DJI communicates and consults with stakeholders through various channels using press releases, index announcements, emails and the distribution of data files. In addition, S&P DJI has a designated client service team available to respond to inquiries.

When a material change to an index methodology is considered, S&P DJI publishes a consultation inviting comments from external parties. A material change alters the index objective or changes the methodology in a way that affects the likelihood that the index will achieve its objective. Examples of

methodology changes that could impact the index objective include altering rules determining the index universe, the selection of its constituents, or the weighting of its constituents. Consultations are posted on the Web site at www.spdji.com, and feedback is accepted only during the posted timeframe. Under normal circumstances, the consultation period is open for a minimum of 30 days from publication. In instances where a material change is deemed to be time sensitive, S&P DJI may determine that a shorter consultation period is required. Time sensitive changes are those that may require consideration or implementation within a shorter timeframe, and where the full consultation time period is not possible. Prior to the Index Committee's final review, S&P DJI will consider the issues and may request clarifications from respondents as part of that review. All feedback from consultations is reviewed and considered before a final decision is made by the Index Committee. Any changes to an index methodology resulting from a consultation are announced on our web site.

Substantive changes to methodology documents not resulting from consultations will also be announced. S&P DJI will generally not issue an announcement for minor edits to methodology documents that it deems not substantive, such as clarifications and format edits that are not related to any kind of methodological change.

Occasionally, S&P DJI may hold client meetings, conference calls, or Advisory Panels.

Complaints Procedure. For any inquiry, comment, or complaint regarding the indices governed by this methodology, a Client Services Form can be found at <http://us.spindices.com/feedback/client-services>.

Expert Judgment

S&P Dow Jones Indices' Index Committees may exercise Expert Judgment when the situation calls for the interpretation of data in calculating and maintaining an S&P DJI Index. S&P DJI maintains internal records of the use of Expert Judgment and the rationale for any such use. Expert Judgment specifically and exclusively refers to S&P DJI's exercise of discretion with respect to its use of data in determining an index in the following context: Expert Judgment includes extrapolating data from prior or related transactions, adjusting data for factors that might influence the quality of data such as market events or impairment of a buyer or seller's credit quality, or weighing firm bids or offers greater than a particular concluded transaction. Other areas of discretion, such as methodology changes, are not, for the purposes of this document, considered Expert Judgment.

Discretion

S&P Dow Jones Indices' Index Committees may apply discretion to make decisions that differ from the index methodology in certain circumstances, including to avoid unnecessary turnover, excessive index changes or adjustments, or possible market disruption.

Appendix I: The Black-Scholes Formula

The choice of which model to be used will be specified in index methodology.

Black Scholes Formula:

For Calls:

$$C = S * N(D_1)e^{-qt} - K e^{-rt}N(D_2)$$

For Puts:

$$P = K e^{-rt}N(-D_2) - (S * N(-D_1)e^{-qt})$$

where:

C = Price of Call Option

P = Price of Put option

S = Spot price of underlying asset

K = Option Strike Price

q = Continuously Compounded Annual Dividend Yield of underlying asset

r = continuously compounded annual interest rate

t = calendar days to expiry/365

σ = Annual volatility in percent

e = Base of the natural log

ln = Natural Log

N = Cumulative Normal Distribution Function

N' = Normal Density Function:

$$\frac{1}{\sqrt{2\pi}} * e^{-\frac{d1^2}{2}}$$

$$D1 = \frac{\ln\left(\frac{S}{K}\right) + t(r - q + \frac{\sigma^2}{2})}{\sigma\sqrt{t}}$$

$$D2 = d1 - \sigma\sqrt{t}$$

Delta: Measuring the sensitivity of the option to movements in the price of the underlying asset:

$$\Delta_{call(t)} = e^{-qT} * N(D_1)$$

$$\Delta_{put(t)} = e^{-qT} * (N(D_1) - 1)$$

Vega: Measuring the sensitivity of the options to changes in volatility:

$$v_{(t)} = \frac{1}{100} S e^{-qt} * N'(D_1) * \sqrt{t}$$

Gamma: Measuring how Delta changes as price changes:

$$\gamma_{(t)} = \frac{e^{-qt} N'(D_1)}{S * \sigma * \sqrt{t}}$$

Theta: Measuring how price changes as time changes:

For Calls:

$$\theta = \frac{1}{365} \left(-\frac{S\sigma e^{-qt}}{2\sqrt{t}} * N'(D_1) \right) - rXe^{-rt}N(d_2) + qSe^{-qt}N(D_1)$$

For Puts:

$$\theta = \frac{1}{365} \left(-\frac{S\sigma e^{-qt}}{2\sqrt{t}} * N'(D_1) \right) + rXe^{-rt}N(-d_2) - qSe^{-qt}N(-D_1)$$

Rho: Measuring how price changes as interest rates change:

For Calls:

$$\rho = Xte^{-rt} * N(D_2)$$

For Puts:

$$\rho = -Xte^{-rt} * N(-D_2)$$

Implied Volatility: Implied volatility is the volatility input that when provided, will produce the current market value of the option using the Black-Scholes formula. This value, when needed for S&P DJI's indices, is found by using a mathematical process to test a range of volatility inputs, until the value that yields the option price closest to market value is found.

Appendix II: The Black Model

The choice of which model to be used will be specified in index methodology.

Black Formula:

For Calls:

$$C = e^{-rt}(FN(D_1) - XN(D_2))$$

For Puts:

$$P = e^{-rt}(XN(-D_2) - FN(-D_1))$$

Where:

F = Current Forward Price

X = Strike Price of the options

r = Continuously Compounded Interest Rate

t = Time in years until the expiry of the options

σ = Implied Volatility of the underlying forward price

e = Base of the natural log

ln = Natural Log

N = Cumulative Normal Distribution Function

N' = Normal Density Function:

$$\frac{1}{\sqrt{2\pi}} * e^{-\frac{d1^2}{2}}$$

$$D1 = \frac{\ln\left(\frac{F}{X}\right) + \left(\frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}$$

$$D2 = d1 - \sigma\sqrt{t}$$

Delta: Measuring the sensitivity of the option to movements in the price of the underlying asset:

$$\Delta_{call(t)} = e^{-rT} * N(d_1)$$

$$\Delta_{put(t)} = e^{-rT} * (N(d_1) - 1)$$

Vega: Measuring the sensitivity of the option to changes in volatility:

$$V_{(t)} = \frac{1}{100} F e^{-rt} N'(D_1) \sqrt{t}$$

Gamma: Measuring how Delta changes as price changes:

$$\gamma_{(t)} = e^{-rt} \frac{N'(D_1)}{F\sigma\sqrt{t}}$$

Theta: Measuring how price changes as time changes:

$$\theta_{call(t)} = \frac{1}{365} \left(-\frac{Fe^{-rt}N'(D_1)\sigma}{2\sqrt{t}} + rFe^{-rt}N(D_1) - rXe^{-rt}N(D_2) \right)$$

$$\theta_{put(t)} = \frac{1}{365} \left(-\frac{Fe^{-rt}N'(D_1)\sigma}{2\sqrt{t}} - rFe^{-rt}N(-D_1) + rXe^{-rt}N(-D_2) \right)$$

Rho: Measuring how price changes as interest rates changes:

$$\rho_{call(t)} = -tc$$

$$\rho_{put(t)} = -tp$$

Implied Volatility: Implied volatility is the volatility input that when provided, will produce the current market value of the option using the Black formula. This value, when needed for S&P DJI's indices, is found by using a mathematical process to test a range of volatility inputs, until the value that yields the option price closest to market value is found.

Disclaimer

Copyright © 2019 S&P Dow Jones Indices LLC. All rights reserved. STANDARD & POOR'S, S&P, S&P 500, S&P 500 LOW VOLATILITY INDEX, S&P 100, S&P COMPOSITE 1500, S&P MIDCAP 400, S&P SMALLCAP 600, S&P GIVI, GLOBAL TITANS, DIVIDEND ARISTOCRATS, S&P TARGET DATE INDICES, GICS, SPIVA, SPDR and INDEXOLOGY are registered trademarks of Standard & Poor's Financial Services LLC ("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 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, 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.