# Capital Market Assumptions and Strategic Asset Allocation Models

Morningstar Investment Management Europe

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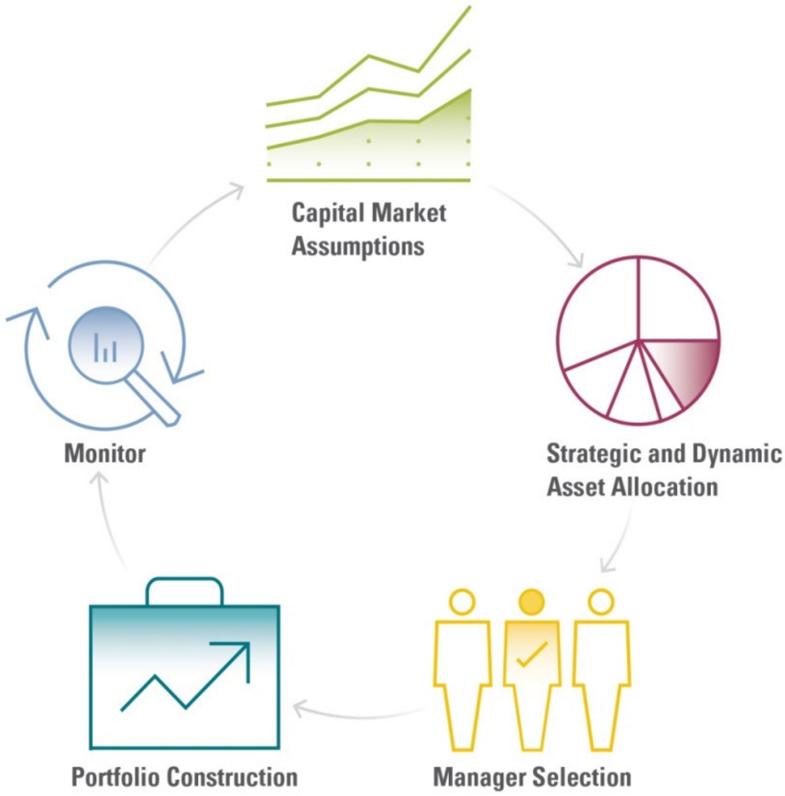
# Section I – Executive Summary

This document outlines the methodology used by Morningstar Investment Management Europe to build capital market assumptions and strategic asset allocation models. This methodology leverages the extensive proprietary research conducted by Morningstar entities across four decades, including Ibbotson Associates, a Morningstar company.

The investment process can be summarised into a series of steps, each of which involves careful consideration and the application of various models and concepts that have been extensively researched and tested through practical implementation.




**Step 1: Capital Market Assumptions**

- Identify opportunity set of asset classes'
- Estimate long and Intermediate-term:
  - Expected returns
  - Standard deviations
  - Skewness
  - Kurtosis
  - Correlations

**Step 2: Asset Allocation**

- Optimisation:
  - Mean-conditional value-at-risk
  - Liability-relative
  - Mean-variance
  - Resampling

**Step 3: Investment Selection**

- Scrutinise extensive database of available investments
- Narrow universe through selection criteria
- Qualitative evaluation: Parent, People, Process, Performance, Price
- Quantitative evaluation: Representation of asset class

**Step 4: Portfolio Construction**

- Concentration risk: Manager, counterparty, strategy
- Diversification
- Tracking error management
- Flexibility

**Step 5: Monitor**

- Regular formal portfolio review
- Interim reviews led by market events
- Rebalancing
- Detailed performance attribution
- Custom benchmarking

Portfolio optimisation is an important tool that allows investors to identify a blend of assets that maximize return for a given level of risk or minimize risk for a given level of return. Optimisation requires forecasts of returns, standard deviations, skewness, kurtosis and correlation coefficients of asset classes over the desired investing horizon.

The Mean-Conditional Value at Risk optimisation process used within our methodology takes non-normal return characteristics into consideration, and in general, prefers assets with positive skewness, small kurtosis, and low variance.

### About Morningstar Investment Management

Drawing on our core capabilities in asset allocation, manager research and portfolio construction, Morningstar Investment Management Europe creates customised investment solutions to help financial institutions meet investor needs. We have both a global point of view and local market expertise, delivered through an international network of experienced investment professionals who specialise in serving regional markets.

When building investment offerings, we benefit from access to quality information from one of the largest investment databases, as well as patented methodologies, intuitive technologies and decades of ground breaking research. Our independence and strong investor focus allow us to develop solutions that help clients stand out within their markets. Our clients include many of the top wealth management firms, insurance companies, banks, asset managers, and retirement plan providers.

Our investment processes incorporate the rich heritage of Ibbotson Associates, a leading independent asset allocation provider offering investment advisory services, retirement advice programs, and customized research. Ibbotson applies academic research to create real-world solutions for financial institutions. Ibbotson was founded in 1977 and is a Morningstar company.

# Section II – Capital Market Assumptions

### Defining the Investable Universe

An often overlooked by investors, but important part of the process is the identification of the appropriate range of asset classes available for inclusion within an investment solution or portfolio. The breadth and depth of the available securities ultimately provides the diversification benefits which a multi-asset solution in based on.

A number of factors may dictate the approach taken to select the appropriate universe and to narrow this universe and focus on investment vehicles that best meet the objectives of the solution and ultimately the interests of the end investor. This may include:

- Domicile of investors
- Base currency of investor

Additional information provided by our clients can be taken into consideration:

- Sophistication of investors
- Investor objectives
- Technical capabilities of product provider

### Proprietary CMAs

### Global Capital Markets Sub-Committee

Morningstar's capital market assumptions are governed by the firm's Global Capital Markets Sub-Committee. This committee, which is part of the investment management group's Global Investment Policy Committee structure, is comprised of senior investment professionals across our investment teams in North America, Europe and Asia. Its responsibilities include 1) the ongoing review the capital market assumptions and 2) developing new forecasting methodologies to evolve institutional best practices.

### Inputs and Estimates

The core methodology used by the majority of market participants to determine investment portfolios is mean-variance analysis.  Mean-variance analysis was developed by Harry Markowitz in the 1950's and provides a mathematical framework for generating portfolios that maximize expected return for a given level of risk (efficient portfolios), and it can assist investors in making strategic asset allocation decisions.

Mean-variance analysis requires three statistical estimates for each asset class: Expected return (Mean), Expected risk (Standard Deviation or Variance) and Expected relationship between the asset classes (Correlation Coefficients).

Morningstar recognises that **asset class return distributions are not normally distributed** and includes Skewness and Kurtosis as inputs to the asset allocation process.

Morningstar, through its heritage in Ibbotson, is widely acknowledged as one of the leading authorities on the development of capital market expectations. Morningstar has written numerous award-winning articles on the subject. Ibbotson's "building block" methodology for estimating returns was first developed in the 1970s and we continue to improve upon it.

**Expected Return – Equity**
Morningstar uses a supply-side building blocks approach to forecast equity returns. First introduced by Diermeier, Ibbotson and Siegel (1984), and later adapted to stocks by Ibbotson and Chen (2003), the supply-side model is based on the idea that equity returns can be decomposed into underlying economic and corporate fundamentals. Our approach separates the expected return of each equity asset class into four key drivers: *1) Inflation 2) Total Yield 3) Growth 4) Change in Valuation*.

**Expected Return – Fixed Income**
Similar to our equity asset class assumptions, Morningstar uses a building blocks approach to forecast returns of fixed income asset classes. The key components of our fixed income model are: *1) Inflation 2) Real Rate 3) Term Spread and 4) Credit Spread.* The expected shape of the yield curve also determines our forecast of the roll return of a fixed-income asset class. Our model also takes into account the impact of rating upgrades and downgrades (credit migration) on credit bond prices.

**Expected Return – Currencies**
The currency expected return is our forecast of the change in the spot exchange rate. In general, for any asset not denominated in the reference currency, the expected return of the asset is based on the expected return in local currency plus the expected currency return. The currency expected return has two main components: 1) the inflation differential between the local currency and the reference currency, and 2) the reversion of real exchange rate to its fair value.

**Standard Deviation**
Forecasting the range of possible outcomes requires the definition of dispersion (standard deviation) around an expected value. Morningstar forecasts standard deviation as one aspect amongst various others that represent risk in an investment context.

Morningstar employs a factor model approach to forecast standard deviation. The idea behind this estimation approach is to model each benchmark as an optimal mix of long-history economic and market factors. A statistical model is used to determine this mix.

One of the advantages of this approach is that it directly addresses the basic problem of the incorporation of information contained in long-history financial data into expectations for short-history benchmarks.

Two main kinds of factors are used:
- Macroeconomic factors: exchange rates and inflation rates.
- Market factors: most are similar to those used by Fama and French in the sense that there is a broad market factor (total equity market total return for stocks, long government bond return for bonds) and then the other factors are expressed as differences from the market factor.

## Skewness and Kurtosis
Mean-CVaR analysis requires a quantifiable measure of Conditional Value at Risk (CVaR) for the resulting portfolio. To calculate this measure, Morningstar must provide estimates of Skewness and Kurtosis to more accurately represent the dispersion of expected monthly returns.

Skewness measures the lack of symmetry in the distribution of returns. As an example, a positively skewed distribution would have frequent small losses and a few extreme gains.

Kurtosis measures the likelihood of extreme events.

**Correlation Coefficient**

The risk of a portfolio is based not only on the risk of each asset class, but on the relationship between the returns of asset classes as well. The relationship between the returns of asset classes is measured by the correlation coefficient.

The correlation coefficient measures the degree to which two asset classes' returns change with respect to each other. The statistic can range between positive one (+1) and negative one (-1) and provides the following information about the relationship between asset classes:

- **Positive one (+1):** perfect positive relationship – two assets classes move together in the same direction. No benefits arise from diversification.
- **Negative one (–1):** perfect negative relationship – two asset classes move together in opposite directions, leading to maximum diversification benefits.
- **Zero (0):** no relationship – the movements of two asset classes are unrelated.

Morningstar estimates correlation coefficients using the same factor model approach than for Standard Deviation.

# Section III – Optimisation

**Overview**
When creating portfolios at the asset class level, Morningstar focuses on three major qualifications: (1) efficiency and robustness, (2) investor preferences, and (3) investability. During the process asset classes are represented by carefully selected indices that represent a diversified proxy of the underlying securities. Portfolios that provide the best risk/return characteristics may not be practical or acceptable to many clients. Furthermore, the most quantitatively efficient portfolios may not take into account possible errors in the input forecast, or the practicality due to liquidity constraints or size (market capitalization) of the asset class. All of these factors are incorporated into the portfolio recommendations.

Morningstar employs a variety of techniques and criteria when developing strategic asset allocation models that are described in the following sections.

**Mean C-VaR**
Asset class return distributions are not normally distributed. Despite this, the typical Markowitz mean-variance optimisation (MVO) framework that has dominated the asset allocation process for over 50 years only relies on the first two moments of the return distribution, mean and variance. Equally important, there is considerable evidence that investor preferences are not satisfied by these two measures. Investors are particularly concerned with significant losses, i.e. downside risk.

One of the promising alternatives to MVO is called mean-conditional value-at-risk optimisation (M-CVaR). CVaR is a comprehensive measure of the entire part of the tail that is being observed, and for many, the preferred measurement of downside risk. Traditional MVO leads to an efficient frontier that maximizes return per unit of variance, or equivalently, minimizes variance for a given level of return. In contrast, M-CVaR maximizes return for a given level of CVaR, or equivalently, minimizes CVaR for a given level of return.

The M-CVaR process used in our methodology takes non-normal return characteristic into consideration, and in general, prefers assets with positive skewness, small kurtosis, and low variance. Figure 8 below highlights why it is dangerous to rely on the normal distribution, and hence only mean and variance, to predict the probability of significant future losses.

## C-VaR
Conditional value-at-risk (CVaR) measures the expected loss in the left tail given that a particular threshold has been met, such as the worst 1st or 5th percentile of outcomes in the distribution of possible future outcomes.

The precursor to CVaR was the standard value-at-risk (VaR) measure. VaR estimates the loss that is expected to be exceeded with a given level of probability over a specified time period. CVaR is closely related to VaR and is calculated by taking a probability weighted average of the possible losses conditional on the loss being equal to or exceeding the specified VaR. Other terms for CVaR include mean shortfall, tail VaR, and expected tail loss.

In contrast with CVaR, the VaR measure is only a statement about one particular point on the distribution. Intuitively, CVaR is a more complete measure of risk relative to VaR and previous studies have shown that CVaR has more attractive properties.

**Optimisation using a Truncated Lévy Flight distribution**
Empirically, almost all asset classes and portfolios have returns that are not normally distributed. Many assets return distribution are not symmetrical. In other words, the distribution is skewed to the left or right of the mean (expected) value. The normal distribution assigns what most people would characterize as meaninglessly small

probabilities to extreme events that empirically seem to occur approximately 10 times more often than the normal distribution predicts.

Some risk measurements, such as CVaR, are focused on the left tail. The normal and lognormal distribution models are considered "thin-tailed" distributions. Using thin-tailed distributions to estimate the downside risk of a portfolio can dramatically underestimate both the magnitude of the downside and the frequency with which these bad events occur.

The Truncated Lévy Flight (TLF) distribution is particularly well suited to financial modelling because it has finite variance, fat tails that empirically fit the data, and perhaps most importantly for financial modellers, it "scales" appropriately overtime. Xiong (2010) shows that the TLF model provides an excellent fit for a variety of asset classes, such as U.S. large-cap equities, U.S. long-term government bonds, and MSCI U.K. equities, in all aspects: the centre, the tails as well as the minimum and maximum.

Thus, in the controlled optimisation in which the skewness and kurtosis of the asset classes are systematically varied, Morningstar uses a multivariate TLF model as the basis for generating asset returns and ultimately estimating a portfolio's CVaR.

In an asset universe with mixed tails, information about skewness and kurtosis can significantly impact the optimal allocations in the M-CVaR optimization. In these cases, the CVaR or expected tail loss can be reduced by performing the M-CVaR optimisation but not MVO.

**Re-sampling in Optimisation**

In a forward-looking context, capital market assumptions are estimates. The true capital market assumptions are not known with certainty; therefore, it is more appropriate to use an optimiser that accounts for the uncertainty in the estimated capital market assumptions. Conceptually, re-sampled optimisation is like a giant scenario test in which multiple small adjustments to the starting capital market assumptions are made, and the resulting asset allocations from all of the different scenarios are averaged.

Rather than using ad hoc methods for creating multiple scenarios (e.g. moving the expected return of asset A up by 50 basis points and that of asset B down by 25 basis points), Monte Carlo simulation is used to simulate the returns of each of the asset classes. The Monte Carlo simulation is based on a forward-looking set of capital market assumptions and one would expect that the simulated returns series created to have similar return, risk, and correlation characteristics to the input parameters.

**Portfolio Spacing**

The asset allocation portfolios are the result of the Mornignstar inputs, construction methodology, the relative constraints used to reflect prudent and practical investor considerations, including basic performance criteria. Other considerations, such as portfolio "spacing" are also reflected in these allocations. Portfolio spacing refers to the change in standard deviation (risk) from one portfolio to the next. The goal is to ensure the risk spread between each portfolio is relatively equal, as there is no benefit in offering five portfolios if they all have similar risk characteristics. As standard deviation estimates for each asset class are to a certain extent inter-related, the order or rank of asset classes by risk is much more stable than return estimates. As a result, Morningstar prefers to base "spacing" upon the variable that will change least from year to year. This helps ensure target portfolios will not experience a drastic shift in asset class weightings from one period to the next.

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