S&P Dow Jones Indices

A Division of S&P Global

S&P Managed Risk Index Series
Methodology

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Introduction

Index Objective

Each index in the S&P Managed Risk Index Series is designed to measure the performance of a dynamic allocation that seeks to achieve a target level of volatility by allocating between an underlying equity index and cash, based on the realized volatilities in the underlying equity and bond indices, while maintaining a fixed allocation to an underlying bond index. The exposure to the underlying equity index includes a synthetic put position, which is designed to measure the hedging of downside risk, implemented using a delta adjustment to the equity exposure.

Collaboration

The S&P Managed Risk Index Series is generated and published under agreements between S&P Dow Jones Indices and Milliman Financial Risk Management LLC.

Highlights

Each S&P Managed Risk Index allocates to the underlying equity index based on the realized volatilities of the underlying equity and bond indices.

The allocation to the underlying bond index is fixed at level (W_B) as daily adjustments are not warranted. The target allocation to the underlying equity index is calculated to maintain a target volatility level and is capped based on the maximum leverage of the index.

Each index includes a constant maturity put option on the underlying equity index to measure the hedging of downside risk. To remove the risk-free rate in the calculation of the Black-Scholes delta of the put, the strike of the option is expressed in "forward moneyness" terms. This forward strike is determined each day by multiplying the moving average of the index level with a strike multiplier.

Please refer to the appendix for a full list of index parameters.

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

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

Approaches

Each S&P Managed Risk Index allocates to an underling equity index based on the realized volatility in the underlying equity index. The underlying bond index has a fixed allocation, W_B.

To calculate the target allocation to the underlying equity index, the S&P Managed Risk Index:

1. Uses an exponentially weighted risk control model to calculate the realized variance of both the underlying equity and bond indices, and the realized covariance between the two underlying indices.
2. Solves quadratic equations to calculate the weight of the underlying equity index that equates the portfolio realized volatility to the target volatility.
3. Adjusts the equity allocation weight based on a put overlay calculation, and applies a cap based on W_B and the maximum leverage of the index.

The index includes a constant maturity put option on the index designed to measure the hedging of downside risk. The forward strike level of the put is a multiple of the moving average of the index level. The index then calculates the delta of the put position with regard to the index level, and proportionally adjusts the effective weight of the underlying equity index.

This put overlay strategy essentially results in a synthetic portfolio made up of three components:

1. A fixed allocation to the underlying bond index.
2. A dynamic allocation to the underlying equity index that is reduced by the delta of the put option.
3. A cash allocation which is 100% minus the allocations in 1 and 2 above.

Rebalancing

The indices are rebalanced daily.

Total Return Index Calculations

On any business day *t*, the total return index value is calculated as:

$$IndexTR_t = AdjW_{E.t-2} * \left(\frac{E_t}{E_{t-1}} - 1 \right) + W_B * \left(\frac{B_t}{B_{t-1}} - 1 \right) + (1 - AdjW_{E.t-2} - W_B) * \left(InterestRate_{t-1} * \frac{NumDays_t}{360} \right) \quad (1)$$

where:

$AdjW_{E.t}$ = Adjusted effective weight of the underlying equity index on day *t*, as defined in formula (7).

W_B = Fixed allocation to the underlying bond index.

E_t = The underlying equity index level on day *t*.

B_t = The underlying bond index level on day *t*.

$InterestRate_{t-1}$ = Interest rate on day *t-1*, as detailed in the appendix.

$NumDays_t$ = Number of calendar days between day *t-1* and *t*.

Allocations

Exponentially Weighted Variance and Covariance. On any business day *t*, the index calculates the realized short-term and long-term variances and covariances of the underlying equity and bond indices. The calculations are based on exponentially weighted moving averages.

The short-term equity variance measure at time *t*:

$$EquityVariance_{S,t} = \begin{cases} \lambda_S * EquityVariance_{S,t-1} + (1-\lambda_S) * \left[\ln\left(\frac{E_t}{E_{t-n}} \right) \right]^2 \text{ K } if \text{ K } t > T_0 \\ \sum_{i=m+1}^{T_0} \frac{\alpha_{S,i,m}}{WF_S} * \left[\ln\left(\frac{E_i}{E_{i-n}} \right) \right]^2 \text{ K } if \text{ K } t = T_0 \end{cases}$$

(2a)

The long-term equity variance measure at time *t*:

$$EquityVariance_{L,t} = \begin{cases} \lambda_L * EquityVariance_{L,t-1} + (1-\lambda_L) * \left[\ln\left(\frac{E_t}{E_{t-n}} \right) \right]^2 \text{ K } if \text{ K } t > T_0 \\ \sum_{i=m+1}^{T_0} \frac{\alpha_{L,i,m}}{WF_L} * \left[\ln\left(\frac{E_i}{E_{i-n}} \right) \right]^2 \text{ K } if \text{ K } t = T_0 \end{cases}$$

(2b)

The short-term bond variance measure at time *t*:

$$BondVariance_{S,t} = \begin{cases} \lambda_S * BondVariance_{S,t-1} + (1-\lambda_S) * \left[\ln\left(\frac{B_t}{B_{t-n}} \right) \right]^2 \text{ K } if \text{ K } t > T_0 \\ \sum_{i=m+1}^{T_0} \frac{\alpha_{S,i,m}}{WF_S} * \left[\ln\left(\frac{B_i}{B_{i-n}} \right) \right]^2 \text{ K } if \text{ K } t = T_0 \end{cases} \quad (2c)$$

The long-term bond variance measure at time *t*:

$$BondVariance_{L,t} = \begin{cases} \lambda_L * BondVariance_{L,t-1} + (1-\lambda_L) * \left[\ln\left(\frac{B_t}{B_{t-n}} \right) \right]^2 \text{ K } if \text{ K } t > T_0 \\ \sum_{i=m+1}^{T_0} \frac{\alpha_{L,i,m}}{WF_L} * \left[\ln\left(\frac{B_i}{B_{i-n}} \right) \right]^2 \text{ K } if \text{ K } t = T_0 \end{cases} \quad (2d)$$

The short-term covariance measure at time *t*:

$$Covariance_{S,t} = \begin{cases} \lambda_S * Covariance_{S,t-1} + (1-\lambda_S) * \left[\ln\left(\frac{E_t}{E_{t-n}}\right)\right]\left[\ln\left(\frac{B_t}{B_{t-n}}\right)\right] \text{ if } t > T_0 \\ \sum_{i=m+1}^{T_0} \frac{\alpha_{S,i,m}}{WF_S} * \left[\ln\left(\frac{E_t}{E_{t-n}}\right)\right]\left[\ln\left(\frac{B_i}{B_{i-n}}\right)\right] \text{ if } t = T_0 \end{cases} \quad (2e)$$

The long-term covariance measure at time *t*:

$$Covariance_{L,t} = \begin{cases} \lambda_L * Covariance_{L,t-1} + (1-\lambda_L) * \left[\ln\left(\frac{E_t}{E_{t-n}}\right)\right]\left[\ln\left(\frac{B_t}{B_{t-n}}\right)\right] \text{ if } t > T_0 \\ \sum_{i=m+1}^{T_0} \frac{\alpha_{L,i,m}}{WF_L} * \left[\ln\left(\frac{E_t}{E_{t-n}}\right)\right]\left[\ln\left(\frac{B_i}{B_{i-n}}\right)\right] \text{ if } t = T_0 \end{cases} \quad (2f)$$

where:

E_t = The underlying equity index level at time *t.*

B_t = The underlying bond index level at time *t.*

T_0 = The start date of the S&P Managed Risk Index.

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_S = 0.94.

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. λ_L = 0.97.

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

$$\alpha_{S,t} = (1-\lambda_S) * \lambda_S^{N+m-i} \quad (3a)$$

$$WF_S = \sum_{i=m+1}^{T_0} \alpha_{S,i,m} \quad (3b)$$

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

$$\alpha_{L,t} = (1-\lambda_L) * \lambda_L^{N+m-i} \quad (3c)$$

$$WF_L = \sum_{i=m+1}^{T_0} \alpha_{L,i,m} \tag{3d}$$

Index Weight and Rebalancing. On any business day *t*, the index calculates the target weight for the underlying equity index as follows:

$$W_{E,t} = Min\left(W_{E,S,t}, W_{E,L,t}\right) \tag{4}$$

where:

$W_{E,t}$ = The weight of the underlying equity index at time *t.*

$W_{E,S,t}$ = The weight of the underlying equity index at time *t*, that solves the short-term target variance equation:

$$TV^2 = {W_{E,S,t}}^2 * EquityVariance_{S,t} + {W_B}^2 * BondVariance_{S,t} + 2 * W_{E,S,t} * W_B * Covariance_{S,t} \tag{5a}$$

$W_{E,L,t}$ = The weight of the underlying equity index at time *t*, that solves the long term target variance equation:

$$TV^2 = {W_{E,L,t}}^2 * EquityVariance_{L,t} + {W_B}^2 * BondVariance_{L,t} + 2 * W_{E,L,t} * W_B * Covariance_{L,t} \tag{5b}$$

where:

TV = Target volatility

W_B = Fixed allocation to the bond index

Note: When solving for equations (5a) and (5b),

- If there are multiple acceptable solutions, the maximum is used.
- If there are no acceptable solutions, zero is used.

Put Option Selection. On any business day *t*, the index will have replicated a constant maturity put option on the underlying equity index with a forward strike that is a multiple *k* of the moving average of the index level. The option delta of the put is calculated from standard Black-Scholes as:

$$\lambda_k = 1 - (1/(252 * AvgPeriod))$$

$$MovingAverage_t = \begin{cases} \lambda_k * MovingAverage_{t-1} + (1-\lambda_k) * IndexTR_t \text{ K } if \text{ K } t > T_0 \\ IndexTR_t \text{ K } if \text{ K } t = T_0 \end{cases}$$

$$d_1 = \frac{\ln\left(\frac{IndexTR_t}{k * MovingAverage_t}\right) + \left(\frac{TV^2}{2}\right) * T}{TV * \sqrt{T}} \tag{6}$$

$$\Delta_t = -N(-d_1)$$

where:

λ_k = The mean-reversion strength factor used for exponential weighting. It determines the weight of each daily index level in the calculation of moving average.

AvgPeriod = A parameter for the index that specifies the speed of mean reversion. Please refer to the appendix for the values used.

k = The multiplier of the put strike. This parameter impacts the forward moneyness of the put option. *k* = 0.875.

T = Time to maturity. *T* = 5 years.

N(*x*) = Standard normal cumulative distribution function.

Adjusted Effective Equity Weight. On any business day *t*, the index adjusts the weight of the underlying equity index using the delta of the put option overlay, subject to a cap based on the maximum allowable leverage and the fixed allocation to the underlying bond index. The index calculates the adjusted effective equity weight as follows:

$$AdjW_{E,t} = \max(0, \min(MaxLeverage - W_B, W_{E,t} + \Delta_t * W_{E,t})) \quad (7)$$

where:

MaxLeverage = The maximum leverage level of the index, which is 100%.

Index Governance

Index Committee

S&P Dow Jones Indices' Global Benchmarks Index Committee maintains the indices. All Committee members are full-time professional members of S&P Dow Jones Indices' staff. The Index Committee meets monthly. At each meeting, the Index Committee reviews any significant market events. In addition, the Index Committee may revise index policy for timing of rebalancings 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 document and/or Fixed Income Policies & Practices document.

Index Policy

Announcements

Announcements of the daily index values are made after the market close each day.

Holiday Schedule

Each index is calculated daily when the underlying equity index is calculated.

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 document.

Recalculation Policy

For more information on the recalculation policy, please refer to S&P Dow Jones Indices' Equity Indices Policies & Practices and Fixed Income Policies & Practices documents for the underlying equity index and bond index, respectively.

For information on Calculations and Pricing Disruptions, Expert Judgment and Data Hierarchy, please refer to S&P Dow Jones Indices' Equity Indices Policies & Practices and Fixed Income Policies & Practices documents for the underlying equity index and bond index, respectively.

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 currency, currency hedged, risk control, and return type versions of the below indices that may exist are also covered by this document. Please contact index_services@spglobal.com for a complete list of indices covered by this document.

Index	Bloomberg
S&P 500 Managed Risk Index	SPXMR
S&P 500 Managed Risk Index - Aggressive	SPXMRA
S&P 500 Managed Risk Index - Moderate Aggressive	SPXMRMA
S&P 500 Managed Risk Index - Moderate	SPXMRM
S&P 500 Managed Risk Index - Moderate Conservative	SPXMRMC
S&P 500 Managed Risk Index - Conservative	SPXMRC
S&P 400 Managed Risk Index	SPMMR
S&P 400 Managed Risk Index - Aggressive	SPMMRA
S&P 400 Managed Risk Index - Moderate Aggressive	SPMMRMA
S&P 400 Managed Risk Index - Moderate	SPMMRM
S&P 400 Managed Risk Index - Moderate Conservative	SPMMRMC
S&P 400 Managed Risk Index - Conservative	SPMMRC
S&P 600 Managed Risk Index	SPSMR
S&P 600 Managed Risk Index - Aggressive	SPSMRA
S&P 600 Managed Risk Index - Moderate Aggressive	SPSMRMA
S&P 600 Managed Risk Index - Moderate	SPSMRM
S&P 600 Managed Risk Index - Moderate Conservative	SPSMRMC
S&P 600 Managed Risk Index - Conservative	SPSMRC
S&P Emerging Plus LargeMidCap Managed Risk Index	SPEMMR
S&P Emerging Plus LargeMidCap Managed Risk Index - Aggressive	SPEMMRA
S&P Emerging Plus LargeMidCap Managed Risk Index - Moderate Aggressive	SPEMMRMA
S&P Emerging Plus LargeMidCap Managed Risk Index - Moderate	SPEMMRM
S&P Emerging Plus LargeMidCap Managed Risk Index - Moderate Conservative	SPEMMRMC
S&P Emerging Plus LargeMidCap Managed Risk Index - Conservative	SPEMMRC
S&P EPAC Ex. Korea LargeMidCap Managed Risk Index	SPBEMR
S&P EPAC Ex. Korea LargeMidCap Managed Risk Index - Aggressive	SPBEMRA
S&P EPAC Ex. Korea LargeMidCap Managed Risk Index - Moderate Aggressive	SPBEMRMA
S&P EPAC Ex. Korea LargeMidCap Managed Risk Index - Moderate	SPBEMRM
S&P EPAC Ex. Korea LargeMidCap Managed Risk Index - Moderate Conservative	SPBEMRMC
S&P EPAC Ex. Korea LargeMidCap Managed Risk Index - Conservative	SPBEMRC
S&P/ASX 200 Managed Risk Index	SPA2MR
S&P/ASX 200 Managed Risk Index - Aggressive	SPA2MRA
S&P/ASX 200 Managed Risk Index - Moderate Aggressive	SPA2MRMA
S&P/ASX 200 Managed Risk Index - Moderate	SPA2MRM
S&P/ASX 200 Managed Risk Index - Moderate Conservative	SPA2MRMC

Index	Bloomberg
S&P/ASX 200 Managed Risk Index - Conservative	SPA2MRC
S&P Global LargeMidCap Managed Risk Index	SPGLMR
S&P Global LargeMidCap Managed Risk Index - Aggressive	SPGLMRA
S&P Global LargeMidCap Managed Risk Index - Moderate Aggressive	SPGLMRMA
S&P Global LargeMidCap Managed Risk Index - Moderate	SPGLMRM
S&P Global LargeMidCap Managed Risk Index - Moderate Conservative	SPGLMRMC
S&P Global LargeMidCap Managed Risk Index - Conservative	SPGLMRC
S&P Global Ex. Australia LargeMidCap Managed Risk Index	SPGXAR
S&P Global Ex. Australia LargeMidCap Managed Risk Index - Aggressive	SPGXARA
S&P Global Ex. Australia LargeMidCap Managed Risk Index - Moderate Aggressive	SPGXARMA
S&P Global Ex. Australia LargeMidCap Managed Risk Index - Moderate	SPGXARM
S&P Global Ex. Australia LargeMidCap Managed Risk Index - Moderate Conservative	SPGXARMC
S&P Global Ex. Australia LargeMidCap Managed Risk Index - Conservative	SPGXARC

FTP

Daily constituent and index level data are available via FTP 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.

Appendix

General Parameters

Short Term Decay Factor (λ_S):	0.94
Long Term Decay Factor (λ_L):	0.97
Time to Maturity (Put Option), *T*:	5 Years
Strike Multiplier (*k*):	0.875

Index Series-Specific Parameters

Index Series	Equity Index	Bond Index	Interest Rate
S&P 500 Managed Risk Index Series	S&P 500	S&P U.S. Aggregate Bond Index	U.S. Overnight Federal Funds Rate
S&P 400 Managed Risk Index Series	S&P MidCap 400		
S&P 600 Managed Risk Index Series	S&P SmallCap 600		
S&P Emerging Plus LargeMidCap Managed Risk Index Series	S&P Emerging Plus LargeMidCap		
S&P EPAC Ex. Korea LargeMidCap Managed Risk Index Series	S&P EPAC Ex. Korea LargeMidCap		
S&P Global LargeMidCap Managed Risk Index Series	S&P Global LargeMidCap		
S&P/ASX 200 Managed Risk Index Series	S&P/ASX 200	S&P/ASX Australian Fixed Interest Index	RBA Overnight Cash Rate
S&P Global Ex. Australia LargeMidCap Managed Risk Index Series	S&P Global Ex. Australia LargeMidCap		

Index Type-Specific Parameters

Index Type	Weight of Bond Index (W_B)	Target Volatility (TV)	Mean Reversion Speed in Years (AvgPeriod)
Managed Risk Index	0%	18%	1.375
Managed Risk Index - Aggressive	10%	16%	1.375
Managed Risk Index - Moderate Aggressive	20%	14%	1.375
Managed Risk Index - Moderate	30%	12%	1.375
Managed Risk Index - Moderate Conservative	40%	10%	1.75
Managed Risk Index - Conservative	50%	8%	2.125

Currency of Calculation

Index Series	Currency
S&P 500 Managed Risk Index Series	USD
S&P 400 Managed Risk Index Series	
S&P 600 Managed Risk Index Series	
S&P Emerging Plus LargeMidCap Managed Risk Index Series	
S&P EPAC Ex. Korea LargeMidCap Managed Risk Index Series	
S&P Global LargeMidCap Managed Risk Index Series	
S&P/ASX 200 Managed Risk Index Series	AUD
S&P Global Ex. Australia LargeMidCap Managed Risk Index Series	

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