

**S&P U.S. Multi-Asset
Riskcasting Indices
*Methodology***

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Introduction

Index Objective and Highlights

The S&P U.S. Multi-Asset Riskcasting Indices measure the performance of a risk-weighted strategy that switches the component indices' allocations based on the Bramham Gardens' Riskcasting signal. Component index allocations alternate between five specific S&P equities, commodities, and sovereign fixed income futures indices, defined below:

Underlying Component Indices	Asset Class
S&P 500 Low Volatility Total Return Index	Equities
S&P 500 Growth Total Return Index	Equities
S&P 10-Year U.S. Treasury Note Futures Excess Return Index	Fixed Income
S&P GSCI Industrial Metals Excess Return Index	Commodities
S&P GSCI Precious Metals Excess Return Index	Commodities

The Riskcasting signal is owned and calculated by Bramham Gardens. The Riskcasting signal is a measure of the U.S. stock market participant's prevailing level of risk aversion. Depending on the degree of risk aversion, allocations to the equity sub-indices can vary from 0% to 70%, with the remainder assigned to the sovereign fixed income futures and commodities sub-indices. The Riskcasting signal is computed every business day after the market close. The index rebalances daily, after the market close, to the target allocation, based on the Riskcasting signal from 7 days to 2 days before the rebalance effective day. Risk aversion information is first extracted at different maturities and strikes from the implied volatility surface derived from the S&P 500 listed put and call options. The resulting information is then filtered using signal processing techniques and synthesized before being transformed into a digital Riskcasting signal, which flags benign and rough periods using a supervised artificial intelligence technique.

For more information about the Riskcasting signal, please refer to the Bramham Gardens' [Riskcasting Signal Methodology](#).

For more information on the component indices, please refer to the respective methodology documents available at www.spdji.com.

Index Family

The current index family includes:

- S&P U.S. Multi-Asset Riskcasting Index
- S&P U.S. Multi-Asset Riskcasting 4% Target Volatility Index
- S&P U.S. Multi-Asset Riskcasting 5% Target Volatility Index

Bramham Gardens

Bramham Gardens is a Paris-based firm that specializes in artificial intelligence-driven investment strategies that screen, anticipate, and signal market risk increases with the goal of delivering a smoother return stream while investing in equity assets. The team is comprised of several PhDs in Financial Economics and Machine Learning.

For more information about Bramham Gardens, please refer to their website www.bramham-gardens.com.

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

This methodology was created by S&P Dow Jones Indices (S&P DJI) 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

Approach

The index allocates among five component indices based on the Riskcasting signal and the targeted risk contributions, as defined in the table below. The risk contributions are determined based on the component indices' realized volatilities.

The underlying commodities and fixed income indices are calculated and published by S&P Dow Jones Indices on a daily basis as excess return indices. For purposes of the S&P Multi-Asset Riskcasting Indices, excess return versions of the S&P 500 Low Volatility and S&P 500 Growth are calculated from their respective Total Return types and used as the underlying equities component indices:

$$Excess\ Return_t = \left(\frac{Total\ Return\ Index_t}{Total\ Return\ Index_{t-1}} - 1 \right) - \left(InterestRate_{t-1} * \frac{NumDays_t}{360} \right)$$

$$Excess\ Return\ Index_t = Excess\ Return\ Index_{t-1} * (1 + Excess\ Return_t)$$

where:

InterestRate = Effective Federal Funds Rate.

The targeted risk contributions for the component indices are dependent on the Riskcasting Signal, as follows:

Component Index Name	Riskcasting Signal		
	Bullish	Neutral	Bearish
S&P 500 Low Volatility Excess Return Index	0%	50%	0%
S&P 500 Growth Excess Return Index	70%	0%	0%
S&P 10-Year U.S. Treasury Note Futures Excess Return Index	15%	50%	50%
S&P GSCI Industrial Metals Excess Return Index	15%	0%	0%
S&P GSCI Precious Metals Excess Return Index	0%	0%	50%

Component Index Weightings

The weight allocations for each component index are determined as follows:

1. Take an average of the targeted risk contribution for each component index, using five trailing days of Riskcasting signals.
2. Calculate the realized volatility of each component index using an exponentially weighted model with a long-term decay factor of 97%.
3. Tilt the five day average targeted risk contributions using the component index volatilities to determine the component index weights (see Step 2 below).
4. If the index targets a specified level of volatility, then further adjust the underlying component index weights as follows:
 - a. Measure the realized volatility of the current index composition based on realized variances and covariances across the component indices, using an exponentially weighted model with short-term and long-term decay factors of 94% and 97%, respectively.
 - b. Proportionally increase/decrease the component index weights to a total maximum leverage of 150% in order to target the specified level of volatility.

As part of the daily rebalancing, the following are calculated:

1. The short- and long-term variance and covariance numbers of all five underlying component indices as defined in *Index Calculations* on the following pages.
2. The weights for each of the five underlying component indices (A) are calculated using the following formula:

$$W_{L,t}^A = \frac{1}{5} \sum_{j=1}^5 \frac{(\text{Variance}_{L,t}^A)^{-1/2} * RCW_{t-j}^A}{\sum_B (\text{Variance}_{L,t}^B)^{-1/2} * RCW_{t-j}^B}$$

where:

$$RCW_{L,t-j}^A = \text{Weight assigned to the underlying sub-index (A) by the Riskcasting signal at time } t-j$$

3. The realized volatility of the index composition, using weights as of time t , is calculated using the following formula:

$$\text{RealizedVolatility}_t = \sqrt{252 \cdot \max(\text{PortfolioVar}_{L,t}, \text{PortfolioVar}_{S,t})}$$

where:

$$\text{PortfolioVar}_{L,t} = \sum_A \sum_B W_{L,t}^A * \text{Covariance}_{L,t}^{A,B} * W_{L,t}^B$$

$$\text{PortfolioVar}_{S,t} = \sum_A \sum_B W_{S,t}^A * \text{Covariance}_{S,t}^{A,B} * W_{S,t}^B$$

Index Calculations

On any business day t when the index is calculated, the excess return and total return index values are calculated using the following formulas:

$$\text{Excess Return}_t = \sum_A \text{Adj}W_{t-2} * W_{t-2}^A * \left(\frac{\text{Index}_t^A}{\text{Index}_{t-1}^A} - 1 \right)$$

$$\text{Total Return}_t = \text{Excess Return}_t + \left(\text{InterestRate}_{t-1} * \frac{\text{NumDays}_t}{360} \right)$$

$$\text{IndexER}_t = \text{IndexER}_{t-1} * (1 + \text{Excess Return}_t)$$

$$\text{IndexTR}_t = \text{IndexTR}_{t-1} * (1 + \text{Total Return}_t)$$

where:

$$\text{Adj}W_{t-2} = \text{Min}(\text{Max Leverage}, \frac{\text{Target Volatility}}{\text{RealizedVolatility}_{t-2}}), \text{ or } 1 \text{ for no target volatility indices}$$

$$W_t^A = \text{The weight of the respective underlying component index (A) as of time } t.$$

$$\text{Index}_t^A = \text{The excess return index level of the respective underlying component index A as of time } t$$

$$\text{InterestRate}_{t-1} = \text{Effective Federal Funds Rate. A 360-day year is assumed for the interest calculations in accordance with U.S. banking practices.}$$

$$\text{NumDays}_t = \text{The number of calendar days between day } t-1 \text{ and } t.$$

Exponentially Weighted Variance and Covariance. On any business day t when the index is calculated, the index calculates the realized short- and long-term variances and covariances of the underlying component indices. The calculations are based on exponentially weighted moving averages, and are as follows:

$Variance_{S,t}^A$ = The short-term variance for index A, at time t , is calculated as:

$$Variance_{S,t}^A = \begin{cases} \lambda_S Variance_{S,t-1}^A + (1 - \lambda_S) \left[\ln \left(\frac{Index_t^A}{Index_{t-1}^A} \right) \right]^2 & \text{if } t > T_0 \\ \sum_{i=m+1}^{T_0} \frac{\alpha_{S,i,m}}{WF_S} \left[\ln \left(\frac{Index_i^A}{Index_{i-1}^A} \right) \right]^2 & \text{if } t = T_0 \end{cases} \quad (1a)$$

$Variance_{L,t}^A$ = The long-term variance for index A, at time t , is calculated as:

$$Variance_{L,t}^A = \begin{cases} \lambda_L Variance_{L,t-1}^A + (1 - \lambda_L) \left[\ln \left(\frac{Index_t^A}{Index_{t-1}^A} \right) \right]^2 & \text{if } t > T_0 \\ \sum_{i=m+1}^{T_0} \frac{\alpha_{L,i,m}}{WF_L} \left[\ln \left(\frac{Index_i^A}{Index_{i-1}^A} \right) \right]^2 & \text{if } t = T_0 \end{cases} \quad (1b)$$

$Covariance_{S,t}^{A,B}$ = The short-term covariance between index A and B, at time t , is calculated as:

$$Covariance_{S,t}^{A,B} = \begin{cases} \lambda_S Covariance_{S,t-1}^{A,B} + (1 - \lambda_S) \ln \left(\frac{Index_t^A}{Index_{t-1}^A} \right) \ln \left(\frac{Index_t^B}{Index_{t-1}^B} \right) & \text{if } t > T_0 \\ \sum_{i=m+1}^{T_0} \frac{\alpha_{S,i,m}}{WF_S} \ln \left(\frac{Index_i^A}{Index_{i-1}^A} \right) \ln \left(\frac{Index_i^B}{Index_{i-1}^B} \right) & \text{if } t = T_0 \end{cases} \quad (1c)$$

$Covariance_{L,t}^{A,B}$ = The long-term covariance between index A and B, at time t , is calculated as:

$$Covariance_{L,t}^{A,B} = \begin{cases} \lambda_L Covariance_{L,t-1}^{A,B} + (1 - \lambda_L) \ln \left(\frac{Index_t^A}{Index_{t-1}^A} \right) \ln \left(\frac{Index_t^B}{Index_{t-1}^B} \right) & \text{if } t > T_0 \\ \sum_{i=m+1}^{T_0} \frac{\alpha_{L,i,m}}{WF_L} \ln \left(\frac{Index_i^A}{Index_{i-1}^A} \right) \ln \left(\frac{Index_i^B}{Index_{i-1}^B} \right) & \text{if } t = T_0 \end{cases} \quad (1d)$$

where:

- T_0 = The start date of S&P U.S Multi-Asset Riskcasting Indices.
- n = The number of days in the return calculation. $n = 1$ as daily returns are used to calculate realized volatility.
- m = The m^{th} trading date prior to T_0 .
- N = The number of trading days observed for calculating the initial variance as of the start date of the index. $N = 60$.
- λ_S = The short-term decay factor used for exponential weighting. The decay factor is a number greater than zero and less than one that determines the weight of each daily return in the calculation of historical variance.
- λ_L = The long-term decay factor used for exponential weighting. The decay factor is a number greater than zero and less than one that determines the weight of each daily return in the calculation of historical variance.
- $\alpha_{S,m,i}$ = Weight of date t in the short-term volatility calculation, as calculated based on the following formula:

$$\alpha_{S,t} = (1 - \lambda_S) * \lambda_S^{N+m-i} \quad (2a)$$

$$WF_S = \sum_{i=m+1}^{T_0} \alpha_{S,i,m} \quad (2b)$$

$\alpha_{L,m,i}$ = Weight of date t in the long-term volatility calculation, as calculated based on the following formula:

$$\alpha_{L,t} = (1 - \lambda_L) * \lambda_L^{N+m-i} \quad (2c)$$

$$WF_L = \sum_{i=m+1}^{T_0} \alpha_{L,i,m} \quad (2d)$$

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

Index Maintenance

Rebalancing

The indices' targeted risk contributions correspond to the Riskcasting signal, which is reviewed at the close on each business day. The targeted risk contributions corresponding to the Riskcasting signal are averaged over a five day period prior to implementation. The effective date for the new target allocation is after the close of the next trading day, also referred to as the open of two trading days in the future.

The indices are rebalanced daily to their targeted risk contribution. The table below illustrates the implementation timing: Asset Class Allocation Timing of Changes	
Reference Data used to calculate the Riskcasting Signal	From T – 3 to T – 7
Riskcasting Signal Calculation	From T – 2 to T – 6
Announcement of changes to Asset Allocation	T – 1
Effective Date of Change	T

All days reflect after the close and count business days.

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 various index calculations, please refer to S&P Dow Jones Indices' Index Mathematics Methodology.

For the inputs necessary to calculate certain types of indices, including decrement, dynamic hedged, fair value, and risk control indices, please refer to the Parameters documents available at www.spdji.com.

Base Dates and History Availability

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 U.S. Multi-Asset Riskcasting Index	10/12/2020	01/05/2006	01/05/2006	100
S&P U.S. Multi-Asset Riskcasting 4% Target Volatility Index	10/12/2020	01/05/2006	01/05/2006	100
S&P U.S. Multi-Asset Riskcasting 5% Target Volatility Index	10/12/2020	01/05/2006	01/05/2006	100

Index Governance

Index Committee

An S&P Dow Jones Indices' Index Committee maintains the indices. All committee members are full-time professional members of S&P Dow Jones Indices' staff. The 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 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.

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

Rebalancing announcements, if needed, are made at the close of two days prior to the rebalancing effective date.

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

Holiday Schedule

The indices are calculated daily, throughout the calendar year. The only days the indices are not calculated are on days when all exchanges where the indices' constituents are listed are officially closed.

A complete holiday schedule for the year is available at www.spdji.com.

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, please refer to S&P Dow Jones Indices' Equity 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.spdji.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 (Currency)	Return Type	Bloomberg
S&P U.S. Multi-Asset Riskcasting Index (USD)	Excess Return Total Return	SPUMRCE SPUMRCT
S&P U.S. Multi-Asset Riskcasting 4% Target Volatility Index (USD)	Excess Return Total Return	SPUMRC4E SPUMRC4T
S&P U.S. Multi-Asset Riskcasting 5% Target Volatility Index (USD)	Excess Return Total Return	SPUMRC5E SPUMRC5T

Index Data

Daily index level data is available via subscription.

For product information, please contact S&P Dow Jones Indices, www.spdji.com/contact-us.

Web site

For further information, please refer to S&P Dow Jones Indices' Web site at www.spdji.com.

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