Morningstar Portfolio Risk Score
Methodology

Morningstar Analytics
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Overview

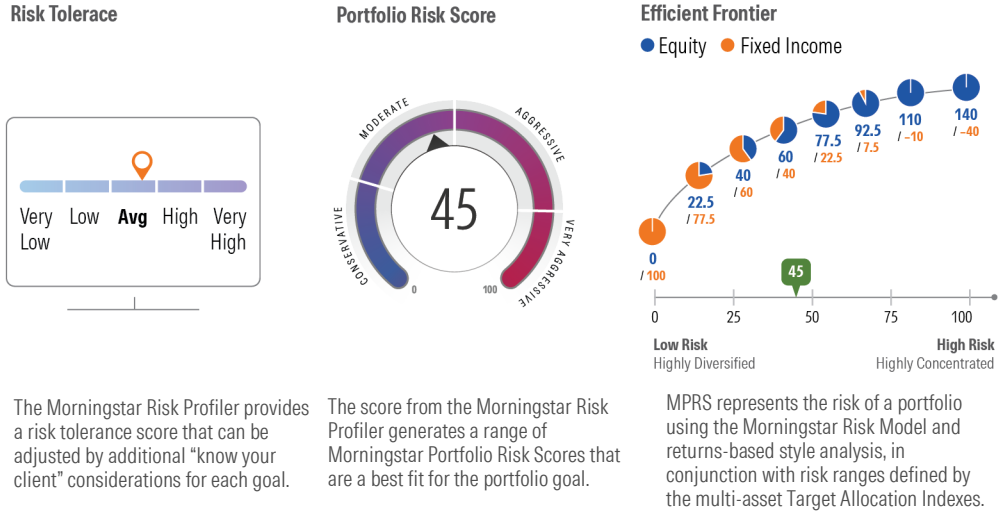
The Morningstar Portfolio Risk Score represents the expected risk of a portfolio and can be used by investors, financial professionals, and those who oversee large groups of financial professionals to assess whether a portfolio's risk matches an investor's risk profile. It has optimal value when combined with the Morningstar Risk Profiler and the personalized Risk Comfort Range of an investor.

At the heart of the system is a risk-scoring engine that is capable of automatically analyzing millions of portfolios and assigning numeric risk scores. Diversified asset-allocation portfolios typically receive a score ranging from 0 to 80, and highly concentrated portfolios and asset-class-specific portfolios (such as a small-growth fund, a sector fund, or a country-specific fund) will typically receive scores between 80 and 100. Scores above 100 indicate elevated to extreme levels of risk and are probably not suitable to represent a complete investor portfolio. The score is based on the portfolio's relationship to an extended risk spectrum based on the Morningstar Target Allocation Index family.

The indexes of the Morningstar Target Allocation Index family provide consistent measures of risk by asset-class exposures to Morningstar building-block indexes and are aligned with the Morningstar Category classifications for asset-allocation funds. The underlying index weights are derived from eligible open-end funds in Morningstar's fund holdings data and therefore reflect the collective wisdom of the numerous asset managers producing asset-allocation funds in the relevant categories. While one cannot invest directly in the Morningstar Target Allocation Index family, we believe the asset allocations embedded in these indexes represent appropriate asset-allocation portfolios for a wide variety of investors.

While no system can guarantee portfolio quality nor ensure against losses, the MPRS can serve as an additional due diligence tool for investors, financial professionals, compliance officers monitoring a large number of portfolios (or funds), and regulators. The Morningstar Risk Ecosystem is depicted in Exhibit 1.

Exhibit 1 Morningstar Risk Profiler and Portfolio Risk Scoring System—The Advice Flow



The Morningstar Risk Profiler provides a risk tolerance score that can be adjusted by additional "know your client" considerations for each goal.

The score from the Morningstar Risk Profiler generates a range of Morningstar Portfolio Risk Scores that are a best fit for the portfolio goal.

MPRS represents the risk of a portfolio using the Morningstar Risk Model and returns-based style analysis, in conjunction with risk ranges defined by the multi-asset Target Allocation Indexes.

Source: Morningstar.

This document explains the methodology behind the Portfolio Risk Score (the right panel of Exhibit 1) and demonstrates its application.

Volatility-Based Risk Scores

The Portfolio Risk Scores are calculated based on the estimated future volatility of fund returns. These volatility estimates are primarily generated using exposure estimates, factor premia covariance estimates, and idiosyncratic volatility forecasts from the Morningstar Risk Model. As a secondary option, volatility estimates may also be generated using Sharpe's returns-based style analysis for portfolios with insufficient risk model coverage.

Volatility is widely understood as a measure of risk. Exhibits 14 and 15 in Appendix A show that risk is generally higher for funds with style tilts and for funds with higher equity weights in the allocation.

Another popular approach of measuring the level of risk in a portfolio is by how much of the portfolio is in growth assets, typically equities. For example, a 60/40 equity/fixed-income portfolio is typically classified as moderate, and an 80/20 portfolio as aggressive. This approach excels in its simplicity and interpretability but requires the classification of asset classes. Moreover, the percentage of growth assets allocation may not accurately capture the risk of the portfolio across different market conditions as shown in Exhibit 16 in Appendix A. The volatility of the S&P 500 in 2022 was almost twice the volatility in 2017, indicating that the same allocation to growth assets can have vastly different risk levels depending on the market.

Unlike the asset-allocation-based approach, a volatility-based scoring approach is not prone to the ambiguous classification of growth assets and can incorporate diverse and nontraditional investment types (for example, alternatives) that do not fall neatly into an asset-allocation approach. A potential

concern of a volatility-based scoring system is the stability of the score, which could vary significantly as the market condition changes.

To ensure the stability of volatility-based scores while retaining the benefits of an asset-allocation-based approach, portfolios are scored based on their volatility relative to the Morningstar Target Allocation Indexes. The indexes work as anchor points that measure the overall market condition and allow us to retain the connection to the traditional allocation views and risk classification.

Morningstar Target Allocation Indexes

For each family of target-allocation categories, Morningstar creates a corresponding family of multi-asset-class indexes, the Morningstar Target Allocation Indexes. Each year, Morningstar calculates the sub-asset-class weights from the average weights of the funds in the category. Exhibits 2, 3, and 4 show the equity/fixed-income split of the five TAIs (and two additional extensions) in the US, UK, and Japan markets. The two extensions represent the high-risk and the extreme-risk portfolios by uniformly increasing the equity allocations in the Aggressive TAI to a total of 110% and 140% and setting the cash allocation to negative 10% and negative 40%, respectively. Empirical analysis suggests that the well-diversified 140% equity portfolio represents the riskiest advisable portfolio for typical investors, and its volatility forecast is mapped to a score of 100. The TAIs provide breakpoints between risk categories and anchor points for the risk score grids that map the portfolio volatility forecasts into risk scores. The "Morningstar Portfolio Risk Score" section demonstrates how TAIs are used to create risk score grids and define the risk categories. There are three configurations for mapping, including a global mapping for US, Canada, Europe, New Zealand, and Australia, and two local-currency mappings for the UK and Japan.

Exhibit 2 Morningstar US Target Asset Allocation Indexes

Asset Class	Conservative	Moderate Conservative	Moderate	Moderate Aggressive	Aggressive	Aggressive Extension 1	Aggressive Extension 2
US Equity	19.0%	32.5%	52.5%	63.0%	77.5%	92.1%	117.3%
DM xUS Equity	3.5%	6.5%	6.5%	12.5%	13.0%	15.5%	19.7%
EM Equity	0.0%	1.0%	1.0%	2.0%	2.0%	2.4%	3.0%
US Core Bond	54.5%	43.0%	29.0%	14.0%	5.0%	0.0%	0.0%
Global Core Bond ex US	8.0%	6.0%	3.5%	2.0%	0.0%	0.0%	0.0%
US High Yield	0.0%	11.0%	3.0%	3.0%	0.0%	0.0%	0.0%
Cash	4.0%	4.0%	4.5%	3.5%	2.5%	-10.0%	-40.0%

Source: Morningstar.

Exhibit 3 Morningstar UK Target Asset Allocation Indexes

Asset Class	Cautious	Moderate Cautious	Moderate	Moderate Adventurous	Adventurous	Adventurous Extension 1	Adventurous Extension 2
UK Equity	3.5%	7.0%	12.5%	18.0%	18.5%	22.6%	28.8%
DM xEU Equity	6.5%	16.5%	27.0%	37.5%	51.5%	62.9%	80%
DEU xUK Equity	0.0%	4.5%	7.5%	9.5%	12.5%	15.3%	19.5%
EM Equity	0.0%	2.0%	3.0%	5.0%	7.5%	9.2%	11.7%
UK Core Bond	25%	19.5%	13.5%	9.0%	2.0%	0.0%	0.0%
Global xUK Core Bond	56.5%	42.5%	30.5%	15.0%	4.5%	0.0%	0.0%
Cash	8.5%	8.0%	6.0%	6.0%	3.5%	-10.0%	-40.0%

Source: Morningstar.

Exhibit 4 Morningstar Japan Target Asset Allocation Indexes

Asset Class	Conservative	Moderate Conservative	Moderate	Moderate Aggressive	Aggressive	Aggressive Extension 1	Aggressive Extension 2
JP Equity	13.5%	22.5%	19.5%	18.0%	13.0%	15.8%	20.1%
Developed ex JP Equity	9.5%	18.0%	26.0%	31.0%	39.0%	47.4%	60.3%
EM Equity	0.0%	0.0%	2.0%	3.5%	6.5%	7.9%	10.1%
JP Listed Property	0.0%	0.0%	3.5%	6.0%	6.0%	7.3%	9.3%
Global Listed Prop. ex JP	0.0%	1.5%	3.0%	8.0%	26.0%	31.6%	40.2%
JP Fixed Income	57.0%	37.0%	19.0%	11.0%	1.5%	0.0%	0.0%
Global FI ex JP Hdg	18.5%	17.5%	27.0%	19.0%	3.5%	0.0%	0.0%
EM Fixed Income	0.0%	2.0%	0.0%	3.5%	4.5%	0.0%	0.0%
Cash	1.5%	1.5%	0.0%	0.0%	0.0%	-10.0%	-40.0%

Source: Morningstar.

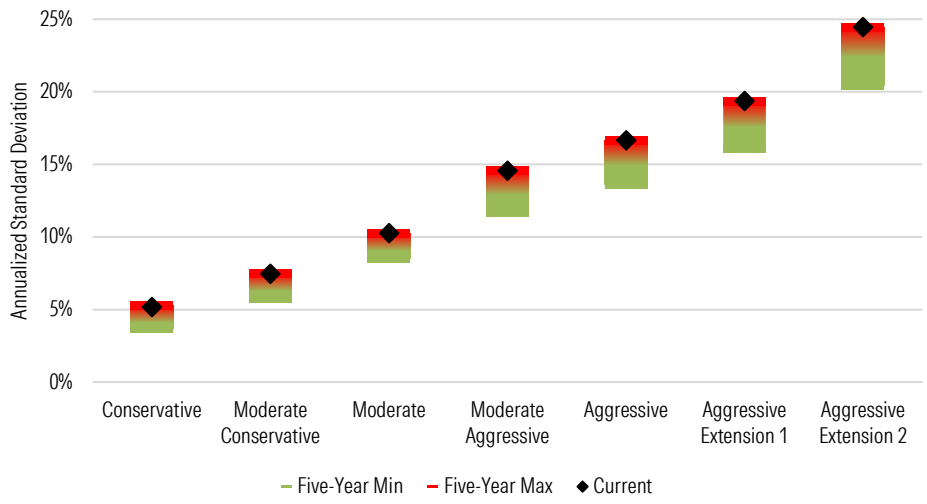
The risk scores are anchored to the growth assets of the TAIs and mapped to the TAIs' latest volatility forecasts. For example, the Aggressive Extension 2 has 140% growth assets, whose volatility forecast of 24.5% is mapped to a score of 100. From this relationship, we can derive a score for the Moderate TAI as 60*(100/140) = 43 and map it to its volatility forecast of 10.9%. The growth asset anchoring and volatility mapping are summarized in Exhibit 5. The risk bands then facilitate the interpretation of risk scores so that the portfolio can be gauged against the individual's risk-comfort range. The risk bands are defined based on the percentiles of TAI forecasts, which are shown in Exhibits 6, 7, and 8. The percentile values, specifically min, median and max, provide the estimated volatility range for each risk band. For example, the conservative risk band has a volatility range from 0% to the median volatility of the Moderately Conservative TAI, which indicates where to draw the line between the conservative and moderate risk bands. The score ranges are simply mapped by the risk score grid.

Exhibit 5 Risk Score Anchoring to US TAI Growth Assets and Mapping to MPRS

Asset Class	Conservative	Moderate Conservative	Moderate	Moderate Aggressive	Aggressive	Aggressive Extension 1	Aggressive Extension 2
Growth Assets (Equity)	22.5%	40.0%	60.0%	77.5%	92.5%	110.0%	140.0%
Fixed Income	77.5%	60.0%	40.0%	22.5%	7.5%	-10.0%	-40.0%
Volatility Forecast	5.2%	7.5%	10.3%	14.6%	16.6%	19.4%	24.5%
MPRS	16	29	43	56	66	79	100

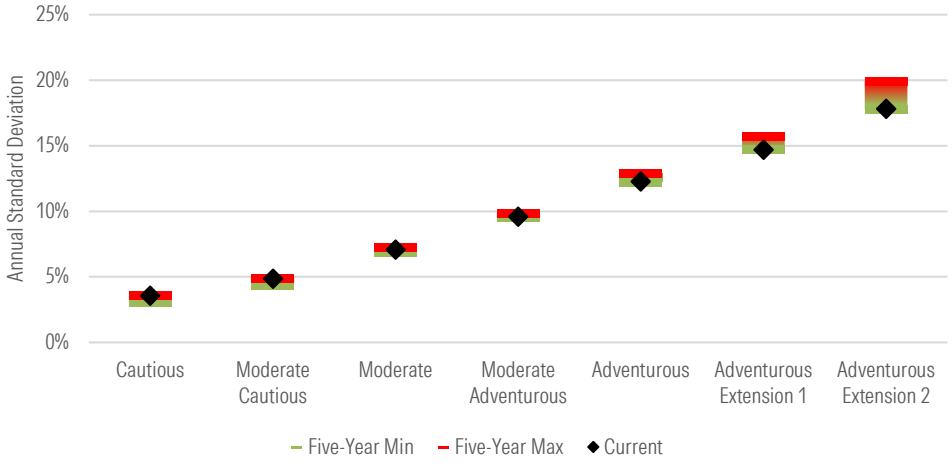
Source: Morningstar.

Exhibit 6 Five-Year Volatility Profiles of US Target Allocation Indexes



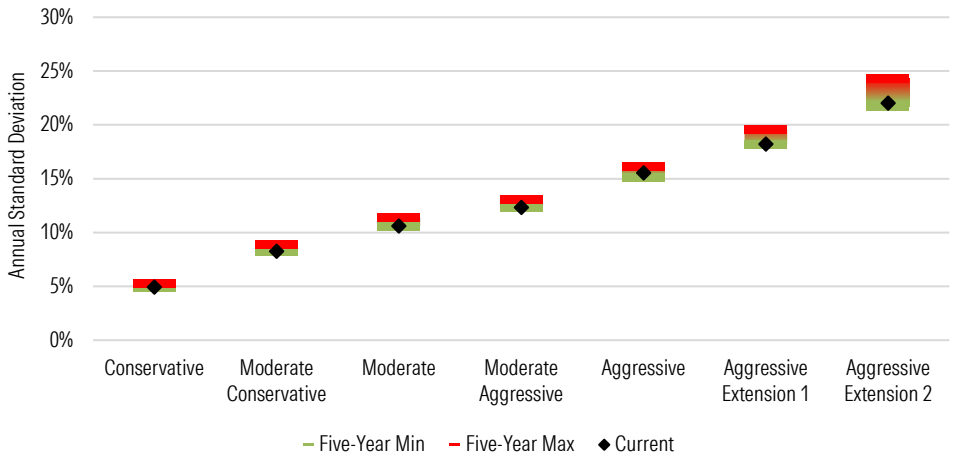
Source: Morningstar.

Exhibit 7 Five-Year Volatility Profiles of UK Target Allocation Indexes



Source: Morningstar.

Exhibit 8 Five-Year Volatility Profiles of Japan Target Allocation Indexes



Source: Morningstar.

Identify Modeling Approach

The Morningstar Portfolio Risk Score uses a consistent methodology to translate a portfolio's level of risk into an overall score. To determine the portfolio's risk estimate, the Portfolio Risk Score system selects between a Morningstar Risk Model-based approach and a returns-based methodology using a returns-based style analysis approach. Between these two approaches, we can cover virtually the entire managed product, stock, and fixed-income universes and client portfolios that hold combinations of these assets. Depending on the information we have about a portfolio, we will select the appropriate methodology to use, with preference given to the Risk Model-based methodology.

Identifying a Portfolio

The process for calculating a Portfolio Risk Score begins by identifying the investments—mutual funds, exchange-traded funds, individual securities, and so on—in the portfolio. When deployed for home office analytics and monitoring, portfolios are typically identified using information from the Morningstar system or a template using Morningstar's unique security identification system. When deployed for direct use by a financial professional (or an individual investor), these users can leverage existing client portfolios, or model portfolios, and upload them using an import feature. Alternatively, they can analyze portfolios on the fly by entering portfolio positions.

The Portfolio Risk Score can also be calculated for managed investment products such as open-end mutual funds, exchange-traded funds, unit investment trusts, US separately managed accounts, model portfolios, variable-annuity/variable-life subaccounts, segregated funds, UK closed-end funds and pooled funds, as well as certain nonmanaged investments like structured products.

The automated analysis of an investment or portfolio is dependent on Morningstar having at least 80% risk model coverage to be eligible for the Risk Model-based methodology, or sufficient returns data

(outlined below) to be eligible for the RBSA methodology. In order to maintain the highest standards of quality, certain risk model coverage has been determined to be ineligible for purposes of MPRS calculation on a category-by-category basis. Refer to Appendix D for more information.

For managed products like funds or ETFs, the process is to score anything with more than 80% risk model coverage. For managed products without sufficient risk model coverage, we require at least 24 months of return history to be eligible for the RBSA approach. We will automatically use proxy return data based on the managed product's category average returns to fill in missing return history up to the required 48 months. For individual securities, the security is covered via the Risk Model-based approach, provided it falls within the Risk Model coverage universe.

For a client (bespoke) portfolio, we use a special process to determine whether to score the portfolio and the approach for the risk estimate. Since there may be many constituents in a client portfolio, we need to examine our coverage of the constituents to determine whether to score or not.

The client portfolio will be scored using the Risk Model-based approach if the weighted sum of each portfolio holding's risk model coverage weight is at least 80%. Upon insufficient risk model coverage data, the returns-based approach will be invoked.

For a returns-based approach, we have a 50% threshold on the amount of real (nonproxied) return data and 90% threshold on the amount of combined return data (real and proxied) to ensure that the aggregated return is meaningfully driven by the holdings, not approximated by the category average, and is fully representative of the overall portfolio. In case of 90% combined returns, the missing 10% is assumed to have the same risk level as the covered returns rather than assumed to be cash. To do so, we check for a percentage of real return data as following:

$$\%\ of\ real\ return_{overall} = \sum_{i=1}^{n} w_i \left(\frac{\#\ of\ overall\ return\ months_i}{48}\right) \cdot \left(1 - \sum_{i=1}^{n} w_i \left(\frac{\#\ of\ proxied\ return\ months_i}{\#\ of\ overall\ return\ months_i}\right)\right)$$

for holding i and a total number of holdings n.

Some scenarios of how a risk score approach (Risk Model-based versus RBSA) is selected for a bespoke portfolio are described in Exhibits 9 and 10:

Exhibit 9 The Risk Model-Based Scenario: The Overall Risk Model Coverage Is at Least 80%

	Weight	Risk Model Coverage
Holding 1	10%	70%
Holding 2	15%	75%
Holding 3	15%	80%
Holding 4	30%	95%
Holding 5	30%	100%
Weighted Sum		**88.8% (≥ 80%)**

Holdings Coverage = 10%×70% + 15%×75% + 15%×80% + 30%×95% + 30%×100% = 88.8%

Exhibit 10 RBSA Scenario: The Percentage of Real Return Data Is More Than 50%

	Weight	Risk Model Coverage	Nonproxied Return (Months)	Proxied Return (Months)	Overall (Nonproxied + Proxied) (Months)
Holding 1	10%	20%	45	0	45
Holding 2	15%	25%	12	36	48
Holding 3	15%	65%	35	13	48
Holding 4	30%	75%	10	38	48
Holding 5	30%	100%	48	0	48
Weighted Sum		**68% (< 80%)**			**60.6% (>50%)**

$$\%\ of\ real\ return$$
$$= \left(10\% \times \frac{45}{48} + 15\% \times \frac{48}{48} + 15\% \times \frac{48}{48} + 30\% \times \frac{48}{48} + 30\% \times \frac{48}{48}\right)$$
$$\times \left(1 - \left(10\% \times \frac{0}{45} + 15\% \times \frac{36}{48} + 15\% \times \frac{13}{48} + 30\% \times \frac{38}{48} + 30\% \times \frac{0}{48}\right)\right)$$
$$= 60.6\%$$

Volatility Estimate of Portfolio Returns

The risk score engine takes the volatility estimate and translates it to a risk score. The first step to calculating the Portfolio Risk Score is to estimate the systematic and idiosyncratic risk of a security and portfolio. The volatility estimate is calculated from either the Risk Model-based approach using Morningstar's Risk Model or an RBSA approach.

Volatility Estimate Using the Morningstar Risk Model-Based Approach

With at least 80% risk model coverage, the system uses the outputs from Morningstar's Risk Model to estimate the portfolio's systematic and idiosyncratic risk. The Morningstar Risk Model identifies the systematic drivers of security returns, which are commonly referred to as *factors*. These factors include style, sector, region, and currency for equities, and duration, spread, and credit for fixed income. It then uses the relationship among these factors and securities' factor exposures to estimate the systematic risk of a portfolio. This relationship among factors is captured by the factor variance-covariance matrix, and the Risk Model supports a variety of methods to forecast the comovement. For the purpose of generating risk scores, we use an empirically derived long-horizon sample variance-covariance matrix. In addition to factor premiums, the Risk Model also produces residual terms for individual security,

which represents the returns not explained by the systematic factors. We model the factor comovement over a 20-year window, stock residual volatility using a sigmoid weighted moving standard deviation since inception, and a bond residual volatility using a simple standard deviation over a 65-day window with a 20-day minimum window. For more details about the volatility forecasting models for a variance-covariance matrix and residual volatility, please refer to the Risk Model Methodology document.

If the portfolio holdings coverage is less than 80% but more than 30% and the portfolio is in the eligible categories, its exposure data may be enhanced by Holdings-and-Returns Based Style Analysis and incorporated into the volatility estimate. Please refer to Appendix D of the Risk Model Methodology document for more details.

After low risk model coverage portfolios are enhanced by HaRBSA, the remaining portfolios that still have some missing coverage will be assumed to extend the same portfolio risk to the missing holdings, rather than assuming that the missing holdings are cash. For example, for a portfolio with a 90% coverage, the total portfolio return standard deviation is scaled by 100/90.

This is a more conservative way to estimate the overall portfolio risk, because if the exposures of the missing portion of the portfolio are assumed to be zero (essentially equivalent to cash), it will underestimate the overall risk of the portfolio.

In addition to the risk assessment based on total portfolio volatility, measuring how much of that total risk is unexplained by the risk factors and is instead specific to an individual security or portfolio can provide an additional dimension of risk. Given that the fundamental factors of the risk model can effectively capture most of the systematic risk, high idiosyncratic risk indicates a possible lack of diversification and a higher likelihood of extreme left-tail events. This is especially important when assessing risk for individual stocks because our stock universe shows a median annualized idiosyncratic risk of 37%, whereas it is only 2.4% for portfolios, which could lead to significant drawdowns and more-frequent left-tail events when held individually as a portfolio. Therefore, for the MPRS calculation only, the residual variance is scaled up by an empirically determined multiplier of 2 to recognize that there is potentially additional risk that can emerge from the idiosyncratic risk.

A portfolio's variance at time t, V_t^P, is modeled as:

$$(\sigma_s^P)^2 = (\vec{x}_t^P)^T \boldsymbol{F_t} \vec{x}_t^P \qquad \text{(H-1)}$$

$$(\sigma_u^P)^2 = (\vec{w}_t^P)^T \Delta_t \vec{w}_t^P \qquad \text{(H-2)}$$

$$V_t^P = m_s(\sigma_s^P)^2 + m_u(\sigma_u^P)^2 \qquad \text{(H-3)}$$

Where

$\vec{x}_t^P$ = the m-element vector of the portfolio's exposures to the m Risk Model factors

$\vec{w}_t^P$ = the n-element vector of the portfolio's holdings weights where n is the number of securities in the portfolio

$\boldsymbol{F_t}$ = the m x m factor premium covariance matrix estimate

Δ_t = the n x n diagonal matrix with residual variance estimates along its diagonal

σ_s^P = the systematic risk

σ_u^P = the idiosyncratic risk

m_s = a scaling multiplier of 1 for systematic variance

m_u = a scaling multiplier of 2 for residual variance

Volatility Estimate by Returns-Based Style Analysis Approach

For investments and portfolios with insufficient risk model coverage, the system uses a returns-based style analysis approach to estimate a security, fund, or portfolio's asset allocation. If the portfolio is a single security or fund, the system will analyze the time series of returns of the security or fund. For portfolios with multiple securities or funds, a custom time series of returns is constructed based on the current holdings and weights. Either way that it is determined, the time series of returns is analyzed using returns-based style analysis as put forth in Sharpe [1988, 1992].

Sharpe's returns-based style analysis, a specialized multifactor model, enables investors to determine a portfolio's effective asset mix using nothing more than historical returns and the historical returns of a broad set of asset-class indexes. The method described by Sharpe is a powerful and popular tool for determining the behavior (investment style) of portfolios and evaluating their performance. More formally, returns-based style analysis takes the form:

$$r_{p,t} = x_1 a_{1,t} + x_2 a_{2,t} + \cdots + x_K a_{K,t} + e_t \qquad \text{(R-1)}$$

Where

$r_{p,t}$ = the return of the portfolio for t = 1, 2,...T; T being the number of months, which is usually 48

$c_1, \ldots, c_K$ = the asset-class coefficients for k = 1, 2,...,K; K being the number of asset-class indexes

$a_{1,t}, \ldots, a_{K,t}$ = are the period t returns for the K asset-class indexes

e_t = is the excess return at time t (for example, the portion of the return that is not explained by the returns of the K asset classes)

Returns-based style analysis determines the asset-class coefficients ($x, \ldots, x_K$) that minimize the variance of the excess return series (e_t), typically subject to $x_k \geqslant 0$ for k = 1, 2, ..., K, and $x_1 + x_2, \ldots, x_K = 1$. In other words, the values of the individual coefficients, or exposures, to the K asset classes are equal to or greater than 0 and sum to 1. These asset-class exposures form what is referred to as the *effective asset allocation* of the portfolio.

We use the returns-based style analysis results to form a custom benchmark for the portfolio. The returns on this benchmark are given by:

$$r_{b,t} = x_1 a_{1,t} + x_2 a_{2,t} + \cdots + x_K a_{K,t} \quad \text{(R-2)}$$

Where

$r_{b,t}$ = is the return of the benchmark for t = 1, 2,...,T x

We then regress the benchmark returns on the portfolio returns:

$$r_{p,t} = \alpha + \beta r_{b,t} + u_t \quad \text{(R-3)}$$

Where

u_t = is the residual term of the regression.

We use three results from this regression in the calculation of the risk score:

1. β. We use the estimated beta coefficient in the calculation of the systematic risk of the portfolio (for well-diversified portfolios, beta is close to 1).
2. The standard error of the regression (estimate of the standard deviation of u), which we denote as σ_u. This is our estimate of unsystematic/idiosyncratic risk.
3. R^2. The goodness-of-fit measure. We use this to determine the degree of confidence in the returns-based style analysis model and to set a floor for the Portfolio Risk Score.

For portfolios and securities with insufficient risk model coverage, we use the effective asset mix or effective asset allocation of the portfolio from the returns-based style analysis. This is the K-element vector of weights on the asset-class indexes included in the returns-based style analysis, which we denote as $\vec{x}_P$.

Within a given country/region, we use the longest possible common period of asset index returns to estimate the K×K covariance matrix of asset-class returns, which we denote as V. We calculate the systematic risk of the portfolio as follows:

$$\sigma_S = |\beta| \sqrt{\vec{x}_P{}' \boldsymbol{V} \vec{x}_P} \quad \text{(R-4)}$$

β being the slope coefficient in equation R-3. For the RBSA model, a scaling multiplier of 1.5 was empirically determined to scale up the residual variance. The scaling multiplier here is lower than the Risk Model-based approach because there are fewer factors in the RBSA model, resulting in less systematic risk being captured by the factors, and the scaling multiplier can penalize on the model's lower explanatory power rather than accounting for additional risk that comes from the idiosyncratic risk. Similarly, as shown in equation H-3, we combine this systematic risk with the scaled idiosyncratic risk to calculate the total risk that will ultimately be translated into the risk score.

In the HaRBSA model, the same scaling multiplier of 1.5 is applied because the HaRBSA model is agnostic of the holdings' residual variances, and the portfolio residual variance is estimated via a Bayesian regression.

The risk score grid, which maps the volatilities to scores, is constructed the same way for all forecasts generated by the risk model. The anchoring points of growth asset weights to scores are based on the latest constituents and volatility forecasts of specific TAIs in each region. Based on this grid for the risk model, a separate grid is created for the returns-based model, which is optimized to reduce the discrepancy between the forecasting methodologies for the risk model and the returns-based model. More details are discussed in the "Morningstar Portfolio Risk Score" section of this paper.

R^2-Based Floor

Returns-based style analysis is only useful if the asset-class index returns sufficiently explain the returns on the portfolio. The goodness-of-fit, or R^2, statistic from the post-returns-based style analysis regression in equation (R-3) measures how well a returns-based style analysis model works. The holdings-based model does not require the post-returns-based style analysis regression and has no floor value for the Portfolio Risk Score. The goodness-of-fit for the holdings-based model is essentially the risk model coverage, and it is addressed by the 80% threshold and the factor exposure scaling.

A low R^2 indicates that there are other factors in the portfolio at play besides the asset-class returns. Since the Portfolio Risk Score is based on asset-class exposures, a low R^2 indicates that risk score is not an appropriate way to assess the risk of the portfolio.

We use the R^2 from the post-returns-based style analysis regression to set a floor on the value of the Portfolio Risk Score. To report the Portfolio Risk Score, we require that it be at least $100(1\text{-}M\times R^2)$, where M is a parameter that we currently set to 3.

If the asset mix of the portfolio came about through either: 1) holding-based analysis, or 2) by specifying the asset mix apart from any actual investments, R^2 can be taken to be 100%.

Risk Score Decomposition

In certain Morningstar Products, the Portfolio Risk Score can be decomposed into two parts reflecting distinct drivers of risk: illiquidity risk and market risk. These two components sum together to equal the total risk score. The market risk, or volatility, is the portion of risk not attributed to any potential illiquidity risk. The illiquidity risk is intended to highlight the portion of the total portfolio's risk stemming from holding illiquid investments. The investments receiving nonzero illiquidity risk are generally private capital and semiliquid funds, as the lack of guaranteed liquidity introduces additional risk. Semiliquid assets encompass unlisted closed-end funds such as interval, tender-offer, and hedge funds. These investment types limit the amount of redemption opportunities, heightening the difficulty of exiting an investment or converting this investment to cash. Similarly, such an investment type may have less frequent or transparent pricing and/or valuation. On the other hand, market, or volatility, risk

captures the risk stemming from underlying expected price movement and total return volatility. Investments that are estimated to have zero liquidity risk are assumed to be driven solely by market risk.

To decompose the risk score into its two relevant components, we estimate a ratio reflecting the contribution of illiquidity to a fund's risk. This ratio is used to scale the total risk score to produce the risk score driven by illiquidity. To arrive at these ratios, we first estimate a liquidity horizon representing how quickly investors could theoretically redeem their capital over a 10-year period. This concept directly relates to liquidity, as it highlights how difficult it may be to exit an investment. The liquidity horizon is estimated in terms of the frequency with which capital is returned to the investor. This frequency depends on the fund type and vehicle-based restrictions. The liquidity horizon, or capital return frequency, is inversely related to the illiquidity ratios. That is, if investors can redeem their capital frequently, less of the total risk is driven by illiquidity.

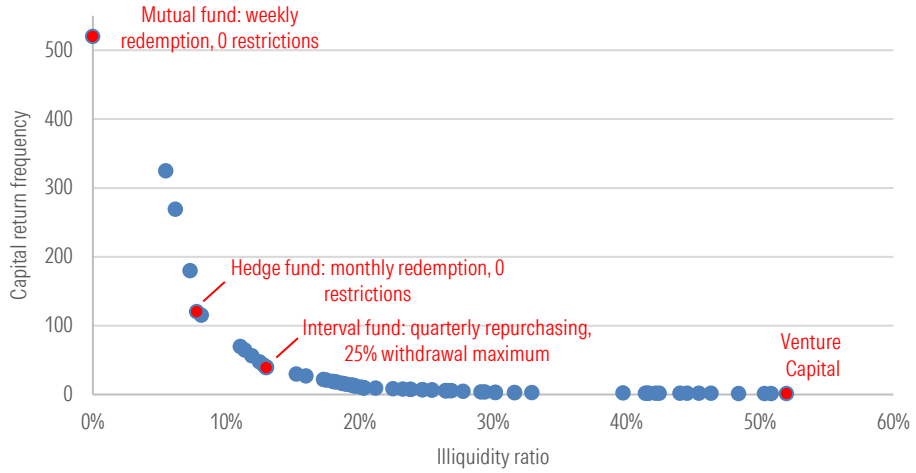
For private assets, before introducing the liquidity horizon, we first calculate an initial illiquidity ratio using the volatility estimation methodology for MPRS for private funds known as RAMQUEST. The ultimate goal of the RAMQUEST process is to increase a private capital fund's reported volatility to align more closely with expectations. There are four main steps in the RAMQUEST adjustment, and we assume that the liquidity risk is the difference in volatility of the desmoothed returns and the final adjusted returns. This volatility difference is then divided by the total final adjusted risk to produce a ratio. For more details on RAMQUEST, see the private capital fund risk modeling methodology document. We then rescale these ratios to align with the capital return frequency, ensuring that those with a larger return frequency result in a lower illiquidity risk ratio.

For semiliquid assets, we calculate the liquidity horizons by using data points that directly reflect the liquidity offered to the investor, such as redemption frequency for hedge funds and repurchase frequency for interval and tender-offer funds. The lower the redemption and repurchase frequencies, the fewer opportunities an investor has to seek liquidity. For hedge funds, there are additional restrictions, such as the initial period in which an investor is restricted from withdrawing their investment, known as the lockup period. Similarly, some funds may require an advanced notice period before an investor can redeem. Both attributes can further reduce the liquidity of the funds. Interval and tender-offer funds provide liquidity to their investors through the predefined repurchase frequencies, but they also limit the amount of capital that can be returned in each period based on a percentage of the fund's outstanding shares. These attributes are used to estimate the capital return frequency. We rescale the capital return frequency to vary between zero and the maximum private capital ratio because we assume that semiliquid investments are at most as illiquid as private investments. These rescaled values are taken as the illiquidity ratio.

To exemplify this, assume a hedge fund offers weekly redemptions with zero lockup period and an advanced notice period. From this data, we assume that an investor could theoretically redeem 520 times over a 10-year period. This is a highly liquid redemption schedule, implying an investor could have their capital returned quickly, so this hedge fund receives an illiquidity ratio of zero. If the hedge fund had a nonzero lockup or advance notice period, we would penalize the capital return frequency of

520 based on how large this period is, and the ratio would increase. A fund with a frequent redemption or repurchase schedule, along with the opportunity for larger withdrawals, implies that the fund is more liquid because the investor can redeem relatively more quickly over a long horizon, resulting in a smaller illiquidity risk ratio. On the other hand, a fund with fewer opportunities to redeem over the period will result in a larger illiquidity ratio. Exhibit 11 highlights how the capital return frequency over a 10-year period relates to the liquidity ratios.

Exhibit 11 Illiquidity Risk Ratios vs. Capital Return Frequency



Source: Morningstar.

Morningstar Portfolio Risk Score

For the calculation regions in the US, Canada, Australia, New Zealand, and Europe, the frame of reference for mapping the volatilities to risk scores is based on the distribution of US TAI volatility estimates. Exhibits 17 and 18 in Appendix A present the volatility profiles and percentiles of the US TAIs and extensions that provide stable and nonoverlapping anchor points over time. Through a series of empirical analysis of volatility distributions, we have determined that the median values of the Moderate Conservative and Moderate Aggressive TAIs can serve as the breakpoints among conservative, moderate, and aggressive risk bands. For very aggressive and extreme risk bands, we use the maximum values of the Aggressive Extension 1 and Aggressive Extension 2 TAIs.

For the UK calculation region, the risk score mapping is based on the distribution of UK TAI volatility estimates using local-currency returns to align the MPRS with the local UK asset-allocation standards and support the local perspective of UK portfolio advisors. For example, instead of using volatility estimates from the USD risk model and anchoring to the US market, the local RBSA model is used to independently identify what volatility level is considered “cautious” in the UK market. Currently, local-currency risk models are not available for the Risk Model-based risk score calculations, and as such, UK securities are excluded from the Risk Model calculation universe. As seen in the US calculation region,

Exhibit 19 shows that the TAI volatility estimates provide stable anchor points over time, and Exhibit 20 shows the five-year volatility ranges corresponding to each risk band.

The Japan calculation region is constructed similarly to the UK region and follows the same guidelines outlined above, using the Japan TAI.

In consultation with consuming products and advisor clients, it has been determined that 140% growth assets (equity, REITs, and so on) would introduce the maximum risk, and this weight is mapped to a score of 100. It serves as an upper limit for a client's portfolio, with anything more aggressive than 100 being normally reserved for concentrated or inherently risky investments that are not suitable for clients under normal circumstances. Therefore, the synthetic TAI with 140% growth assets receives a score of 100, and its latest forecast is anchored to this score. From this anchor point, all other anchor points can be calculated for other TAIs. For example, the Moderate TAI is assigned a score of 60*(100/140) = 43, and this score is mapped to its latest forecast of 10.3%. Exhibit 12 shows the volatility ranges and corresponding risk score ranges for all calculation regions.

In addition to the simplified system of three risk categories (conservative, moderate, and aggressive), Appendix B shows a system of five traditional risk categories (conservative, moderately conservative, moderate, moderately aggressive, and aggressive) that provides a more granular classification of risk scores. The same risk score grid is used for consistent mapping between volatilities and risk scores, but the volatility ranges of the "categories" can be different. For purposes of assigning a risk score category to an MPRS score, the conventional rounding is applied to the raw MPRS number. As an example, an MPRS of 23.78 would be considered as 24, or moderate.

Exhibit 12 Mapping Between Portfolio Annual Volatility and Risk Scores

For the US calculation region:

	Volatility Range (Risk Model)	Volatility Range (RBSA)	Risk Score Range
Conservative	0.0% ≤ vol < 6.5%	0.0% ≤ vol < 5.6%	0 ≤ RS < 24
Moderate	6.5% ≤ vol < 13.7 %	5.6% ≤ vol < 10.5%	24 ≤ RS < 53
Aggressive	13.7% ≤ vol < 19.4%	10.5% ≤ vol < 16.7%	53 ≤ RS < 79
Very Aggressive	19.4% ≤ vol < 24.5%	16.7% ≤ vol < 24.4%	79 ≤ RS < 100
Extreme Risk	24.5% ≤ vol ≤ 50.0%	24.4% ≤ vol ≤ 50.0%	100 ≤ RS ≤ 200

For the calculation regions in Canada, Australia, New Zealand, and Europe:

	Volatility Range	Risk Score Range
Conservative	0.0% ≤ vol < 6.5%	0 ≤ RS < 24
Moderate	6.5% ≤ vol < 13.7%	24 ≤ RS < 53
Aggressive	13.7% ≤ vol < 19.4%	53 ≤ RS < 79
Very Aggressive	19.4% ≤ vol < 24.5%	79 ≤ RS < 100
Extreme Risk	24.5% ≤ vol ≤ 50.0%	100 ≤ RS ≤ 200

For the UK calculation region:

	Volatility Range	Risk Score Range
Cautious	0.0% ≤ vol < 4.6%	0 ≤ RS < 22
Moderate	4.6% ≤ vol < 9.7%	22 ≤ RS < 47
Adventurous	9.7% ≤ vol < 15.7%	47 ≤ RS < 76
Very Adventurous	15.7% ≤ vol < 20.0%	76 ≤ RS < 97
Extreme Risk	20.0% ≤ vol ≤ 50.0%	97 ≤ RS ≤ 200

For the Japan calculation region:

	Volatility Range	Risk Score Range
Conservative	0.0% ≤ vol < 8.6%	0 ≤ RS < 32
Moderate	8.6% ≤ vol < 12.6%	32 ≤ RS < 48
Aggressive	12.6% ≤ vol < 19.6%	48 ≤ RS < 86
Very Aggressive	19.6% ≤ vol < 24.3%	86 ≤ RS < 108
Extreme Risk	24.3% ≤ vol ≤ 50.0%	108 ≤ RS ≤ 200

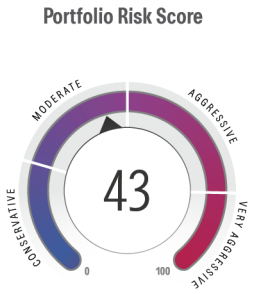
Source: Morningstar.

Based on the TAI growth asset anchoring and score mapping outlined in Exhibit 5, we construct the 50,000-point grid that prepopulates the volatility to score mapping. The points between TAI anchors are linearly interpolated. Since the volatility forecasts are stable over time, the grid is adjusted once a year to reflect the current market environment. This ensures that the scores are calculated relative to the broad investable universe, whose changes reflect the shifts of the fund's risk level, not the shifts of the overall market risk. Depending on the region and the scoring methodologies, we map the volatilities to scores using four risk score grids based on 1) the Risk Model volatility estimates for US, Canada, Australia, New Zealand, and Europe, 2) the USD RBSA volatility estimates for the US, 3) the GBP RBSA volatility estimates for the UK, and 4) the JPY RBSA volatility estimates for Japan. The RBSA risk score grid was additionally created for the US region to reduce the discrepancy between the Risk Model-based and RBSA scoring methodologies. As shown in Exhibit 12, RBSA volatility ranges have been adjusted so that RBSA scores increase in general, giving more impact on scores between 40 and 80, to be more aligned with the Risk Model-based scores.

Mapping to Risk Comfort Range

Exhibit 13 illustrates what the financial professional and client would jointly see in the expression of the Risk Comfort Range. Here, it is presented in the orientation of the current or proposed portfolio with a Portfolio Risk Score of 43, in relation to the individual's Risk Comfort Range of 34-47. The Risk Comfort Range was determined as the range of 34-47 based on a suitability score of 57. The Portfolio Risk Score (43) falls within the bounds of the Risk Comfort Range.

Exhibit 13 Risk Comfort Range of 34-47 (Suitability Score of 57) and Morningstar Portfolio Risk Score of 43



Source: Morningstar.

Risk Comfort Range is a crucial concept, as it diverges from most legacy solutions that simplified systems to categorize clients and products into static investment policy bands. Clients are grouped in these bands, and products and portfolios are rated to be appropriate for people in a specific band or higher. As an example, money market funds may be rated a 1, fixed income a 2, allocation funds a 3, large-cap developed equity a 4, and emerging-market and small-cap funds a 5. A client in band 3 can be recommended products from bands 1, 2, or 3—but not from higher-risk bands.

The products and portfolios are themselves scored using the Portfolio Risk Score on a scale from 0 to 80 for diversified asset-allocation portfolios, to whatever is appropriate above this, based on the risk of the portfolio. Asset-allocation funds generally score within 80, while a portfolio composed of one or two stocks might have a score in excess of 100.

The Risk Comfort Range introduces a tailored band for a client where the range is a good fit for them. This addresses issues with legacy systems where a client may be at the high end of band 3 but still not allowed access to band 4 products. This means that a portfolio or product may fall in the Risk Comfort Range of clients who, as an example, were historically in the high end of band 3 and the lower end of band 4.

The Risk Comfort Range is instrumental in providing more tailored personal advice to clients and a more versatile ability to apply investment solutions. Financial professionals can blend adjacent preconstructed portfolios for a client, arriving at a best-fit solution from a risk-profiling perspective.

For more information on the Risk Comfort Range, please refer to the Morningstar Risk Comfort Range Methodology document.

Conclusion

Financial professionals and those who oversee groups of financial professionals have a duty to make sure the portfolios they are using are well-diversified and that they are assigning individuals to an

appropriate risk-based portfolio. With the creation of the volatility-based Morningstar Portfolio Risk Score, there is an objective and rigorous way for financial professionals (and individuals) to clearly understand how portfolio risk is measured, including an assessment of nontraditional portfolio constructions that was otherwise challenging in the asset-allocation approach.

This system enables investors, financial professionals, compliance personnel, and regulators to assess risk (using a risk score) relative to the long-term risk profiles of Asset Allocation Indexes, in which the indexes have been used to create an intuitive risk spectrum. The system recalibrates the risk score grid to reflect changing volatility levels in the overall market. Because the risk score engine is powered by the Morningstar Risk Model, it can be further enhanced by the full capabilities of the holdings-based style analysis such as factor decomposition and in-depth analysis of risk attribution.

The Morningstar Portfolio Risk Score enables investors to be matched with portfolios that align with their risk profile, as well as measure the risk of concentrated portfolios.

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Appendix A: Data

The volatility estimates presented here are from Morningstar Risk Model, and the time horizon is one year as of July 31, 2025. The time windows for the forecast calculation are 20 years for the factor covariance matrix and three months for residual variance. The historical returns were used to calculate the realized volatilities in Exhibit 16.

Exhibit 14 Estimated Annual Standard Deviations for the Morningstar Style Box Indexes

	Value	Blend	Growth
Large	15.4%	17.4%	20.8%
Median	18.2%	18.3%	20.1%
Small	21.3%	20.8%	21.6%

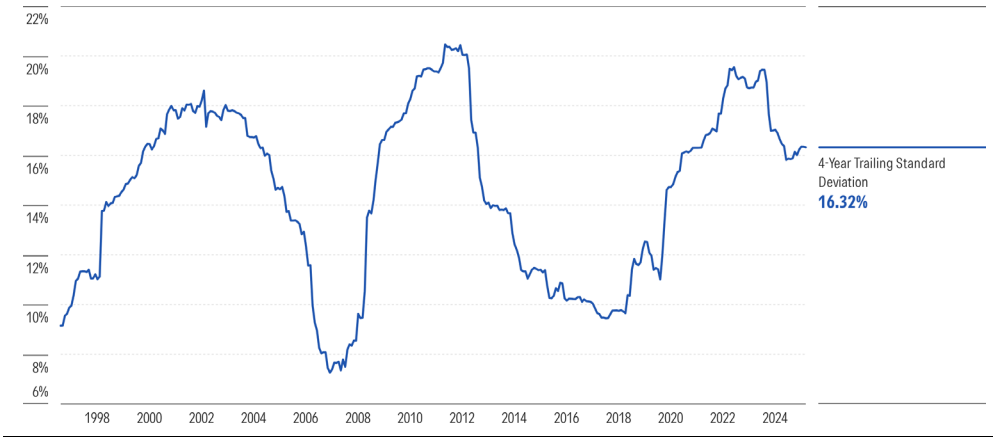
Source: Morningstar.

Exhibit 15 Estimated Annual Standard Deviations for the US Morningstar Target Allocation Indexes

Name of TAI	Equity	Fixed Income	Estimated Annual Standard Deviation
Morningstar US Conservative TAI	22.5%	77.5%	5.2%
Morningstar US Moderate Conservative TAI	40.0%	60.0%	7.5%
Morningstar US Moderate TAI	60.0%	40.0%	10.3%
Morningstar US Moderate Aggressive TAI	77.5%	22.5%	14.6%
Morningstar US Aggressive TAI	92.5%	7.5%	16.6%
Morningstar US Aggressive TAI Extended 1	110.0%	0.0%	19.4%
Morningstar US Aggressive TAI Extended 2	140.0%	0.0%	24.5%

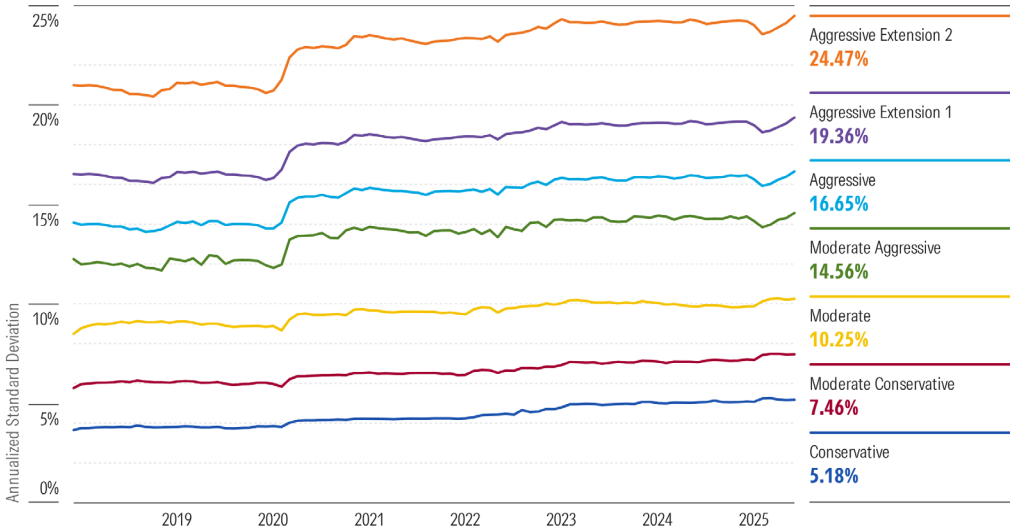
Source: Morningstar.

Exhibit 16 Historical Annualized Four-Year Trailing Standard Deviation of S&P 500 Monthly Returns



Source: Morningstar.

Exhibit 17 Time Series of US TAI Volatility Estimates



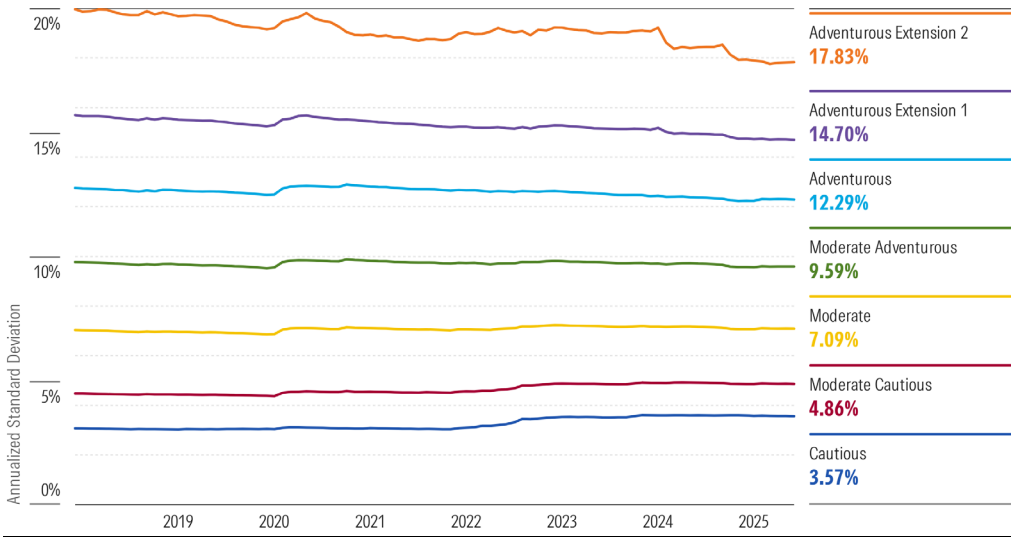
Source: Morningstar.

Exhibit 18 Percentiles of US TAI Volatility Estimates

Percentile	Conservative	Moderate Conservative	Moderate	Moderate Aggressive	Aggressive	Aggressive Extension 1	Aggressive Extension 2
0%	3.7%	5.8%	8.5%	11.7%	13.6%	16.1%	20.4%
10%	3.8%	6.0%	8.9%	12.0%	13.9%	16.4%	20.8%
20%	3.8%	6.1%	9.0%	12.2%	14.0%	16.5%	21.0%
30%	4.0%	6.2%	9.2%	13.2%	15.1%	17.6%	22.4%
40%	4.2%	6.4%	9.5%	13.5%	15.6%	18.2%	23.1%
50%	4.2%	6.5%	9.6%	13.7%	15.7%	18.4%	23.3%
60%	4.4%	6.7%	9.8%	13.8%	15.8%	18.5%	23.5%
70%	4.9%	7.0%	9.9%	14.1%	16.2%	19.0%	24.0%
80%	5.0%	7.1%	10.0%	14.2%	16.3%	19.0%	24.1%
90%	5.1%	7.2%	10.1%	14.3%	16.4%	19.1%	24.2%
100%	5.3%	7.5%	10.3%	14.6%	16.6%	19.4%	24.5%

Source: Morningstar.

Exhibit 19 Time Series of UK TAI Volatility Estimates



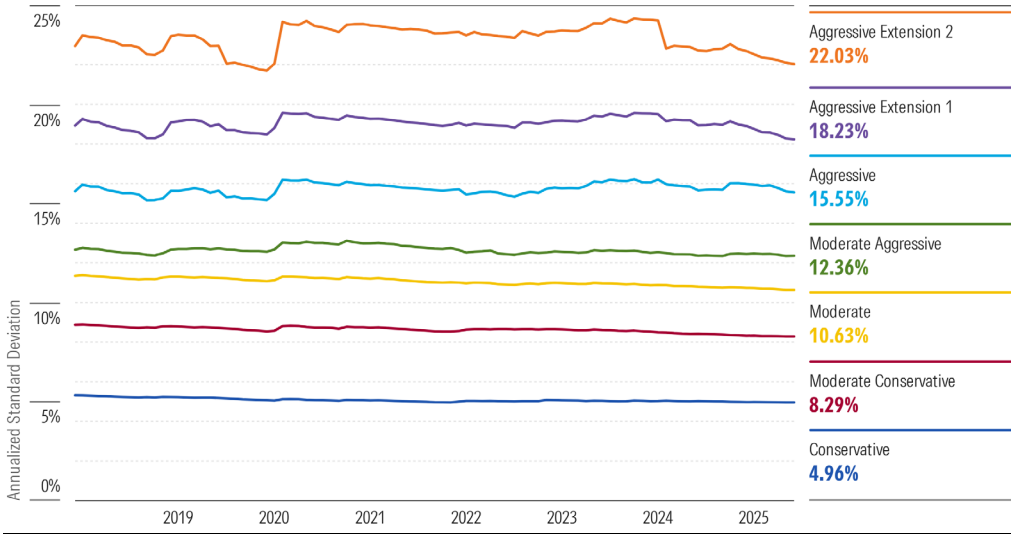
Source: Morningstar.

Exhibit 20 Percentiles of UK TAI Volatility Estimates

Percentile	Cautious	Moderate Cautious	Moderate	Moderate Adventurous	Adventurous	Adventurous Extension 1	Adventurous Extension 2
0%	3.03%	4.37%	6.86%	9.53%	12.24%	14.70%	17.76%
10%	3.05%	4.43%	6.94%	9.59%	12.33%	14.91%	18.36%
20%	3.05%	4.45%	6.98%	9.65%	12.44%	15.13%	18.71%
30%	3.06%	4.51%	7.04%	9.68%	12.53%	15.17%	18.91%
40%	3.08%	4.54%	7.06%	9.71%	12.60%	15.22%	19.02%
50%	3.10%	4.56%	7.08%	9.72%	12.62%	15.27%	19.08%
60%	3.24%	4.65%	7.10%	9.74%	12.64%	15.35%	19.20%
70%	3.52%	4.86%	7.13%	9.76%	12.68%	15.47%	19.34%
80%	3.57%	4.87%	7.17%	9.78%	12.73%	15.52%	19.68%
90%	3.60%	4.90%	7.19%	9.82%	12.80%	15.59%	19.75%
100%	3.61%	4.92%	7.23%	9.88%	12.90%	15.69%	19.96%

Source: Morningstar.

Exhibit 21 Time Series of Japan TAI Volatility Estimates



Source: Morningstar.

Exhibit 22 Percentiles of Japan TAI Volatility Estimates

Percentile	Conservative	Moderate Conservative	Moderate	Moderate Aggressive	Aggressive	Aggressive Extension 1	Aggressive Extension 2
0%	4.96%	8.28%	10.63%	12.35%	15.16%	18.23%	21.70%
10%	4.98%	8.38%	10.77%	12.41%	15.36%	18.58%	22.22%
20%	5.01%	8.53%	10.88%	12.47%	15.53%	18.81%	22.72%
30%	5.02%	8.57%	10.93%	12.51%	15.61%	18.93%	22.94%
40%	5.03%	8.61%	10.98%	12.56%	15.68%	18.99%	23.35%
50%	5.05%	8.64%	11.02%	12.60%	15.75%	19.08%	23.48%
60%	5.07%	8.66%	11.14%	12.65%	15.85%	19.14%	23.65%
70%	5.08%	8.73%	11.21%	12.70%	15.92%	19.21%	23.73%
80%	5.18%	8.75%	11.25%	12.76%	16.02%	19.28%	23.95%
90%	5.23%	8.80%	11.29%	12.98%	16.10%	19.45%	24.09%
100%	5.32%	8.89%	11.38%	13.12%	16.22%	19.57%	24.33%

Source: Morningstar.

Appendix B: Risk Categories

A risk score can belong to either three simplified or five traditional risk categories, as shown in the table below. Both systems use an identical risk score grid to provide consistent mapping between volatilities and risk scores. For example, a risk score of 25 belongs to the Moderate category in the simplified system and the Moderately Conservative category in the traditional system.

Exhibit 23 Volatility Range and Risk Score Range for Risk Categories

For the calculation regions in the US, Canada, Australia, New Zealand, and Europe:

	Simplified Three Risk Categories (plus Two Extreme Risk Categories)		Traditional Five Risk Categories (plus Two Extreme Risk Categories)	
	Volatility Range	Risk Score Range	Volatility Range	Risk Score Range
Conservative	0% ≤ vol < 6.5%	0 ≤ RS < 24	0% ≤ vol < 5.5%	0 ≤ RS < 18
Moderately Conservative			5.5% ≤ vol < 8.0%	18 ≤ RS < 32
Moderate	6.5% ≤ vol < 13.7%	24 ≤ RS < 53	8.0% ≤ vol < 11.0%	32 ≤ RS < 45
Moderately Aggressive			11.0% ≤ vol < 14.1%	45 ≤ RS < 54
Aggressive	13.7% ≤ vol < 19.4%	53 ≤ RS < 79	14.1% ≤ vol < 19.4%	54 ≤ RS < 79
Very Aggressive	19.4% ≤ vol < 24.5%	79 ≤ RS < 100	19.4% ≤ vol < 24.5%	79 ≤ RS < 100
Extreme Risk	24.5% ≤ vol ≤ 50%	100 ≤ RS ≤ 200	24.5% ≤ vol ≤ 50%	100 ≤ RS ≤ 200

For the UK calculation region:

	Simplified Three Risk Categories (plus Two Extreme Risk Categories)		Traditional Five Risk Categories (plus Two Extreme Risk Categories)	
	Volatility Range	Risk Score Range	Volatility Range	Risk Score Range
Cautious	0% ≤ vol < 4.6%	0 ≤ RS < 22	0% ≤ vol < 4.0%	0 ≤ RS < 19
Moderately Cautious			4.0% ≤ vol < 5.9%	19 ≤ RS < 29
Moderate	4.6% ≤ vol < 9.7%	22 ≤ RS < 47	5.9% ≤ vol < 8.4%	29 ≤ RS < 41
Moderately Adventurous			8.4% ≤ vol < 11.1%	41 ≤ RS < 54
Adventurous	9.7% ≤ vol < 15.7%	47 ≤ RS < 76	11.1% ≤ vol < 15.7%	54 ≤ RS < 76
Very Adventurous	15.7% ≤ vol < 20.0%	76 ≤ RS < 97	15.7% ≤ vol < 20.0%	76 ≤ RS < 97
Extreme Risk	20.0% ≤ vol ≤ 50%	97 ≤ RS ≤ 200	20.0% ≤ vol ≤ 50%	97 ≤ RS ≤ 200

For the Japan calculation region:

	Simplified Three Risk Categories (plus Two Extreme Risk Categories)		Traditional Five Risk Categories (plus Two Extreme Risk Categories)	
	Volatility Range	**Risk Score Range**	**Volatility Range**	**Risk Score Range**
Conservative	0% ≤ vol < 8.6%	0 ≤ RS < 32	0% ≤ vol < 6.8%	0 ≤ RS < 25
Moderately Conservative			6.8% ≤ vol < 9.8%	25 ≤ RS < 36
Moderate	8.6% ≤ vol < 12.6%	32 ≤ RS < 48	9.8% ≤ vol < 11.9%	36 ≤ RS < 45
Moderately Aggressive			11.9% ≤ vol < 14.1%	45 ≤ RS < 56
Aggressive	12.6% ≤ vol < 19.6%	48 ≤ RS < 86	14.1% ≤ vol < 19.6%	56 ≤ RS < 86
Very Aggressive	19.6% ≤ vol < 24.3%	86 ≤ RS < 108	19.6% ≤ vol < 24.3%	86 ≤ RS < 108
Extreme Risk	24.3% ≤ vol ≤ 50%	108 ≤ RS ≤ 200	24.3% ≤ vol ≤ 50%	108 ≤ RS ≤ 200

Appendix C: MPRS for Sample Funds

Exhibit 24 MPRS for Sample Funds in Different Sectors and Regions

Name	SecId	Morningstar Category	Base Currency	Risk Score
Invesco S&P 500 Equal Weight Utilts ETF	FOUSA05V5P	US Fund Utilities	USD	54
Dimensional US Targeted Value ETF	F0000162E9	US Fund Small Value	USD	91
Vanguard Short-Term Investment-Grade Adm	FOUSA00H6E	US Fund Short-Term Bond	USD	8
iShares Global REIT ETF	F00000T1FW	US Fund Real Estate	USD	77
SPDR Portfolio S&P 500 ETF	FEUSA04AE6	US Fund Large Blend	USD	73
iShares US Energy ETF	FEUSA0000T	US Fund Equity Energy	USD	106
iShares JP Morgan USD Em Mkts Bd ETF	FOUSA06LLM	US Fund Emerging Markets Bond	USD	42
SPDR Portfolio Corporate Bond ETF	F00000M8DJ	US Fund Corporate Bond	USD	22
SPDR Blmbg Intl Corp Bd ETF	F00000GX0C	US Fund Global Bond	USD	42
iShares US Consumer Staples ETF	FEUSA0000S	US Fund Consumer Defensive	USD	50
SPDR S&P Telecom ETF	FEUSA04AHG	US Fund Communications	USD	93
WisdomTree US Hi Yld Corp Bd	F00000WTHP	US Fund High Yield Bond	USD	37
TD High Yield Bond - I	F0CAN05MF4	Canada Fund High Yield Fixed Income	CAD	51
iShares MSCI World ETF	F000003V29	Canada Fund Global Equity	CAD	69
RBC Global Corporate Bond Fund A	F0CAN05PDI	Canada Fund Global Corporate Fixed Income	CAD	45
BMO Mid Corporate Bond ETF	F000005PNY	Canada Fund Canadian Corporate Fixed Income	CAD	37
Invesco Canadian Plus Div Cl Ser A	F0CAN070P2	Canada Fund Canadian Dividend & Income Equity	CAD	77
Invesco Pure Canadian Equity Cl Ser A	F0CAN05OB7	Canada Fund Canadian Equity	CAD	82
TD Canadian Small Cap Equity - F	F0CAN06GXZ	Canada Fund Canadian Small/Mid Cap Equity	CAD	98
Invesco Global Real Estate F	F000000R29	Canada Fund Real Estate Equity	CAD	75
Mackenzie US Mid Cap Opportunities A	F000015AKN	Canada Fund US Small/Mid Cap Equity	CAD	86
Dimensional Global Core Equity AUD Hgd	F0AUS06YSK	Australia Fund Equity World Large Blend	AUD	48
Dimensional Global Core Equity AUD Hgd	F000002BMN	Australia Fund Equity World - Currency Hedged	AUD	57
Vanguard International Property Secs Idx	F0AUS066H8	Australia Fund Equity Global Real Estate	AUD	56
Schroder Australian Equity Fund - PC	F0AUS05F6S	Australia Fund Equity Australia Large Blend	AUD	49
SPDR MSCI Australia Sel Hi Div Yld ETF	F00000JU4P	Australia Fund Equity Australia Large Value	AUD	52
Dimensional UK Smlr Coms Inc	F0GBR04V8L	EAA Fund UK Small-Cap Equity	GBP	102
Vanguard FTSE 100 ETF GBP Acc	F00000OC1S	EAA Fund UK Large-Cap Equity	GBP	61
SPDR FTSE UK All Share ETF Acc	F00000NXU8	EAA Fund UK Large-Cap Equity	GBP	65
Ninety One GSF UK Alpha I Acc GBP	F00000VAEP	EAA Fund UK Large-Cap Equity	GBP	72
iShares Core FTSE 100 ETF GBP Acc	F000005PTT	EAA Fund UK Large-Cap Equity	GBP	64
Vanguard UK Invm Grd Bd Idx £ Acc	F000001W0U	EAA Fund GBP Corporate Bond	GBP	28

Source: Morningstar.

Appendix D: Exclusion Rules for Morningstar Risk Model-Based Scoring

The fund categories and securities that are excluded from the risk model outputs are also excluded from the risk score calculation to only accept reliable volatility forecasts as input data. Exhibit 25 shows the summary of exclusion rules. In addition to the exclusions by the Risk Model, all securities outside the supported regional categories (fund categories in the US, Canada, and Europe) and not based in supported currencies (USD, CAD, and Euro) are excluded. Those securities that are not eligible for the risk model go through the returns-based style analysis.

Exhibit 25 MPRS Calculation Exclusions for Asset Classes

Asset Class	Exclusion Rule
Equity	► Holdings data coverage < 80% ► In the excluded categories
Fixed Income	► Holdings data coverage < 30% ► In the excluded categories
Allocation	► Holdings data coverage < 30% ► Bond weight < 40% for US ► Bond weight < 20% for non-US ► In the excluded categories
Commodity	► In the excluded categories or an excluded share class
Alternative	► In the excluded categories

For more information about the rationale behind the exclusions and the excluded categories, please refer to the appendix pages of the Global Multi-Asset Risk Model methodology document.

Appendix E: Contributors and Version History

Version 1.7, Sept. 26, 2025

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Updates in This Version

- Updated to incorporate the risk score grid update.
- Updated to add information about the 90% combined return threshold for RBSA.

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Updates in This Version

- Updated to reflect the Risk Model 3.0 outputs, excluded categories, risk category definitions (volatility and score ranges), and a new risk score grid construction.
- Updated to include new Risk Score Decomposition methodology available in select Morningstar Products.

Version 1.5, Feb. 27, 2025

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Updates in This Version

- Updated to reflect expansion of MPRS to the Japan region.

Version 1.4, Oct. 25, 2024

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Updates in This Version

- Updated to reflect methodology implementation of a new volatility mapping grid for US region RBSA scores.

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Updates in This Version

- Updated to reflect new methodology changes for the UK calculation region—application of RBSA methodology only, and use of distinct volatility-to-MPRS mapping grids between UK and all other calculation regions.

Version 1.2, July 17, 2024

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Updates in This Version

- Updated to reflect residual variance scaler methodology enhancement applying to both the Risk Model and RBSA MPRS calculations.
- Updated to include a description of the new Multi-Asset Risk Model residual forecast methodology.
- Updated to reflect that conventionally rounded values are used in determining the risk score range for display in Product.

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Updates in This Version

- Updated Real Return Threshold for Client Portfolios to 50% from 90%, and corresponding examples.
- Added Appendix E: Contributors and Version History.

Version 1.0, March 19, 2024

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Updates in This Version

- All versions of this document before Jan. 31, 2024, are represented as Version 1.0.

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