MORNINGSTAR®

Morningstar Portfolio Risk Score
Methodology

Morningstar Inc.
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Contents

Overview

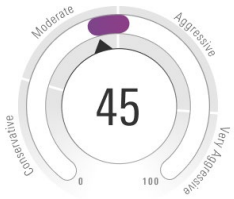
The Morningstar Portfolio Risk Score assesses risk and diversification to help investors, financial professionals, and those who oversee large groups of financial professionals to assess whether the riskiness of the portfolio matches the risk profile of an investor. It has optimal value when combined with the Morningstar Risk Profiler and the personalized Risk Comfort Range of an investor. The Portfolio Risk Score enables investors to be matched with suitable portfolios that align with their respective risk profile.

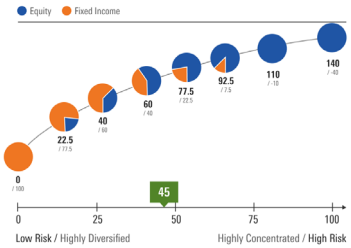
At the heart of the system is a risk-scoring engine that is capable of automatically analyzing millions of portfolios and assigning a numeric risk score in which diversified asset-allocation portfolios typically receive a score ranging from 0 to 80 and highly concentrated portfolios and asset-class-specific 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, or MTAI, 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, MPRS can serve as an additional due-diligence tool for investors, financial professionals, compliance officers monitoring a large number of portfolios (or funds), and for 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 KYC 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 scores the risk of a portfolio using our holdings-based Risk Model, and our multi-asset Target Allocation Indexes to define risk ranges.

Source: Morningstar.

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

Return Volatility-Based Risk Scores

The Portfolio Risk Scores are calculated based on the estimated volatility of fund returns. The volatility estimates are primarily generated by the Morningstar Risk Model's holdings-based style analysis (HBSA) and supplemented by Sharpe's return-based style analysis (RBSA) for portfolios with insufficient holdings data. Volatility is widely understood as a measure of risk. Exhibits 6 and 7 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 growth assets, typically equities, in the portfolio. 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 assets 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 4 in Appendix A. The volatility of S&P 500 in 2022 is 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 ambiguous classification of growth assets and can incorporate diverse and non-traditional 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 market condition changes.

To ensure the stability of volatility-based scores while retaining the benefits of 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, or TAIs. Each year, Morningstar calculates the sub-asset-class weights from the average weights of the funds in the category. Exhibit 2 presents the equity/fixed income split of the five TAIs (and two additional extensions) in the U.S. market. 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 of110% and 140% and setting the cash allocation to negative 10% and negative 40%, respectively.

Exhibit 2 Morningstar U.S. Target Asset Allocation Indexes

Asset Class	Conservative	Moderate Conservative	Moderate	Moderate Aggressive	Aggressive	Aggressive Extension 1	Aggressive Extension 2
US Equity	16.5%	28.5%	47.0%	55.0%	68.5%	81.5%	103.7%
DM xUS Equity	5.0%	9.5%	10.5%	18.0%	19.5%	23.2%	29.5%
EM Equity	1.0%	2.0%	2.5%	4.5%	4.5%	5.4%	6.8%
US Core Bond	58.5%	45.0%	30.5%	15.5%	4.0%	0.0%	0.0%
Global Core Bond ex US	11.5%	9.5%	4.5%	2.5%	0.5%	0.0%	0.0%
Cash	7.5%	5.5%	5.0%	4.5%	3.0%	-10.0%	-40.0%

Source: Morningstar.

To ensure that the risk scores are stable over time and not clustered around 15% to 20% volatility range, the risk scores are anchored to the risk bands derived from the long-term risk profiles of the U.S. TAIs as shown in Exhibit 3. 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 U.S. TAIs were chosen as a reference point to anchor the risk scores and define the mapping between volatility ranges and risk bands. In other words, the risk scores are calculated relative to the U.S. market.

Exhibit 3 5-Year Volatility Profiles of U.S. Target Allocation Indexes

Source: Morningstar.

Identify Modelling 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 uses a hybrid approach combining a holdings-based methodology from Morningstar's Risk Model and a returns-based methodology using a return-based style analysis approach. Between these two approaches, we can cover virtually the entire managed product, stock, and fixed-income universes and client portfolios. Depending on the information we have about a portfolio, we will select the optimal methodology to use, with preference giving to the holdings-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 or 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 stocks, fixed-income securities, and managed investment products such as open-end mutual funds, exchange-traded funds, collective investment trusts, unit investment trusts, separately managed accounts, variable-annuity/variable-life subaccounts, segregated funds, and pooled funds.

The automated analysis of a portfolio is dependent on Morningstar having at least 80% portfolio holdings coverage identified through Morningstar's Risk Model or 24 months (preferably 48 months) of trailing returns for the current constituents (mutual funds, ETFs, individual securities, and so on) of a portfolio. In general, for a portfolio to receive a Morningstar Portfolio Risk Score, the scoring engine requires Security IDs for 100% of the portfolio.

There are checks in place to determine whether the portfolio to be scored contains a sufficient returns history or holdings data. If insufficient data exist, we would not be confident in the score and would not score the portfolio/fund in question.

For funds or ETFs, the process is to score anything with more than 80% holdings coverage identified through the Morningstar Risk Model and, for ones without sufficient holdings data, at least 24 months of return history and utilize proxy data based on the category average returns to fill in missing return history up to the required 48 months. For individual securities, the security is covered via the holdings-based approach provided it falls within the Risk Model coverage universe. No return history is required in these cases.

For a client (bespoke) portfolio, we use a special process to determine whether to score the portfolio and the approach for 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 by the holdings-based approach if the weighted sum of the holdings-coverage weights is at least 80%. Upon insufficient holdings data, the returns-based approach will be invoked.

For a returns-based approach, we multiply the weight of each constituent in the portfolio by the number of actual months of return history it has. The portfolio will be scored if the weighted sum meets or exceeds 24 months and not scored if it is less than 24 months. For portfolios that will be scored, the

constituents that are missing return history will use proxy data based on the category average for each constituent to the extent that their individual returns history is less than 48 months. The constituents' return histories are then rolled up into a composite return history for the portfolio for 48 months, which is the return history ultimately used for the subsequent analysis.

Some examples of what this might mean for a bespoke portfolio are:

- A custom portfolio with five constituents and holdings-based coverage weight at 92% will be scored based on risk estimate using the Risk Model.
- A custom portfolio with five constituents and holdings-based coverage weight at 70% will not be scored based on risk estimate using the Risk Model. Next, our system will test whether the portfolio can be scored using a returns-based approach.
- Assuming not scored by the holdings-based approach using the Risk Model, a custom portfolio with five constituents where each constituent has exactly 24 months of return history would have the remaining history proxied based on category averages for each of the constituents and would be scored.
- Assuming not scored by the holdings-based approach using the Risk Model, a custom portfolio with 50% of the portfolio held in one holding with a full 48 months of return history and other constituents with one month of history would be scored. The constituents with one month of returns would have 47 months of return history based on their respective category averages.

Volatility Estimate of Portfolio Returns

The risk score engine takes the volatility estimate and translate it to risk score. The first step to calculate 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 HBSA approach using Morningstar's Risk Model or an RBSA approach depending on the holding's coverage.

Volatility Estimate by Morningstar Risk Model

With at least 80% holdings weight coverage, the system uses the outputs from Morningstar's Risk Model to estimate the portfolio's systematic and idiosyncratic risk. Morningstar Risk Model identifies the systematic drivers of security returns, which are commonly referred 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 and residual volatility over a 3-month window.

Prior to estimating the portfolio risk, the portfolio and TAI factor exposures are scaled in such a way that the missing holdings are assumed to have the same level of risk as the covered holdings in the portfolio. For example, for an equity-only portfolio with 90% holdings coverage, we multiply the equity factor exposure for the portfolio by a factor of 100/90 to cover the missing 10% holdings coverage. For multi-asset portfolios, our equity coverage is typically good, and any missing coverage is assumed to be fixed income related. That is, for a 60/40 (60% equity and 40% fixed income) multi-asset portfolio with 90% holdings coverage, we multiply the fixed income factor exposure by a factor of 40/30 to cover the missing 10% holdings coverage.

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

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

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

$$(\sigma_u^P)^2 = (\vec{w}_t^P)^T \Delta_{\boldsymbol{t}} \vec{w}_t^P \quad \text{(H-2)}$$

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

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
$\Delta_{\boldsymbol{t}}$ = 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

Volatility Estimate by Return-Based Style Analysis

With insufficient holdings data covered by the Risk Model, 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 $x_k \geq 0$ 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:

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

Where

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

We then regress the benchmark returns on the portfolio returns:

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

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 σ_u. This is our estimate of unsystematic/idiosyncratic risk.
3. R2. 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 holdings data, 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 $\vec{x}_P$.

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 V. We calculate the systematic risk of the portfolio as follows:

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

β being the slope coefficient in equation R-3. We combine this systematic risk with the idiosyncratic risk to calculate the total risk that will ultimately be translated into the risk score.

Both the holdings-based and returns-based methodologies result in the same application of the risk score function, and thus the same overall risk score.

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 holdings 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 $100(1-M\times R^2)$, 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%.

Morningstar Portfolio Risk Score

The volatility ranges of the risk bands were defined using the U.S. TAIs and extensions' 5-year volatility estimate history. Exhibits 9 and 10 in Appendix A present the volatility profiles and percentiles of the U.S. TAIs and extensions that provide stable and non-overlapping anchor points over time. Through 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.

Exhibit 4 provides definitions for the risk bands in terms of volatilities and risk scores. The risk scores are in proportion to volatility ranges with 28.2% volatility being a score of 100.

Exhibit 4 Mapping Between Portfolio Annual Volatility and Risk Scores

	Volatility Range	Risk Score Range
Conservative	0% - 6.8%	0 - 24
Moderate	6.8% - 13.4%	24 - 48
Aggressive	13.4% - 22.2%	48 - 79
Very Aggressive	22.2% - 28.2%	79 - 100
Extreme Risk	28.2% - 50%	100 - 200

Source: Morningstar.

Based on this volatility to risk score mapping in each risk band, we rank portfolios by volatility. Since percentile ranking can be unstable when the market environment shifts dramatically or securities are removed from or added to the investment universe, we've constructed a grid that is calibrated on an annual basis. For each risk band, we construct 10,000 equally spaced points that connect volatilities to risk scores. For example, the 5,000th point in the Conservative risk band is:

$$\text{Volatility} = \frac{5000}{10000} \times (6.8\% - 0\%)$$

$$\text{Risk Score} = \frac{5000}{10000} \times (24 - 0)$$

and the 15,000th point in the Moderate risk band is:

$$\text{Volatility} = 6.8\% + \frac{15000 - 10000}{10000} \times (13.4\% - 6.8\%)$$

$$\text{Risk Score} = 24 + \frac{15000 - 10000}{10000} \times (48 - 24)$$

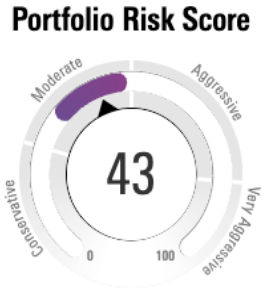
Beyond the 50,000th point in the Extreme risk band, we simply extrapolate points from any two points in the Extreme Risk band. The risk band beyond Extreme cannot be reliably pre-defined because the maximum volatility is unknown until the universe is observed. Risk scores beyond 200 are capped at 500. Using two points in the Extreme risk band (v_1, v_2, rs_1, rs_2), and the portfolio volatility v_p,

$$\text{Risk Score} = rs_1 + (rs_2 - rs_1) \times \frac{v_p - v_1}{v_2 - v_1}$$

Mapping to Risk Comfort Range or Custom Risk Bands

Exhibit 5 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 5 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-markets and small-cap funds a 5. If a client is placed in Band 3, they 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 assessment of non-traditional 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 re-calibrates 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's HBSA methodology and the time horizon is 1 year as of November 30, 2022. The time windows for the forecast calculation are 20 years for the factor covariance matrix and 3 months for residual variance. The historical returns were used to calculate the realized volatilities in Exhibit 8.

Exhibit 6 Estimated Annual Standard Deviations for the Morningstar Style Box Indexes

	Value	Blend	Growth
Large	21.0%	20.4%	22.0%
Median	22.5%	22.8%	22.9%
Small	24.8%	23.9%	23.9%

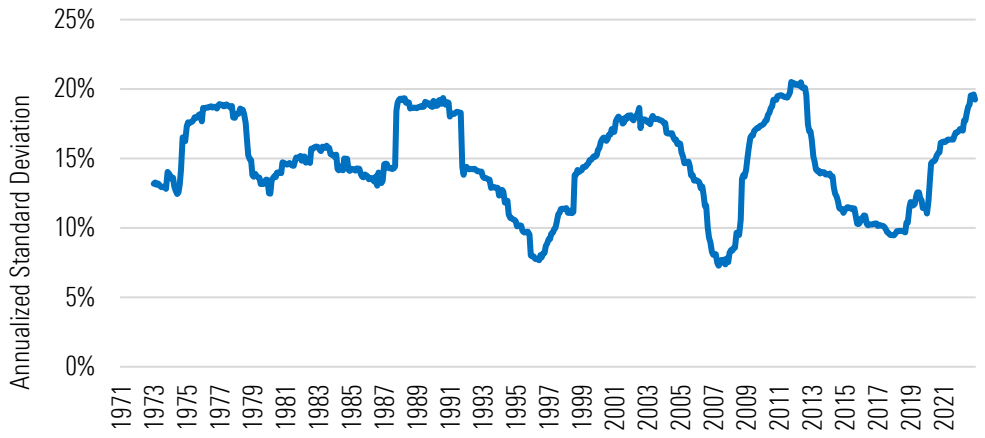
Source: Morningstar

Exhibit 7 Estimated Annual Standard Deviations for the U.S. Morningstar Target Allocation Indexes

Name of TAI	Equity	Fixed Income	Estimated Annual Standard Deviation
Morningstar U.S. Conservative TAI	22.5%	77.5%	5.2%
Morningstar U.S. Moderate Conservative TAI	40.0%	60.0%	8.0%
Morningstar U.S. Moderate TAI	60.0%	40.0%	12.0%
Morningstar U.S. Moderate Aggressive TAI	77.5%	22.5%	15.5%
Morningstar U.S. Aggressive TAI	92.5%	7.5%	18.6%
Morningstar U.S. Aggressive TAI Extended 1	110.0%	0.0%	22.2%
Morningstar U.S. Aggressive TAI Extended 2	140.0%	0.0%	28.3%

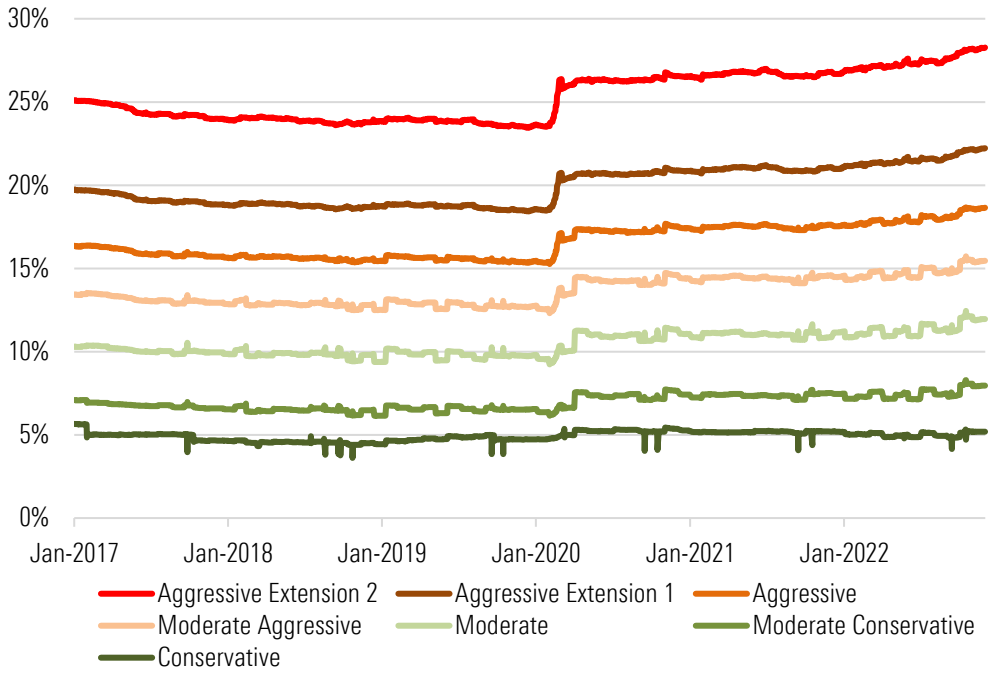
Source: Morningstar

Exhibit 8 Historical Annualized 4-year Trailing Standard Deviation of S&P 500 Monthly Returns



Source: Morningstar

Exhibit 9 5-year Timeseries of TAI Volatility Estimates



Source: Morningstar

Exhibit 10 5-year Percentiles of TAIs

Percentile	Conservative	Moderate Conservative	Moderate	Moderate Aggressive	Aggressive	Aggressive Extension 1	Aggressive Extension 2
0%	3.6%	6.1%	9.2%	12.3%	15.3%	18.4%	23.4%
10%	4.5%	6.4%	9.7%	12.7%	15.5%	18.6%	23.7%
20%	4.7%	6.5%	9.8%	12.8%	15.6%	18.8%	23.9%
30%	4.7%	6.6%	9.9%	12.9%	15.7%	18.8%	24.0%
40%	4.9%	6.7%	10.0%	13.0%	15.8%	19.0%	24.2%
50%	5.0%	6.8%	10.2%	13.4%	16.3%	19.6%	24.9%
60%	5.0%	7.2%	10.8%	14.2%	17.2%	20.7%	26.3%
70%	5.1%	7.3%	11.0%	14.4%	17.4%	20.9%	26.5%
80%	5.2%	7.4%	11.1%	14.5%	17.6%	21.0%	26.8%
90%	5.2%	7.5%	11.2%	14.6%	17.8%	21.3%	27.1%
100%	5.7%	8.3%	12.4%	15.7%	18.7%	22.2%	28.3%

Source: Morningstar

Appendix B: MPRS for Sample Funds

Name	SecId	Morningstar Category	Base Currency	Risk Score
Invesco S&P 500 Equal Weight Utilts ETF	F0USA05V5P	US Fund Utilities	USD	68.88
Invesco S&P SmallCap Info Tech ETF	F000005OGX	US Fund Technology	USD	92.21
Dimensional US Targeted Value ETF	F0000162E9	US Fund Small Value	USD	90.95
Vanguard Short-Term Investment-Grade Adm	F0USA00H6E	US Fund Short-Term Bond	USD	7.56
iShares Global REIT ETF	F00000T1FW	US Fund Real Estate	USD	74.74
SPDR Portfolio S&P 500 ETF	FEUSA04AE6	US Fund Large Blend	USD	73.67
iShares US Energy ETF	FEUSA0000T	US Fund Equity Energy	USD	142.31
iShares JP Morgan USD Em Mkts Bd ETF	F0USA06LLM	US Fund Emerging Markets Bond	USD	41.57
SPDR Portfolio Corporate Bond ETF	F00000M8DJ	US Fund Corporate Bond	USD	22.43
SPDR Blmbg Intl Corp Bd ETF	F00000GX0C	US Fund Global Bond	USD	34.41
iShares US Consumer Staples ETF	FEUSA0000S	US Fund Consumer Defensive	USD	64.38
SPDR S&P Telecom ETF	FEUSA04AHG	US Fund Communications	USD	88.04
WisdomTree US Hi Yld Corp Bd	F00000WTHP	US Fund High Yield Bond	USD	27.01
TD Canadian Core Plus Bond - F	F0CAN071SD	Canada Fund Canadian Fixed Income	CAD	21.39
TD High Yield Bond - I	F0CAN05MF4	Canada Fund High Yield Fixed Income	CAD	33.29
iShares MSCI World ETF	F000003V29	Canada Fund Global Equity	CAD	70.87
RBC Global Corporate Bond Fund A	F0CAN05PDI	Canada Fund Global Corporate Fixed Income	CAD	21.63
BMO Mid Corporate Bond ETF	F000005PNY	Canada Fund Canadian Corporate Fixed Income	CAD	15.41
Invesco Canadian Plus Div Cl Ser A	F0CAN070P2	Canada Fund Canadian Dividend & Income Equity	CAD	80.70
Invesco Pure Canadian Equity Cl Ser A	F0CAN05OB7	Canada Fund Canadian Equity	CAD	82.11
TD Canadian Small Cap Equity - F	F0CAN06GXZ	Canada Fund Canadian Small/Mid Cap Equity	CAD	82.68
Invesco Global Real Estate F	F000000R29	Canada Fund Real Estate Equity	CAD	72.29
Mackenzie US Mid Cap Opportunities A	F000015AKN	Canada Fund US Small/Mid Cap Equity	CAD	78.25
Dimensional Global Core Equity AUD Hgd	F0AUS06YSK	Australia Fund Equity World Large Blend	AUD	43.69
Dimensional Global Core Equity AUD Hgd	F000002BMN	Australia Fund Equity World - Currency Hedged	AUD	56.35
Vanguard International Property Secs Idx	F0AUS066H8	Australia Fund Equity Global Real Estate	AUD	57.80
State Street Australian Fixed Inc Idx Tr	F0AUS05E7P	Australia Fund Bonds - Australia	AUD	12.76
UBS Short-Term Fixed Income Fund	F0AUS05C9W	Australia Fund Australian Short Term Fixed Interest	AUD	2.71
iShares JP Morgan USD EmMkts Bd AUDH ETF	F00000WYMH	Australia Fund Bonds - Emerging Market Debt	AUD	37.10
Schroder Australian Equity Fund - PC	F0AUS05F6S	Australia Fund Equity Australia Large Blend	AUD	51.36
BlackRock Australian Share Plus	F0AUS05HH8	Australia Fund Equity Australia Large Growth	AUD	59.44
SPDR MSCI Australia Sel Hi Div Yld ETF	F00000JU4P	Australia Fund Equity Australia Large Value	AUD	55.47
Dimensional UK Smlr Coms Inc	F0GBR04V8L	EAA Fund UK Small-Cap Equity	GBP	89.75
Vanguard FTSE 100 ETF GBP Acc	F00000OC1S	EAA Fund UK Large-Cap Equity	GBP	84.36
L&G Global High Yield Bond I USD Inc	F00000WN33	EAA Fund Global High Yield Bond - GBP Hedged	GBP	41.06
SPDR FTSE UK All Share ETF Acc	F00000NXU8	EAA Fund UK Large-Cap Equity	GBP	77.11
Ninety One GSF UK Alpha I Acc GBP	F00000VAEP	EAA Fund UK Large-Cap Equity	GBP	86.85
iShares Core FTSE 100 ETF GBP Acc	F000005PTT	EAA Fund UK Large-Cap Equity	GBP	85.43
Vanguard FTSE 250 ETF GBP Acc	F000013LQM	EAA Fund UK Mid-Cap Equity	GBP	73.61
Vanguard UK S/T Invm Grd Bd Idx Â£ Acc	F00000PZUV	EAA Fund GBP Corporate Bond - Short Term	GBP	8.63
Vanguard UK Invm Grd Bd Idx £ Acc	F000001W0U	EAA Fund GBP Corporate Bond	GBP	22.34

Source: Morningstar

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