S&P Dow Jones Indices
Indices

A Division of S&P Global

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

January 2021

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Introduction

Overview

This document covers constituent and index actions, used in the management of S&P Dow Jones options indices. 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 most options indices but it is imperative to review each specific index methodology, as certain indices may differ from the general approaches.

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 utilizes 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 Index Levels

Zero and Negative Index Levels

A negative index level is possible for certain types of indices including hedged, long/short, inverse and leveraged indices, particularly for inverse indices that apply leverage.

- In the event an intraday index calculation results in a zero or negative value, S&P DJI will publish the zero or negative value as calculated.

- In the event an end-of-day index calculation results in a zero value or negative value, S&P DJI will publish an official closing index value of zero on that day. Index levels will only be assessed after the close of trading for purposes of this determination and will not take into consideration intraday levels for those indices calculated in real-time.

Any index assigned an official closing level of zero will be reviewed by the Index Committee to determine if the index will be discontinued or if the index will be restarted with a new base value. In the event the index is restarted, S&P DJI will announce such action and will treat these indices as two separate time series. Until the Index Committee has made this determination, the intraday and end-of-day index level will continue to be published with a value of zero.

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 observable most easily visible in options when re-recorded options prices are lower than their intrinsic value. An option's intrinsic value is determined as follows:

For Index or Single Stock Options:

> For Calls:
>
>> Intrinsic Value = (Underlying closing level or price * $e^{(r-q)*t}$ - Strike Price)
>
> For Puts:
>
>> Intrinsic Value = Strike Price - (Underlying closing level or price * $e^{(r-q)*t}$)

For Options on Futures:

> For Calls:
>
>> Intrinsic Value = Maturity matched futures price – Strike Price
>
> For Puts:
>
>> Intrinsic Value = Strike Price – 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.

Recalculation Policy

Recalculation 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	If amended input prices due to vendor errors or exchange updates are discovered within two trading days of its occurrence, the Index Manager may, at their discretion, recalculate the index without involving the Index Committee. In the event any such recalculation event is discovered beyond such two-trading day period, the applicable Index Committee shall decide whether the index should be recalculated.
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.
Implementation Errors	In that case that differences occur between announced rebalances and implemented rebalances are discovered, the index committee will meet to determine whether these are corrected.
Errors due to S&P DJI data entry errors, methodology misapplication, etc.	These errors 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 index recalculations and files being reposted.

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 (Snap Price)

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.

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 such options, and the methodology for calculating such theoretical values in the relevant index methodology.

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

Index Terminations

S&P DJI may determine that an index should be discontinued. Reasons for an index termination could include:

- An index duplicates another S&P DJI index

- Data required for an index is no longer available or no longer reliable

- Market conditions, regulations, or potential index constituents have changed, rendering the index unlikely to achieve its stated objective

- Declining investor use or interest

All proposals to discontinue an index are assessed to determine any potential impact on the market. S&P DJI may, at its discretion, consult with market participants regarding an index termination.

If the data on a discontinued index is provided to clients at the time of termination, S&P DJI may suggest possible appropriate alternative S&P DJI indices. Index terminations will be announced in advance, and vendors will be notified. Index levels and related data on a discontinued index are retained by S&P DJI. If financial product issuers or investment managers choose to use an S&P DJI index, regardless of index family, as the basis of an index-linked financial product or an investment fund, they should consider the potential need to terminate or modify the terms of a financial product resulting from the termination of the calculation of the index.

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, except for 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:

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

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

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

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:

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

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:

$$\theta = \frac{1}{365} \left(-\frac{S\sigma e^{-qt}}{2\sqrt{t}} * N'(D_1) \right) - rXe^{-rt}N(d2) + qSe^{-qt}N(D_1)$$

For Puts:

$$\theta = \frac{1}{365} \left(-\frac{S\sigma e^{-qt}}{2\sqrt{t}} * N'(D_1) \right) + rXe^{-rt}N(-d2) - qSe^{-qt}N(-D_1)$$

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:

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

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.

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