# S&P 500 RavenPack AI Indices
## *Methodology*

March 2024

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# Introduction

**Index Objective and Highlights**

The S&P 500 RavenPack AI Indices[1] measure exposure to the S&P 500 RavenPack AI Sentiment Index (the underlying index) while applying a news sentiment-driven rotation process that combines U.S. equities and fixed income, complemented by a daily risk control mechanism.

*For information on the underlying index, please refer to the S&P 500 RavenPack AI Sentiment Indices Methodology, available at [www.spglobal.com/spdji/](www.spglobal.com/spdji/).*

*For more information on RavenPack, please refer [here](here).*

**Index Family**

The index family includes the following:

| Index | Volatility Target | Decrement Factor |
|---|---|---|
| S&P 500 RavenPack AI Index (USD) ER[2] | 5% | 0.5% p.a. |
| S&P 500 RavenPack AI Sentiment Balanced Index (USD) ER[3] | 5% | 0.5% p.a. |
| S&P 500 RavenPack AI News Algo Index (USD) ER[4] | 5% | 0.75% p.a. |
| S&P 500 RavenPack AI Non-Decrement Index (USD) ER | 5% | 0% p.a. |

*Note that the target volatilities determining index exposure are based on an exponentially decaying calculation. The actual index realized volatility may deviate from the target volatilities.*

**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](Equity Indices Policies & Practices) |
| S&P Dow Jones Indices' Index Mathematics Methodology | [Index Mathematics Methodology](Index Mathematics Methodology) |
| S&P Dow Jones Indices' Fixed Income Policies & Practices Methodology | [Fixed Income Policies & Practices](Fixed Income Policies & Practices) |
| S&P Dow Jones Indices' Fixed Income Mathematics Methodology | [Index Mathematics Methodology](Index Mathematics Methodology) |

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[1] Use of the term "Artificial Intelligence" or "AI" in the name of the index does not imply that the S&P 500 RavenPack AI Indices are designed to include companies involved in the use, production, or commercialization of artificial intelligence. S&P Dow Jones Indices (S&P DJI) uses the term to indicate that the indices rely upon data sourced from RavenPack which is in part created from static, rules-based computational methods (with no machine learning capability) to automatically derive a mathematical result that might account for relevance, novelty, or a given sentiment about a company based on algorithmic analysis of news articles.

[2] The index launched on 10/06/2017 as the Credit Suisse RavenPack AI Index. On 03/27/2024, S&P DJI assumed index calculation and benchmark administrator roles.

[3] The index launched on 10/06/2017 as the Credit Suisse RavenPack Artificial Intelligence Sentiment Balanced Index. On 03/27/2024, S&P DJI assumed index calculation and benchmark administrator roles.

[4] The index launched on 04/29/2022 as the Credit Suisse RavenPack News Algo Index. On 03/27/2024, S&P DJI assumed index calculation and benchmark administrator roles.

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.

# Index Construction

## Component Indices

At each rebalancing, the index universe is the four component indices listed below, with the index rotating allocations between the component indices:

| Component Indices | Asset Class | Calculation Variable |
|---|---|---|
| S&P 500 RavenPack AI Sentiment Index (USD) TR | Equity | EQUITY TR |
| Index-specific Equity Excess Return Index | Equity | EQUITY |
| S&P 2-Year U.S. Treasury Note Futures ER Index[5] | Fixed Income | 2Y |
| S&P 10-Year U.S. Treasury Note Futures ER Index[6] | Fixed Income | 10Y |

*For information on the S&P 2-Year & 10-Year U.S. Treasury Note Futures ER Indices, please refer to the S&P Futures Indices Methodology, available at www.spglobal.com/spdji/.*

## Equity Excess Return Component Selection

Each index uses the following version of the Equity Excess Return Index for index calculation:

| Index | Equity Excess Return Index | Index Code |
|---|---|---|
| S&P 500 RavenPack AI Index | S&P 500 RavenPack AI Sentiment Index (USD) ER | CSRPAISE |
| S&P 500 RavenPack AI Non-Decrement Index | S&P 500 RavenPack AI Sentiment Index (USD) ER | CSRPAISE |
| S&P 500 RavenPack AI Sentiment Balanced Index | S&P 500 RavenPack AI Sentiment Index AISB (USD) ER | CSRPAIBE |
| S&P 500 RavenPack AI News Algo Index | S&P 500 RavenPack AI Sentiment Index NEWS (USD) ER | CSRPAINE |

## Index Construction

For each index calculation day, the index calculates as follows[7]:

$$Index_t = Index_{t-1} \times \left(1 + \sum_{j \in \{10Y, 2Y, Equity\}} w_{t-1}^{Asset} \times \left(\frac{Asset_{j_t}}{Asset_{j_{t-1}}} - 1\right) - DF \times \frac{Act(t, t-1)}{360}\right)$$

*where*:

$Index_t$ = level of the index on day *t*

$w_{t-1}^{Asset}$ = weight of underlying component indices on day *t-1*

$Asset_{j_t}$ = level of the underlying component index *j* on day *t* (See *Component Indices*)

$Act(t, t-1)$ = actual number of calendar days between day *t* and day *t-1*

$DF$ = index decrement factor

For each index calculation day, calculate the weight of the underlying reference asset as follows:

$$w_t^{Asset} = VT_t \times \hat{w}_t^{Asset}$$

*where*:

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[5] For information on historical fixed income components, please see *Appendix I.*
[6] For information on historical fixed income components, please see *Appendix I.*
[7] Intermediate calculations and end-of-day index values calculate and publish with full precision.

$VT_t$ = volatility target participation adjustment on day $t$

$\widehat{w}_t^{Asset}$ = preliminary weight of the reference asset on day $t$

Calculate the preliminary weights for each index calculation day and each underlying component index as follows:

$$\widehat{w}_t^{Equity} = \min\left[1, \frac{5\%}{\sqrt{252} \times \dfrac{\sigma_{1,EquityTR,EquityTR_{max\,(1,t-1)}} + \sigma_{2,EquityTR,EquityTR_{max\,(1,t-1)}}}{2}}\right]$$

$$\widehat{w}_t^{10y} = \left(1 - \widehat{w}_t^{Equity}\right) \times \left(1 - \frac{RiskSignal_{max\,(1,t-1)}^{FI}}{2}\right)$$

$$\widehat{w}_t^{2y} = \left(1 - \widehat{w}_t^{Equity}\right) \times \left(\frac{RiskSignal_{max\,(1,t-1)}^{FI}}{2}\right)$$

*where*:

$\sigma_{j,Asset_1,Asset_{2\,t}}$ = covariance between $Asset_1$ and $Asset_2$ for period $t$ using $\lambda_j$

$RiskSignal_t^{FI}$ = risk-signal calculation based on the 10Y Treasury note futures component

For each index calculation day, calculate the covariance between $Asset_1\ and\ Asset_2$ using a particular $\lambda_j$ as follows:

$$\sigma_{j,Asset_1,Asset_{2\,t-1}}^2 = \lambda_j \times \sigma_{Asset_1,Asset_{2\,t-1}}^2 + (1 - \lambda_j) \times Ln\left(\frac{Asset_{1_t}}{Asset_{1_{t-1}}}\right) \times Ln\left(\frac{Asset_{2_t}}{Asset_{2_{t-1}}}\right)$$

Calculate initial value estimates as follows[8]:

$$\sigma_{j,EquityTR,10Y_1}^2 = -0.20 \times \sigma_{j,EquityTR,EquityTR_1} \times \sigma_{j,10Y,10Y_1}$$

$$\sigma_{j,EquityTR,2Y_1}^2 = -0.10 \times \sigma_{j,EquityTR,EquityTR_1} \times \sigma_{j,2Y,2Y_1}$$

$$\sigma_{j,10Y,2Y_1}^2 = 0.85 \times \sigma_{j,10Y,10Y_1} \times \sigma_{j,2Y,2Y_1}$$

$$\sigma_{j,EquityTR,EquityTR_1}^2 = \frac{0.13^2}{252}$$

$$\sigma_{j,10Y,10Y_1}^2 = \frac{0.050^2}{252}$$

$$\sigma_{j,2Y,2Y_1}^2 = \frac{0.012^2}{252}$$

*where*:

$\lambda_1$ = 0.93

$\lambda_2$ = 0.97

$Asset_{i_t}$ = asset price of $i$ for period $t$

For each index calculation day, calculate the Volatility Target Participation Adjustment as follows:

$$VT_t = \min\left[1.5, \frac{5\%}{\max\left[\sigma_{1,P_t}, \sigma_{2,P_t}\right]}\right]$$

where:

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[8] Covariance calculations are based on the S&P 500 RavenPack AI Sentiment Index TR. Index-level calculation is based on the Equity Excess returns (ER), as defined in *Equity Excess Return Component Selection.*

$\sigma_{j,P_t}$ = The expected volatility of the portfolio for time $t$ computed with $\lambda_j$

For each index calculation day, calculate the expected volatility of the portfolio for time $t$ calculated with $\lambda_j$ as follows:

$$\sigma_{j,P_t} = \sqrt{252 \times \begin{pmatrix} \sigma^2_{j,EquityTR,EquityTR_{max\,(1,t-1)}} \times \widehat{w}_t^{Equity^2} + \sigma^2_{j,10Y,10Y_{max\,(1,t-1)}} \times \widehat{w}_t^{10Y^2} + \sigma^2_{j,2Y,2Y_{max\,(1,t-1)}} \times \widehat{w}_t^{2Y^2} \\ +2 \times \sigma^2_{j,EquityTR,10Y_{max\,(1,t-1)}} \times \widehat{w}_t^{Equity} \times \widehat{w}_t^{10Y} + 2 \times \sigma^2_{j,EquityTR,2Y_{max\,(1,t-1)}} \times \widehat{w}_t^{Equity} \times \widehat{w}_t^{2Y} \\ +2 \times \sigma^2_{j,10Y,2Y_{max\,(1,t-1)}} \times \widehat{w}_t^{10Y} \times \widehat{w}_t^{2Y} \end{pmatrix}}$$

For each index calculation day, calculate the risk signal based on the 10Y Treasury note futures component as follows:

$$RiskSignal_t^{FI} = g\left( 10 - \sum_{i=t-9}^{t} f\left(MA_{i-1}^{10y} - Asset_{10Y_i}\right) \right) \times f(t-10)$$

*where*:

$f(x) = \begin{cases} 0, & x \leq 0 \\ 1, & x > 0 \end{cases}$ is an indicator function returning one if a number is strictly positive, else returning zero

$g(x) = \begin{cases} 0, & x \neq 0 \\ 1, & x = 0 \end{cases}$ is an indicator function returning one if a number is equal to zero, else returning zero

$MA_t^{10y}$ The 200-day moving average of the 10Y Treasury note futures component

*where*:

$$MA_t^{10y} = \frac{1}{\min(200,t)} \sum_{i=\max(1,t-199)}^{t} Asset_{10Y_i}$$

# Index Maintenance

**Rebalancing**

The index rebalances and calculates daily. If a component index level does not publish for a rebalancing date, the index uses the component's latest available closing value.

**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*.

*For information on index calculation, please refer to S&P Dow Jones Indices' Index Mathematics Methodology.*

**Base Date and History Availability**

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

| Index | Launch Date | First Value Date | Base Date | Base Value |
|---|---|---|---|---|
| S&P 500 RavenPack AI Index | 10/06/2017 | 09/02/2005 | 09/02/2005 | 100 |
| S&P 500 RavenPack AI Sentiment Balanced Index | 10/06/2017 | 09/02/2005 | 09/02/2005 | 100 |
| S&P 500 RavenPack AI News Algo Index | 04/29/2022 | 09/02/2005 | 09/02/2005 | 100 |
| S&P 500 RavenPack AI Non-Decrement Index | 03/27/2024 | 09/02/2005 | 09/02/2005 | 100 |

# Index Governance

**Index Committee**

An 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 and are communicated to clients in end-of-day files.

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

**Pro-forma Files**

In addition to the daily composition file (.SDML), S&P Dow Jones Indices provides constituent pro-forma files each time the index rebalances. The pro-forma file is typically provided daily in advance of the rebalancing date and contains all constituents, and their corresponding weights and index shares effective for the upcoming rebalancing.

*Please visit www.spglobal.com/spdji for a complete schedule of rebalancing timelines and pro-forma delivery times.*

**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**

For information on Unexpected Exchange Closures for the equity components, please refer to S&P Dow Jones Indices' Equity Indices Policies & Practices Methodology.

For information on Unexpected Exchange Closures for the futures components, please refer to S&P Dow Jones Indices' Commodities Indices Policies & Practices Methodology.

**Recalculation Policy**

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

*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 RavenPack AI Index (USD) ER | CSRPAI5E | .CSRPAI5E |
| S&P 500 RavenPack AI Sentiment Balanced Index (USD) ER | CSRPAISB | .CSRPAISB |
| S&P 500 RavenPack AI News Algo Index (USD) ER | CSRPNEWS | .CSRPNEWS |
| S&P 500 RavenPack AI Non-Decrement Index (USD) ER | - | - |

**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

**Historical Fixed Income Components**

For history prior to 03/27/2024 (the Transition Date), the index's fixed income components were:

- Credit Suisse 2-Year U.S. Treasury Note Futures Index
- Credit Suisse 10-Year U.S. Treasury Note Futures Index.

**Transition for Fixed Income Components**

Effective on the Transition Date, the fixed income components changed from Credit Suisse indices to S&P indices.

For any Index Business Day on and after the Transition Date, the S&P 2-Year US Treasury Note Futures Index and S&P 10-Year US Treasury Note Futures Index are the fixed income components used for index calculation. The calculation of all the intermediary values relying on the use of historical values, such as Moving Average, Risk Signal, and all covariance calculations, use the historical values of the S&P component indices, even if the historical dates precede the Transition Date.

For the equity index, the realized volatility used to normalize the sector weights calculates with full precision until the Transition Day and uses these values going forward from the Transition Date.

The weighting scheme (preliminary, target, and final weights) is considered continuous and handled differently. When calculating the Target Weights for the S&P indices on the Transition Date, use the preliminary weights on the index business day preceding the Transition Date, as calculated from the respective Credit Suisse indices.

Similarly, the final weight for the S&P indices on the Transition Date calculated using the Credit Suisse indices' final weights on the index business day preceding the Transition Date. As a result, the index level on the Transition Date calculated using the final weight for the Credit Suisse indices on the index business day preceding the Transition Date and the official closing level of the S&P Indices for the Transition Date and the index business day preceding the Transition Date.

# Appendix II

**Transition Mechanics**

Effective on 03/27/2024, S&P Dow Jones Indices assumed the indices' index calculation and benchmark administrator roles. On transition date *t*, the weights of the component indices on day *t-1* ($w_{t-1}^{Asset}$), the historical levels of each headline index, and the underlying TR and ER indices onboarded from the previous index calculating agent (Credit Suisse) at published values up until that date. The covariance matrix for day *t-1* calculated using:

- S&P 2-Year U.S. Treasury Note Futures ER Index historical values (Full precision value)

- S&P 10-Year U.S. Treasury Note Futures ER Index historical values (Full precision value)

- Predecessor Credit Suisse RavenPack Artificial Intelligence Sentiment Index historical values (rounded up to the published value)

This covariance matrix was used to compute the weights for 03/27/2024, which was the first day that S&P Dow Jones Indices calculated the index as per Index Construction.

Every other internal variable (such as Risk Signal, VT (Volatility target participation adjustment), Moving Average for 10Y Treasury note futures) calculated with the S&P Treasury Futures Indices for that date and is used as a basis for the transition date model.

On 03/27/2024, the index used each variable with data provided and rounded as follows:

| Variable | Data Provider | Rounding | Data Used |
|---|---|---|---|
| $Index_{t-1}$ | CS | Full Precision | 03/26/2024 |
| $w_{t-1}^{Asset}$ | CS | Full Precision | 03/26/2024 |
| $Asset_{j_{t-1}}$: 2Y | S&P | SPUST2P Full Precision | 03/26/2024 |
| $Asset_{j_{t-1}}$: 10Y | S&P | SPUSTTP Full Precision | 03/26/2024 |
| $Asset_{j_{t-1}}$: Equity ER | CS | Full Precision, using rounded IndexTR | 03/26/2024 |

# 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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