S&P Dow Jones Indices

A Division of S&P Global

S&P 500 Dynamic Intraday TCA Index
Methodology

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Table of Contents

Introduction

Index Objective and Highlights

The S&P 500 Dynamic Intraday TCA Index aims to provide exposure to the S&P 500 through the use of E-mini S&P 500 Futures while applying an intraday volatility control and trend-following mechanism. The index rebalances up to 13 times daily using a time-weighted average price (TWAP) as defined in *Index Maintenance* and *Appendix I*.

To perform the calculations, the index uses a futures price index as defined in *Appendix II*. The underlying futures contract is the active E-mini S&P 500 Futures contract.

For information on the underlying index and the S&P 500, please refer to the S&P Futures Indices Methodology and S&P U.S. Indices Methodology documents, respectively, available at www.spglobal.com/spdji/.

Index Family

The index family includes the following:

Index	Vol Target[1]	Rebalancing Fee	Replication Fee
S&P 500 Dynamic Intraday Index	15%	0%	0%
S&P 500 Dynamic Intraday TCA Index	15%	0.02%	0.12%

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' Commodities Indices Policies & Practices Methodology	Commodities Indices Policies & Practices
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.

[1] The target volatilities which determine futures exposure are based on rolling 64 and 260 intraday period calculations. The actual index realized volatility may deviate from the target volatilities.

Index Construction

For each index calculation day, the uncapped index calculates as follows:

$$Index_t = Index_{t-1} + \sum_{i=1}^{last} \left[n_{t,i-1} \times \left(SP_{t,i}^{EXEC} - SP_{t,i-1}^{EXEC} \right) - Fees_{t,i} \right]$$

where:

$Index_t$	= The index level for day *t*
$Fees_{t,i}$	= The fees paid for day *t* and intraday window *i*[2]
$SP_{t,i}^{EXEC}$	= Execution price for the futures subindex for day *t* and intraday window *i*
$n_{t,i}$	= Units held of the underlying index for day *t* and intraday window *i*

For each index calculation period, the fees calculate as follows:

$$Fees_{t,i} = SP_{t,i}^{EXEC} \times \left| n_{t,i} - n_{t,i-1} \right| \times (rebalancing\ fees) + SP_{t,i-1}^{EXEC} \times \left| n_{t,i-1} \right| \times \frac{Act(i, i-1)}{365} \times (replication\ fees)$$

where:

$Act(i, i-1)$	= The time elapsed in days between the current and the previous execution
$Replication\ fee$	= The fee due to the replication of the index
$Rebalancing\ fee$	= The trading costs associated with rebalancing the index

For each index calculation intraday period, the number of units for each index component calculates as follows[3]:

1. If $\frac{\left| n_{t,i}^{target} - n_{t,i-1} \right|}{n_{t,i-1}} > 10\%$:

$$n_{t,i} = n_{t,i-1} + \min\left(MaxTurnover_{t,i}, \max\left(-MaxTurnover_{t,i}, n_{t,i}^{target} - n_{t,i-1} \right) \right)$$

2. Otherwise:

$$n_{t,i} = n_{t,i-1}$$

where:

$n_{t,i}^{target}$	= The number of target units calculated for day *t* and intraday window *I*
$MaxTurnover_{t,i}$	= The maximum allowed turnover calculated for day *t* and intraday window *i*

For each index calculation intraday period, the maximum allowed turnover calculates as follows:

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[2] For any formula referencing intraday windows, whenever i-1=0, use the last available value for the previous day.

[3] In case of a halt that leads to the market being closed for the remainder of the day, the final number of units only changes by the prorated trade amount. That is, if $T_{t,i} = (n_{t,i} - n_{t,i-1})$ is the intended trade for the window t, i, then $n_{t,i} = n_{t,i-1} + \frac{ceil(Actual\ Number\ of\ TWAPs_{t,i})}{Minimum\ Number\ of\ TWAPS_{t,i}} \times T_{t,i}$ where $ceil(Actual\ Number\ of\ TWAPs_{t,i})$ is the rounded up number of 1-minute TWAPs elapsed in the execution window until market closure. For estimation of Threshold & Trend Factor, the day is considered a partial day and skipped.

$$MaxTurnover_{t,i} = TurnoverConstant_i \times \frac{Index_{t-1}}{SP_{t,i}^{REF}}$$

where:

$SP_{t,i}^{REF}$ = Reference price for the futures sub-index for day *t* and intraday window *i*

$TurnoverConstant_i$ = The turnover constant for the window, which is 60% if it is the closing window, otherwise 10%

For each index calculation intraday period, the target number of units calculates as follows:

$$n_{t,i}^{target} = w_{t,i} \times \frac{Index_{t-1}}{SP_{t,i}^{REF}}$$

where:

$w_{t,i}$ = The target weight for day *t* and intraday window *i*

with the initial number of target units equal to 0.

For each index calculation intraday period, the target weight calculates as follows:

$$w_{t,i} = \min\left(250\%, \frac{Target\ Volatility}{Volatility_{t,i}} \times TrendFactor_{t,i} \times VAF_t\right)$$

where:

$Volatility_{t,i}$ = The calculated volatility for the S&P 500 Futures for day *t* and intraday window *i*

VAF_t = The Variance Adjustment Factor computed for day *t*

$TrendFactor_{t,i}$ = The Trend Factor for day *t* and intraday period *i*

$Target\ Volatility$ = The index target volatility

For each index calculation intraday period, the volatility calculates as follows:

$$Volatility_{t,i} = Max(Volatility_{t,i}^{ST}, Volatility_{t,i}^{LT})$$

where:

$$Vol_{t,i}^{ST} = \sqrt{252 \times 13} \times \sqrt{\frac{\sum_{j=0}^{64}\left(\ln\left(\frac{SP_{t,i-j}^{REF}}{SP_{t,i-j-1}^{REF}}\right) - \frac{1}{65} \times \sum_{m=0}^{64} \ln\left(\frac{SP_{t,i-m}^{REF}}{SP_{t,i-m-1}^{REF}}\right)\right)^2}{64}}$$

$$Vol_{t,i}^{LT} = \sqrt{252 \times 13} \times \sqrt{\frac{\sum_{p=0}^{259}\left(\ln\left(\frac{SP_{t,i-p}^{REF}}{SP_{t,i-p-1}^{REF}}\right) - \frac{1}{260} \times \sum_{q=0}^{259} \ln\left(\frac{SP_{t,i-q}^{REF}}{SP_{t,i-q-1}^{REF}}\right)\right)^2}{259}}$$

For each index calculation intraday period, the trend factor calculates as follows:

1. For each final intraday period of day *t*, $TrendFactor_{t,last} = 1$
2. If $\left|IntradayReturn_{t,i}\right| \geq Threshold_{t,i}$:

$$TrendFactor_{t,i} = \min\Big(2, \max\Big(TrendFactor_{t,i-1} + min\Big(33\%, max\big(-33\%, 15 \times Gearing_{t,i} \times IntradayReturn_{t,i}\big)\Big), 0\Big)\Big)$$

3. Otherwise:

$$TrendFactor_{t,i} = TrendFactor_{t,i-1}$$

where:

$Threshold_{t,i}$ = The threshold for defining a trend for day *t* and intraday period *i*

$Gearing_{t,i}$ = The gearing computed for day *t* and intraday period *i*

$IntradayReturn_{t,i}$ = The return from the last TWAP available from the previous day to period *i*

For each index calculation period, the threshold for defining a trend calculates as follows:

$$Threshold_{t,i} = 0.8\% + \sqrt{\sum_{j=1}^{22} ln^2\left(\frac{SP_{t-j,i}^{REF}}{SP_{t-j-1,last}^{EXEC}}\right) \times \lambda^{j-1} \times (1-\lambda)}$$

where:

$SP_{t,last}^{EXEC}$ = The last available value of the Execution TWAP for day *t*

λ = The decay factor that is equal to $0.5^{3/22}$ with a volatility calculation window of two full trading days

For each index calculation period, the intraday return calculates as follows:

$$IntradayReturn_{t,i} = \frac{SP_{t,i}^{REF}}{SP_{t-1,last}^{EXEC}} - 1$$

For each index calculation period, the intraday gearing calculates as follows:

$$Gearing_{t,i} = \min\left(1, \max\left(0, \frac{\left(\frac{\left|IntradayReturn_{t,i}\right|}{Threshold_{t,i}} - 1\right)}{1.5\%}\right)\right)$$

The index uses a variance adjustment factor to perform a second order adjustment to the total weight with a limit of +/- 20% when volatility targeting.

For each index calculation period, the variance adjustment factor calculates once at close as follows:

If the number of observation days (calculated index days) is less than 42, $VAF_t = 1$.

Otherwise:

$$VAF_t = \min\left(1.2, \max\left(0.8, \sqrt{\max\left(0, \frac{84 - 42 \times \left(\frac{IHV_t}{TargetVolatility}\right)^2}{42}\right)}\right)\right)$$

where:

IHV_t = The Index Historical Volatility

For each index calculation date *t*, the Index Historical Volatility, IHV_t, calculates as follows:

$$IHV_t = \sqrt{252 \times \frac{1}{41} \times \sum_{k=1}^{42}\left[ln\left(\frac{Index_{t-k}}{Index_{t-k-1}}\right) - \frac{1}{42}\sum_{k=1}^{42}\ln\left(\frac{Index_{t-k}}{Index_{t-k-1}}\right)\right]^2}$$

Index Maintenance

Rebalancing

The index rebalances daily up to 13 times, using two TWAP periods: one for signal calculation and one for rebalancing execution. The following are the periods for the calculations and rebalance:

Window	TWAP Execution Period	Minimum Number of One-minute TWAPs	Maximum Window End Time
1	9:00 to 9:15 CT	15	3:15 CT
2	9:30 to 9:45 CT	15	3:15 CT
3	10:00 to 10:15 CT	15	3:15 CT
4	10:30 to 10:45 CT	15	3:15 CT
5	11:00 to 11:15 CT	15	3:15 CT
6	11:30 to 11:45 CT	15	3:15 CT
7	12:00 to 12:15 CT	15	3:15 CT
8	12:30 to 12:45 CT	15	3:15 CT
9	13:00 to 13:15 CT	15	3:15 CT
10	13:30 to 13:45 CT	15	3:15 CT
11	14:00 to 14:15 CT	15	3:15 CT
12	14:30 to 14:45 CT	15	3:15 CT
13	14:50 to 15:05 CT	15	3:15 CT

Window	TWAP Reference Period	Minimum Number of One-minute TWAPs	Maximum Window End Time
1	8:50 to 8:55 CT	1	8:55 CT
2	9:20 to 9:25 CT	1	9:25 CT
3	9:50 to 9:55 CT	1	9:55 CT
4	10:20 to 10:25 CT	1	10:25 CT
5	10:50 to 10:55 CT	1	10:55 CT
6	11:20 to 11:25 CT	1	11:25 CT
7	11:50 to 11:55 CT	1	11:55 CT
8	12:20 to 12:25 CT	1	12:25 CT
9	12:50 to 12:55 CT	1	12:55 CT
10	13:20 to 13:25 CT	1	13:25 CT
11	13:50 to 13:55 CT	1	13:55 CT
12	14:20 to 14:25 CT	1	14:25 CT
13	14:30 to 14:45 CT	1	14:45 CT

At each signal period, the TWAP calculates with the E-mini S&P 500 Futures contract, a price index is updated, and the index calculation follows from this index. The price index tracks the returns of the futures contract.

Due to certain market events, the timing of the rebalancing can change:

- For any regularly scheduled early market closure, the index does not rebalance. The index is marked at the TWAP from 11:30 to 11:45 CT.
- For any unscheduled full-day market closure, the index does not rebalance.

- For any unscheduled partial-day market closure in which the market does not re-open, all execution windows after the halt are canceled.
- Trading halts that occur during an execution window expand the window-end period until 15 one-minute TWAPs are observed.
- For any trading halts that span the entirety of a reference window, the previous reference price is used to calculate the target units. If a trading halt occurs for only part of a reference window, and there is at least a one-minute TWAP for that window, the TWAP calculates with the available data.

Currency of Calculation and Additional Index Return Series

The indices calculate in U.S. dollars.

In addition to the indices detailed in this methodology, additional return series versions of the indices may be available, including, but not limited to: currency, currency hedged, decrement, fair value, inverse, leveraged, and risk control versions. For a list of available indices, please refer to the *S&P DJI Methodology & Regulatory Status Database*.

Base Date and History Availability

The index history availability, base dates, and base values are shown in the table below.[4]

Index	Launch Date	First Value Date	Base Date	Base Value
S&P 500 Dynamic Intraday Index	08/14/2023	12/30/2005	12/30/2005	100
S&P 500 Dynamic Intraday TCA Index	08/14/2023	12/30/2005	12/30/2005	100

[4] For history prior to 10/23/2009, due to unavailability of tick data for the S&P 500 Total Return Index, the index calculated using only the S&P 500 E-mini futures. For a detailed description of the historical calculation please refer to *Appendix II.*

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. 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' Equity Indices Policies & Practices Methodology.

Index Policy

Announcements

All index constituents are evaluated daily for data needed to calculate index levels and returns. All events affecting the daily index calculation are typically announced in advance via the Index Corporate Events report (.SDE), delivered daily to all clients. Any unusual treatment of a corporate action or short notice of an event may be communicated via email to clients.

For more information, please refer to the Announcements section of S&P Dow Jones Indices' Commodity Indices Policies & Practices Methodology.

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/.

Rebalancing

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.

Unexpected Exchange Closures

A stock market circuit breaker that halts trading for the remainder of a given business day is considered a market disruption event.

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

Recalculation Policy

Intraday index calculations are executed for some index versions whenever the index's primary exchanges are open. In case an issue arises during calculation, the index is restated, based on feasibility assessment by the index committee, for every reported intraday index level period following the issue.

Real-Time Calculation

Real-time, intraday index calculations are executed for some versions of the index, whenever the index's primary exchanges are open. Real-time indices are not restated.

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 S&P Dow Jones Indices' Web site at *www.spglobal.com/spdji/,* 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
S&P 500 Dynamic Intraday Index	SPFYNI	.SPFYNI
S&P 500 Dynamic Intraday TCA Index	SPFDYNI	.SPFDYNI

Index Data

Daily constituent and index level 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/.

Appendix I: TWAP Calculation

The TWAP calculation is a two-step calculation.

1. Calculate the TWAP for a fixed one-minute window
2. Calculate the average of the one-minute TWAPs.

For each one-minute window, the TWAP calculates as:

$$TWAP_{start,end} = \frac{\sum_{0 \le i < N} p_i \times (t_{i+1} - t_i) + p_{-1} \times (t_0 - start) + p_N \times (end - t_N)}{end - start}$$

where:

$start$ = The initial time of the calculation window

end = The end time of the calculation window

$(t_{i+1} - t_i)$ = The time difference between the *i*-th and the following trade

p_i = The price of the *i*-th trade

p_{-1} = The price of the last trade preceding the start of the one-minute window

p_N = The price of the last trade of the one-minute window

Calculate the one-minute TWAPs until the minimum number of one-minute TWAPs is obtained. The end of the window can be extended until the minimum number of one-minute TWAPs up to Max End Period.

If during any reference period the index cannot calculate the minimum number of one-minute TWAPs due to a lack of quotes, use the last available one-minute TWAP for such a window.

Appendix II: Futures Subindex Calculation and Roll

To calculate the index, construct a futures subindex based off the returns of the underlying futures contract as follows:

$$Futures\ Subindex_0 = 100$$

$$Futures\ Subindex_{t,i} = Futures\ Subindex_{t,i-1} \times \frac{ES^A_{t,i}}{ES^A_{t,i-1}}$$

where:

$ES^A_{t,i}$ = Calculated TWAP for day *t* and intraday window *i* of the active E-mini S&P 500 futures contract

The active contract of the E-mini S&P 500 futures is generally the contract nearest to expiry.

The active contract switches to the E-mini S&P 500 contract with the second nearest expiry [after the close of trading five scheduled trading days preceding the last trading day of the expiring futures contract.[5]]

If the final TWAP execution window on the roll day does not consist of all 15 1-minute TWAP windows, the switch will instead take place after the close of trading on the following trading day.

[5] As per the equation above, the final futures subindex value on roll day (*t, 13*) is calculated using the TWAP values of the near-expiry contract (considered active on roll day). The first futures subindex value on roll day+1 *(t+1, 1)* is calculated using the TWAP values of the next-expiry contract (which is now considered the active contract).

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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