

Cboe S&P 500 Dispersion Index *Methodology*

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Introduction

Index Objective

The Cboe S&P 500 Dispersion Index, also called the Dispersion Index or DSPXSM, measures the expected dispersion in the S&P 500[®] over the next 30 calendar days, as derived from the prices of options on the S&P 500 and selected S&P 500 constituents using a modified VIX[®] methodology.

Data Source

Equity options data are sourced from the Options Price Reporting Authority (OPRA). The level of VIX is sourced from Cboe, Exchange, Inc. (“Cboe”).

Collaboration

The Cboe S&P 500 Dispersion Index is generated and published under agreements between Cboe and S&P Dow Jones Indices. Eligible constituents are selected, and index level is calculated by Cboe according to the rules in this methodology. S&P Dow Jones Indices thanks Cboe for its contributions to the development and the calculation of the Cboe S&P 500 Dispersion Index.

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

This methodology was created by S&P Dow Jones Indices and Cboe 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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Eligibility Criteria

The Cboe S&P 500 Dispersion Basket Index

The Cboe S&P 500 Dispersion Basket Index, also called the Dispersion Basket Index or DSPBX, measures the performance of a subset of S&P 500 (the Underlying Index) constituents that have a wide range of quoted call and put options with expiry dates between 10 and 120 calendar days. The index provides a representative universe of large-cap U.S. equities conducive to the calculation of the 30-day implied dispersion of the S&P 500.

For more details, see the Cboe S&P 500 Dispersion Basket Index Methodology, available [here](#).

Index Universe

The index universe consists of listed options on the S&P 500 (in particular, those used to calculate the VIX index levels) and listed options on all constituents of the Basket Index, subject to further eligibility criteria as described in the following sections and adjusted for any composition changes due to the current rebalancing.

Multiple Share Classes and Dual Listed Companies

Options on all publicly listed multiple share class lines are eligible for index inclusion, subject to meeting the eligibility criteria. For more information regarding the treatment of multiple share classes, please refer to Approach A within the Multiple Share Classes section of the S&P Dow Jones Indices' Equity Indices Policies & Practices Methodology.

Index Construction

Outline of the Dispersion Index Methodology

The Dispersion Index calculates as the square root of the difference between (i) the weighted average expected variance of constituents of the Basket Index – ranging among all such constituents whose expected variance can be calculated at that point in time – and (ii) the expected variance of the S&P 500, as represented by the square of the current level of the Cboe Volatility Index (“VIX”). The Dispersion Index is floored at zero.

The index calculates according to the following formula:

$$DSPX = 100 * \sqrt{\max\left(\sum_{i=1}^L w_i \hat{\sigma}_{i,30}^2 - VIX^2, 0\right)}$$

where, among other conditions detailed in the subsequent sections:

$\hat{\sigma}_{i,30}^2$ = A current or recent estimate of 30-day variance for each constituent i of the Basket Index, based on a version of the VIX methodology, provided such a variance calculation is available (see *Valid Variance Condition* and *Pulled-Forward Variance* sections).

w_i = The FMC weight of each constituent as a proportion of the total weight of constituents from the Basket Index included in the calculation at that point in time.

VIX = The Cboe Volatility Index (VIX) index value.

Further conditions and details of the calculation are provided below and are integrated into the *Calculating the Dispersion Index* section.

Terminology: Options, Classes, Strips, Valid Quotes and Valid Option Strips

Only standard monthly, standard quarterly, and Friday weekly call and put options linked to members of the Basket Index that are listed on U.S. exchanges are eligible for consideration.

For any member of the index universe on any trading day, the “option class” associated to that constituent is the set of all options sharing that underlying.

Within a specific option class, an “option strip” refers to all the options in that class sharing a particular expiry date.

Within a specific option strip, a “valid quote” is defined as a two-sided quote in which the ask price is non-zero and is greater than or equal to the bid price.

At any point in time, a strip of options is said to be a “valid strip” if there is at least one strike in that strip for which there is a valid quote for both the put and call.

Note: These definitions may be compared with the definition of a “valid option” as described in the *Valid Options for the Valid Variance Condition* section.

Selection of Option Expiration Dates

At each point in time and for each constituent of the Basket Index, if possible, two valid option strips with standard third Friday expiration are selected as the “Near Term” and “Next Term” maturities, respectively. The Near Term expiration must have 10 or more days to expiry and 30 or fewer days to expiry, and the Next Term expiration must have more than 30 days to expiry and 120 or fewer days to expiry. If there are no standard expirations satisfying these conditions, the closest eligible weekly Friday expiration to 30 days that satisfies the condition is used. Finally, if there are no possible Near Term or no possible Next Term expirations including weeklies that satisfy the condition, the constituent is dropped from the calculation.

The Implied Forward

For any valid option strip, an implied forward for the underlying stock calculates using put-call parity on the strike where the absolute difference between the call and put mid-price is minimized, provided that option has a valid quote. If there are multiple strikes with the same difference between the call and put mid-price, the lowest strike is selected. The implied forward for an option strip j is equal to:

$$F_j = K_j + e^{rT} * (C_j - P_j)$$

where:

F_j = The implied forward

K_j = The strike price at which the absolute difference between the call and put option mid-price is minimized

C_j = The call midprice at strike K_j

P_j = The put midprice at strike K_j

r = The same interest rate associated to the time horizon T used in the VIX calculation¹

T = The annualized time to expiry given by:

$$T = \frac{\text{Minutes in Current Day} + \text{Minutes in Settlement Day} + \text{Minutes in Other Days}}{\text{Minutes in a Year}}$$

ATM Options and OTM Options

For each valid option strip, the ATM (at-the-money) call option and ATM put option, and the associated strike K_{zero} , are identified by taking the strike at or directly below the implied forward.

OTM (out-of-the-money) options for that strip are identified by selecting all calls with strikes greater than K_{zero} and put strikes less than K_{zero} .

Valid Options for the Valid Variance Condition

At any point in time, for each valid option strip on a particular equity constituent, the options are filtered in sequence by the following rules:

- Filter out any OTM call options with strikes higher than two consecutive OTM call options with zero bids, even if they have non-zero bids.
- Filter out any OTM put options with strikes lower than two consecutive OTM put options with zero bids, even if they have non-zero bids.
- Filter out any remaining options without valid quotes.

¹ For more details, please refer to the Cboe Volatility Index Mathematics Methodology, available [here](#).

- Filter out any remaining options with zero bids.

The remaining OTM call and put options, as well as the ATM option, are “valid options” for the purposes of calculating the Valid Variance Condition on that constituent at that point in time.

Valid Variance Condition

At any point that the Dispersion Index calculates for a given constituent in the Basket Index, that constituent is said to have a “valid variance” at that time if there is a Near Term options strip and a Next Term options strip which are both valid options strips, *and* both strips have, firstly, a valid quote for the ATM call option and the ATM put option and, secondly, at least three OTM call options that are valid options, and finally, at least three OTM put options that are valid options.

Individual Stock Variance Calculation

At any point that the Dispersion Index calculates, for each constituent i of the Basket Index that has a valid variance at that point in time, an expected variance $\sigma_{i,30}^2$ for that constituent calculates based on the prices of valid options in the Near Term and Next Term options strips according to the following two steps:

- 1) Calculate the Near Term and Next Term variance contribution for stock i :

$$\sigma_{i,Near}^2 = \frac{2}{T_{Near}} \sum_k^M \left[\frac{\Delta K_{k,Near}}{K_{k,Near}^2} * e^{r_{Near} T_{Near}} * Q(K_{k,Near}) \right] - \frac{1}{T_{Near}} \left(\frac{F_{Near}}{K_{Zero,Near}} - 1 \right)^2$$

$$\sigma_{i,Next}^2 = \frac{2}{T_{Next}} \sum_k^M \left[\frac{\Delta K_{k,Next}}{K_{k,Next}^2} * e^{r_{Next} T_{Next}} * Q(K_{k,Next}) \right] - \frac{1}{T_{Next}} \left(\frac{F_{Next}}{K_{Zero,Next}} - 1 \right)^2$$

where:

$\sigma_{i,Near}^2, \sigma_{i,Next}^2$ = The near term and next term variance of stock i respectively.

T_{Near}, T_{Next} = The annualized time to expiry for the Near Term and Next Term strips, respectively.

r_{Near}, r_{Next} = The interest rates associated to the Near Term and Next Term maturities, respectively.²

$K_{k,j}$ = The strike of valid option k and for maturity j .

$\Delta K_{k,j}$ = The strike increment called Delta K associated to the option with maturity j and strike $K_{k,j}$. Delta K calculates by taking half of the difference between the strike prices on either side of $K_{k,j}$. When a strike $K_{k,j}$ has only one strike bordering it, a simple difference is taken to calculate Delta K.

$Q(K_{k,j})$ = The option mid-price at strike $K_{k,j}$. If the strike is below the ATM option strike, then the put mid-price is used. If the strike is above the ATM option strike, then a call mid-price is used. If the strike is equal to the ATM strike, the midpoint of the call and put mid-price is taken.

F_{Near}, F_{Next} = The implied forward for the Near Term and Next Term strips, respectively.

K_{zero} = The strike of the ATM option.

² The same interest rate calculation method used in VIX is used here. For more details, please refer to the Cboe Volatility Index Mathematics Methodology, available [here](#).

- 2) After the Near Term and Next Term variance contributions calculate, a 30-day variance $\sigma_{i,30}^2$ calculates as a weighted average of the Near Term and Next Term variances, weighted by their time to expiration and annualized as shown in the formula below:

$$\sigma_{i,30}^2 = \left\{ T_{Near} \sigma_{i,Near}^2 \left[\frac{(N_{Next} - N_{30})}{(N_{Next} - N_{Near})} \right] + T_{Next} \sigma_{j,Next}^2 \left[\frac{(N_{30} - N_{Near})}{(N_{Next} - N_{Near})} \right] \right\} \times \frac{N_{365}}{N_{30}}$$

where:

N_{Near} = The number of minutes until expiration of the Near Term options

N_{Next} = The number of minutes until expiration of the Next Term options

N_{30} = The number of minutes in the given 30-day term

N_{365} = The number of minutes in a calendar year (525,600)

Note: Providing such calculation is completed, the value $\sigma_{i,30}^2$ is said to be the “valid variance” associated to the constituent i at that point in time.

Pulled-Forward Variance

At each point in time, for each constituent of the Basket Index, if that constituent does not have a valid variance (see section *Valid Variance Condition*), then a “pulled-forward variance” – equal to a valid variance for that constituent calculated at an earlier point in time – may be used. The conditions under which a pulled forward value may be used are as follows:

Intraday Index and End of Day Index level

At any point that the Dispersion Index calculates, if there is a constituent of the Basket Index without a valid variance, then one of three calculations will be conducted:

- a) If a valid variance was available for that constituent *earlier in that trading day*³, then the most recently available valid variance will be used.
- b) If no valid variance was available for that constituent earlier in that trading day, but a valid variance for that constituent was used in the calculation of the End of Day Index level *at the close on the prior trading day*, then that valid variance will be used.
- c) Otherwise, that constituent will be excluded from the calculation at that point in time and the weight of the remaining constituents will be reweighted in the calculation.

Additionally, if either condition (a) or (b) applies, the resulting value for that constituent’s variance used in the calculation will be called a “pulled-forward variance”. Accordingly, the maximum length of time that a Basket Index constituent can have a pulled-forward variance is from first calculation of the index on any trading day (when a value from the prior day’s close may be used), up to and including the close of the same trading day.

For avoidance of doubt: In any calculation of the Index, any then-current constituent of the Basket Index that *does* have a valid variance at that point in time will have that variance included in the calculation, even if that constituent had previously been excluded or had a pulled-forward variance.

Back-Tested End of Day Index level

For the calculation of Back-Tested End of Day Index Levels, rather than calculating regularly throughout the trading day, a single hypothetical index calculation was run on the data current at 2:58pm Chicago time (i.e., two minutes prior to the equity market close at 3pm Chicago / 4pm New York), and again at the market close. For each day in the back-test period, any constituent of the Basket Index without a valid

³ The dissemination of Dispersion Index levels begins at 9:45 a.m. New York time, but a valid variance, if available, may be pulled from earlier calculations, up to the market open, i.e., 9:30 a.m. New York time at the earliest.

variance at the market close, but with a valid variance available at 2:58pm, had that earlier variance pulled forward. Any constituent of the Basket Index without a valid variance at the close, and without a valid variance at the earlier calculation point that day, was excluded from the calculation for that day, with the weight of the remaining constituents reweighted accordingly in the final calculation.

Calculating the Dispersion Index

At any point that the Dispersion Index is calculated, it calculates according to the formula as introduced in the *Outline of Methodology* section:

$$DSPX = 100 * \sqrt{\max\left(\sum_{i=1}^L w_i \hat{\sigma}_{i,30}^2 - VIX^2, 0\right)}$$

where:

- $i = 1, \dots, L$ represent the constituents of the Basket Index currently included in the calculation.
- If the constituent i has a valid variance, then $\hat{\sigma}_{i,30}^2 = \sigma_{i,30}^2$ is equal to the then-current 30-day variance (see *Individual Stock Variance Calculation* section). Otherwise $\hat{\sigma}_{i,30}^2$ is a pulled-forward variance (see *Pulled-Forward Variance* section).
- w_i = The FMC weight for stock i , calculated as a proportion of the sum of the FMC of the L constituents of the Basket Index whose variance is included in the calculation at that point in time (including constituents with pulled-forward variance).⁴
- VIX = The Cboe Volatility Index (VIX) index value.

And additionally:

- If, at any time, there is not a valid variance nor an available pulled-forward variance for *any* constituent of the Basket Index, then the Dispersion Index does not calculate and further updates to the index level is suspended until such time as a valid variance is available.
- If the VIX has suspended publication, the Dispersion Index also suspends publication.

⁴ The weights of each constituent may fluctuate intraday due to the impact of intraday equity price changes on constituent FMC. Additions and deletions from the Basket Index effective at the close on any day will not be reflected in the Dispersion Index until the first calculation on the following trading day.

Index Maintenance

Rebalancing

The index rebalances at each calculation time.

Additions and Deletions

Constituents added or removed from the Basket Index will have their contribution to the calculation of the Dispersion Index adjusted at the open on the following trading day.

For details on additions and deletions to the Basket Index, see the Cboe S&P 500 Dispersion Basket Index Methodology, available [here](#).

Corporate Actions

The equity option classes used to calculate DSPX may be changed to reflect corporate actions, including stock splits, special dividends, merger & acquisition, spin-offs, and delisting. Adjusted options classes will be used to calculate DSPX until unadjusted series with same expiration date are available for trading.

For more information on Corporate Actions, please refer to the Market Capitalization Indices section of S&P Dow Jones Indices' Equity Indices Policies & Practices Methodology.

Base Date and History Availability

The index history availability, base date, and base value are shown in the table below.

Index	Launch Date	First Value Date	Base Date
Cboe S&P 500 Dispersion Index	09/27/2023	06/19/2014	06/19/2014

The methodology for the Back-Tested End of Day index level differs in an important respect from the live Index levels. In particular, the Intraday and End of Day Index levels may have inputs representing 30-day variance estimates for Basket Index constituents that are “pulled forward” from various possible earlier points in time (see *Valid Variance Condition*, *Pulled-Forward Variance*, and *Calculating the Dispersion Index* sections). The Back-Tested End of Day Index level may only contain inputs that are “pulled forward” by approximately two minutes from just before to the market close, to the market close.

Index Governance

Index Committee

An S&P Dow Jones Indices' Index Committee maintains the index. All committee members are full-time professional members of S&P Dow Jones Indices' staff or full-time professional members of Cboe's staff. The Index Committee meets regularly. At each meeting, the Committee reviews 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 the indices, and any significant market events. In addition, the Index Committee may revise index policy covering rules for selecting companies, treatment of dividends, share counts or other matters.

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

S&P Dow Jones Indices' Index Committees reserve the right to make exceptions when applying the methodology if the need arises. In any scenario where the treatment differs from the general rules stated in this document or supplemental documents, clients will receive sufficient notice, whenever possible.

In addition to the daily governance of indices and maintenance of index methodologies, at least once within any 12-month period, the Index Committee reviews the methodology to ensure the indices continue to achieve the stated objectives, and that the data and methodology remain effective. In certain instances, S&P Dow Jones Indices may publish a consultation inviting comments from external parties.

For information on Quality Assurance and Internal Reviews of Methodology, please refer to S&P Dow Jones Indices' Options Indices Policies & Practices Methodology.

Index Policy

Announcements

S&P DJI notifies clients either via email or, in certain instances, via Index Announcements, which are also available at www.spglobal.com/spdji.

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

For more information, please refer to the Announcements sections of S&P Dow Jones Indices' Equity Indices Policies & Practices Methodology and the S&P Dow Jones Indices' Options Indices Policies & Practices Methodology, respectively.

Holiday Schedule

The index calculates daily, throughout the calendar year, when the U.S. equity markets are open.

A complete holiday schedule for the year is available on 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 and the S&P Dow Jones Indices' Options Indices Policies & Practices Methodology, respectively.

Recalculation Policy

For information on the recalculation policy, please refer to S&P Dow Jones Indices' Equity Indices Policies & Practices Methodology and the S&P Dow Jones Indices' Options Indices Policies & Practices Methodology.

Real-Time Calculation

An "Intraday" level for the Dispersion Index updates regularly during each U.S. equity market trading day from 9:45 a.m. until 4:00 p.m. New York time. A distinct "End of Day" level for the Dispersion Index publishes after the market close.

For information on Calculations and Pricing Disruptions, Expert Judgment and Data Hierarchy, please refer to S&P Dow Jones Indices' Equity Indices Policies & Practices Methodology.

Contact Information

For questions regarding an index, please contact: index_services@spglobal.com.

Index Dissemination

Index levels are available through Cboe's Web site at www.cboe.com major quote vendors (see codes below), numerous investment-oriented Web sites, and various print and electronic media.

Tickers

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

Index	BBG	RIC
Cboe S&P 500 Dispersion Index	DSPX	.DSPX

Index Data

Index levels and data are 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/.

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).

Intellectual Property Notices/Disclaimer

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