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Authors:
Dr. Olaf Scherf
Global Head Risk Engineering

Dr. Alex Kusen
Investment Officer

SAA robustness: what it means

Key take aways

- Portfolios need to be systematically robust to unforeseen changes in market behaviour, and thus to the assumptions used in portfolio construction and optimisation.
- Traditional investment approaches however can tend to be oversimplified and their long-term portfolio performance can be surprisingly fragile when the underlying assumptions are overtaken by reality.
- Our investment approach accepts that the world is characterized more by "shades of grey" than oversimplified black and white. We aim to use available information in a more effective way to help us manage uncertainty about assumptions used for portfolio optimisation and evaluation and to avoid risk concentration.
- We think that it is worth accepting a slightly lower expected return than from a theoretically-optimum investment outcome, in return for a portfolio that should prove more resilient to unexpected economic and financial market changes ahead.

01 Robustness and uncertainty

The world is an unpredictable place. The past dozen years show us that nothing in markets can be taken for granted. At the start of 2020, the global economy was in reasonable shape. But only a few months later we were in the middle of a market and economic crisis. Markets and most policymakers underestimated the threat posed by COVID-19 and the associated Sars-CoV-2 pandemic and this provided further evidence of the uncertainty of any future market parameters.

The crisis has allowed us to learn something about risk. The losses of individual asset classes were roughly as expected. But, in an echo of the start of the global financial crisis in 2007/08, hopes that expected asset class correlations would provide significant diversification benefits were not realized. Almost all asset classes were affected negatively (see Figure 1). The current crisis has reminded us that such "black swan" events are more common than might be suspected.

We know that long-term investment success relies on the capability to deal with risk and stay invested in times of strong market downturns. This means that finding a sound way to predict risk and return, together with efficient measures to avoid unacceptable losses, is important. We then apply a close-to-reality risk model based on a global portfolio covering a full cycle of market moves and explicitly including "black swan" events ("fat tails") and unstable correlations that could pose a significant risk to investors (see Figure 2).

Can we also learn something about robustness? To understand the concept of robustness in a Strategic Asset Allocation (SAA) context, it may help to start with an example from the physical rather than financial world. During their development cars are tested for robustness in both the desert and Arctic Circle. Most cars are clearly not optimized for such conditions – as they will rarely be used in them – but their manufacturers design them in a way that they can continue to work. These cars are meant to demonstrate a general definition of robustness – being generally strong in constitution under a variety of very different conditions.

Robustness in finance has a similar meaning. Here we are dealing with different optimization problems to find a way in which portfolios can continue to perform well in different market environments. Robustness can refer both to the way we determine the assumptions used in the process to derive an allocation and also the optimization process itself – and the result:

a) robust (reliable) forecasts of expected returns (e.g. following the methodological idea of "triangulation", using broader or better inputs and models leading to a deeper understanding of the economy and the impact on the expected returns);
b) robust estimates of the risk parameters such as volatility and correlations (e.g. by taking into account systematic biases or using parameter types that are less sensitive to small samples or "fat-tailed" statistics that include extreme events); and
c) robustness of the portfolios against uncertainty in both risk and return parameters (by considering the uncertainty in the optimization process itself).

Here, we are using the term robustness in the sense of dealing with uncertainties regarding the assumptions for optimizations, i.e. in the selection of a specific solution for a portfolio. (In particular, a robust set-up should avoid the rather common mistake of simply preparing for a rerun of the last market downturn, given that history does not repeat itself.)

The problem with the classical allocation optimization approach according to Markowitz is that it is based on an implicit assumption that we can predict future capital market parameters with full certainty. This typically results in concentrated allocations in certain asset classes – increasing the risk of losses or missed opportunities if these asset classes do not perform as expected. This is not just a matter of fine tuning. In reality, a small change or shock to one parameter of these investment approaches could lead to a completely different optimal allocation. In short: if the forecast assumptions of the optimization are met, then it can deliver an optimal result. But if the assumptions are not exactly met – as is much more likely – then this investment approach can prove brittle and the outcomes poor.

Unfortunately, naïve discretionary adjustments of the portfolio in response to this behavior proved to be expensive and unreliable. We have already dealt with the problems around market timing in a previous special report.

Before we look at traditional investment approaches that try to deal with robustness, it is worth establishing the difference between robustness and risk. It might seem that the easiest way to increase robustness in a portfolio would simply be to reduce risk. But this is not a simple matter and brings us quickly back to uncertainty around the assumptions used to reduce perceived risk and how they can be wrong. Our attempts to reduce risk (against a particular event or set of events) can easily be of the wrong magnitude, or end up adding to risk elsewhere in the portfolio. To a certain degree risk is related to things we understand that we cannot control and robustness is related to assumptions we define or rely on (and hence tend to believe that we can control).

One analogy could be with building a house. The basic design of a house should reflect obvious risks – so we need steep roofs for areas with high snowfall, or external shutters to deal with high winds. But for increasing robustness we need a good understanding how the components of the house (the strength under different sorts of stresses or the wood used in the window frames, the quality of the brick stock etc.) will behave under a range of possible conditions and over a long time span.

We explore how traditional investment approaches attempt to do this – and their inherent limitations – in the next section, before looking at our own approach to develop the concept of robustness.

02 From heuristics to robustness

Finding a robust solution for SAA is a complex problem because of the large number of influencing factors or assumptions that have to be taken into account. These typically operate in a non-linear way –creating a situation in which one is unlikely to find a simple way to derive a solution.

A typical procedure for solving such complex problems with limited resources – in terms of data or analytic capacity, particularly when there are needs for a high degree of transparency or intuitive understanding – involves the use of heuristics. A heuristic approach may include short cuts, "rules of thumb" or simple trial and error to find a probably imperfect but still useful solution to a problem. To take up a tangible example from everyday life, let's imagine a soccer game. If we want to bet which soccer team will win the game and we are not familiar with soccer, one heuristic might be to bet on the team that has spent the most money on players: however, as we know, this will be an imperfect predictor of a single game. As we can see, heuristics can have many advantages (speed, easy to understand, etc.) but also weaknesses that we will return to later.

Traditional investment allocation approaches typically rely heavily on heuristics. Consider four of them:

- Using allocation restrictions (maximum or minimum weights) for avoiding too concentrated portfolios depend on fixing levels which will be chosen based on experience or regulatory requirements of the investor. Unfortunately, these restrictions tend to dominate the SAA and it remains unclear how a reasonable balance between risk and return can be achieved.
- Equilibrium models – e.g. the "world portfolio" under the Black-Litterman approach – avoid the problem of assumptions on risk and return of the individual asset classes by assuming they are at levels which would support what we can see in the existing global market allocation. However, the idea that the global market portfolio provides a good balance between risk and return for a real investor is somewhat debatable, e.g. from the perspective that for different portfolio currencies the risk contributions of asset classes may differ substantially.
- Risk parity or minimum variance portfolios look at the problem from a different angle, arguing that since the expected return assumptions for each asset class are

generally unreliable, we should instead equally-weight all asset classes on the basis of their risk contribution to the portfolio. It remains unclear, why neglecting relatively reliable information on differences between the expected returns of some asset classes (like equities and government bonds) and at the same time relying on unstable correlations leads to a good balance between efficiency and robustness.

- An equally-weighted portfolio (on the basis of value) is perhaps the most simple "heuristic": taking no capital account forecasts or assumptions into account whatsoever. Unfortunately, the resulting risk return profile is strongly dependent on the definition of the asset classes – more differentiation leads to a higher weight.

All these approaches dodge the central issue: their implicit assumption is that we simply do not (and cannot) know enough about future markets for a reliable estimation of future market parameters and therefore use dramatic over-simplifications to find solutions.

Overall, there are systematic disadvantages when using a heuristic for dealing with uncertainty in the context of portfolio optimization. First, they can encourage investors to neglect valuable information (when it is not used by the simplified model). Second, they may encourage a lack of transparency regarding the relevance of the remaining assumptions. Third, they may encourage investors to ignore the effect of uncertainty (potentially massive) regarding the individual assumptions.

Rather than try and reduce a complex situation down to a simple black and white line drawing (as these heuristic approaches do) we would admit instead that we live in a world characterized by shades of grey – and analyze it on this basis, uncertainty and all.

03 Robustness and optimization

Moving to this "shades of grey" world – from heuristics to robustness – involves finding a sensible balance between optimal efficiency and explicit robustness.

In this uncertain world, we need to use all the information that we have, even if it is incomplete. We want to use this information to help us develop a more precise understanding of the influence of the various assumptions regarding the capital market parameters when identifying a better allocation.

We are in a situation where explicit consideration of the uncertainty of the individual parameters is possible, not least due to the computing power that is now available. The uncertainty of the parameters can be explicitly modelled using an uncertainty distribution (see Figure 3). This figure describes uncertainty via likelihood distributions on possible values for expected correlations.

As we dig into the uncertainty issue, the next question is what level of uncertainty can be reasonably assumed to be typical? A comparison with the historical variability of the different parameters in connection with the properties of the sample distribution allows an obvious possible reference point.

From there, an increased or lower uncertainty can be selected for the individual parameters, if necessary. The point is that, while we may not describe our uncertainty fully, we can still use our knowledge to explore different scenarios to specifically avoid unwanted bets on parameters that are perceived as particularly uncertain and thus dangerous to portfolios.

The robustness of an allocation is determined via a "loss risk under uncertainty" in the case of particularly unfavourable possible parameter combinations according to the uncertainty distribution. The lower this "risk of loss under uncertainty" is for an allocation with a given risk profile (based on the capital market assumptions), the more robust the portfolio (see Figure 4).

We return to the point that, generally, an optimization is more robust, if it depends less on the relevant assumptions being exactly met. A detailed analysis how the assumptions, quantified via parameters (in case of portfolio optimization, the expected returns and risk contributions of the asset classes), enter the optimization procedure is key for understanding and including the uncertainties regarding the parameters. Unfortunately the increase of robustness generally comes with a downside. Neglecting information in the optimization leads to less optimal results, in case the assumptions turn out to be exactly right. The difference between the optimal result and the more robust result based on the assumptions can be considered as the ex-ante price you have to pay for relying less on uncertain assumptions. We pay a small price (give up some return) in order to get an ever greater protection advantage.

To repeat: this "shades of grey" analysis may be imperfect, but we think that it is more effective than the black and white over-simplification of an approach based on heuristics. What it allows us to do is to take into account that we might have more reliable information about some areas than others and are able to use this additional information wisely. We also should acknowledge that there is a danger of relying on information assumed to be true but which in fact is not. There is a second danger of priding yourself on your robustness, not realizing that it applies only to relatively unimportant areas.

In general, one should not overestimate the behavior of a single – albeit significant – market movement. In the next market scenario, the strategy may behave differently. The pursuit of robustness is nothing more than to understand the persistence of unfavorable surprises – and being prepared from the outset. Optimization is not just a matter of pressing a button.

Finally, increasing the robustness of an investment strategy via the SAA has systematic limits. The robustness can be substantially increased even further by a so-called convex strategy using market instruments, where a (slight) reduction in the upside potential of a strategy is exchanged in return for a strong reduction in the potential downside of a portfolio. As an example, during the market drop at the end of February 2020 the hedging impact of a convex protection helped compensate for the missing diversification effect. Such a hedging strategy can provide a higher risk-adjusted expected return after hedging costs, if implemented efficiently as a systematic extension of the SAA.

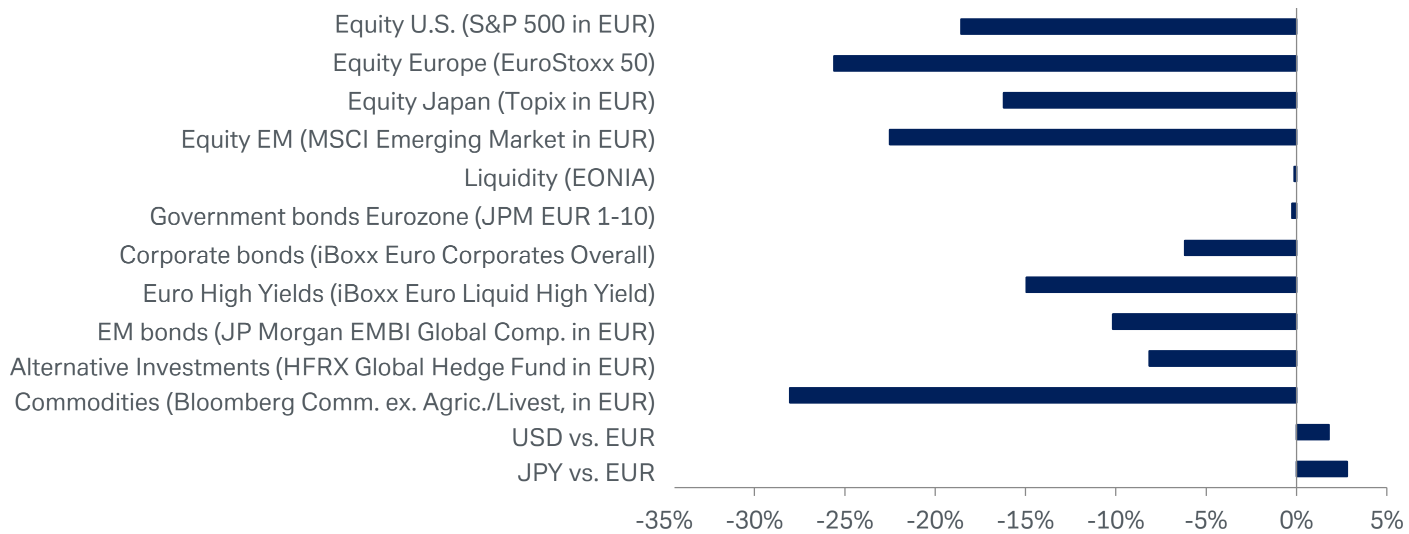
04 Conclusion

Achieving portfolio “robustness”, as we explain in this paper, depends on the realization that we are dealing with probabilities and dependencies which are to some degree uncertain. Any assumption on future asset class returns has to be accompanied by an assessment of risks and their potential impact on a portfolio as well as an assessment of the errors on the expected returns and risk on how they could affect the attractiveness of the portfolio: optimization is really a balance between efficiency and robustness. The danger – as evident in many traditional investment approaches – is that we may tend to oversimplify a naturally complex situation, thereby neglecting potentially valuable information and also impeding our ability to identify risky bets on assumptions about the future market behavior.

In reality, creating a robust portfolio may require giving up some small potential theoretical performance gains (on the assumption of a given outcome) to increase the likelihood that the risk adjusted portfolio return is substantially less affected in case our assumptions do not materialize. To return to the automotive analogy that we started with, this is the price of using better components to have a car that works reliably even in extreme winters.

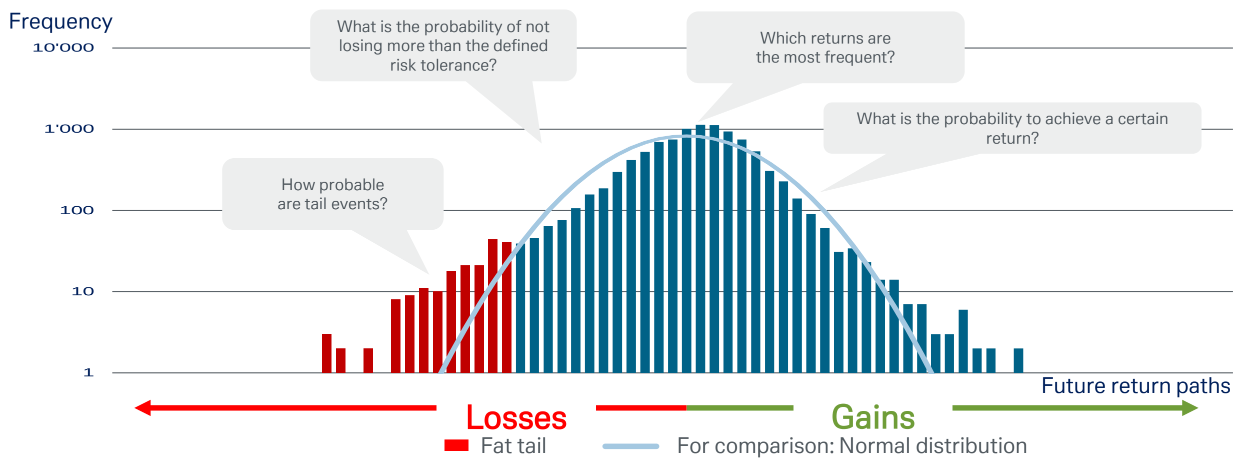
In short, we should aim for the best but prepare for the worst.

Figure 1: Jan. to March 2020: high correlation, (nearly) all asset classes in negative territory



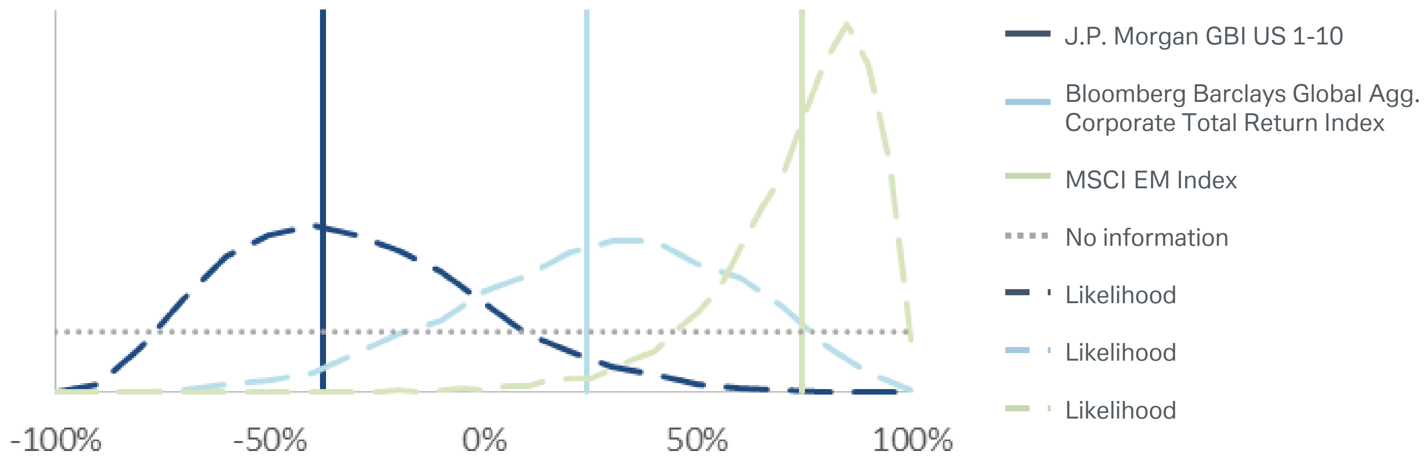
Source: Bloomberg Finance L.P., Deutsche Bank Wealth Management. Data as of May 5, 2020.
Past performance is not indicative of future returns.

Figure 2: Probability distribution of future returns



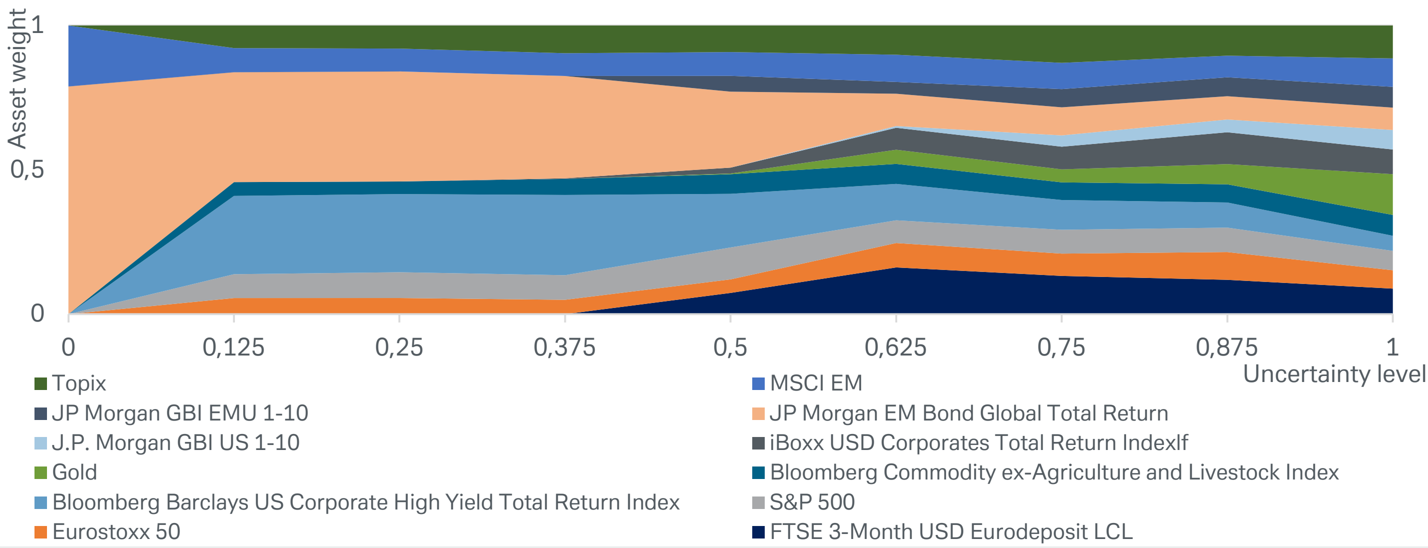
Source: Bloomberg Finance L.P., Deutsche Bank Wealth Management. Explanatory chart based on own calculations. The shape of the distribution is calibrated to historical returns. Returns and frequency are both displayed on a logarithmic scale. Data as of May 5, 2020.

Figure 3: Likelihood distribution of expected correlations (of the S&P 500 to the indices mentioned) for different levels of uncertainty



Source: Bloomberg Finance L.P., Deutsche Bank Wealth Management. Chart is based on own calculations since 2008. Solid lines: point forecasts; dashed lines: likelihood based on historical data; dotted lines: no correlation information = all values have the same likelihood. Data as of May 5, 2020.

Figure 4: Portfolio allocations for different levels of parameter uncertainty



Source: Bloomberg Finance L.P., Deutsche Bank Wealth Management. Chart is based on own calculations . Portfolio allocations for different levels of uncertainty equally for all parameters (expected return, volatility and correlation), starting on the left with no uncertainty (Markowitz case) resulting in a highly concentrated portfolio and ending with full uncertainty with an almost equally weighted portfolio on the right. All allocations show the same level of risk (here volatility). The uncertainty of 0.5 denotes the level derived from historical market data. A more specific analysis of the impact of uncertainty on the level of individual parameters is – of course – possible. Data as of May 5, 2020.

Glossary

The Bloomberg Commodity ex-Agriculture and Livestock maps raw materials (exclusive futures contracts from the agriculture & livestock sector). The index does not take into account the dividends of the index components (price index).

Correlation is a statistical measure of how two securities (or other variables) move in relation to each other.

The EONIA (Euro Over Night Index Average) is a reference rate on the interbank market in the euro area for unsecured loans in euros. The index does not take into account the dividends of the index components (price index). The calculation is carried out by the European Central Bank as an independent institution.

EUR is the currency code for the euro, the currency of the Eurozone.

The EuroStoxx 50 Index tracks the performance of blue-chip stocks in the Eurozone and includes the super-sector leaders in terms of market capitalization.

The HRFX Global Hedge Fund Index (EUR) tracks selected hedge fund strategies. The index does not take into account the dividends of the index components (price index). The index is calculated by Hedge Fund Research, Inc. (HFR) (index sponsor).

The iBoxx Euro Corporates Overall is a broadly diversified index for corporate bonds listed in euros that have at least an investment grade rating. The index is a bond index. The index is calculated by Markit Indices Limited (index sponsor).

The iBoxx Euro Liquid High Yield tracks liquid euro-denominated high-yield bonds. The index is a bond index. JPY is the currency code for the Japanese yen, the Japanese currency.

The JP Morgan EMBI Global Composite tracks the performance of actively traded USD bonds issued by government and quasi-governmental entities in emerging markets. The index is a bond index. The index is calculated by JP Morgan (index sponsor).

JP Morgan GBI EMU 1-10 tracks the performance of euro area government bonds with maturities of 1-10 years. The index is a bond index. The index is calculated by JP Morgan (index sponsor).

JP Morgan US Government Bond Index reflects the performance of U.S. government bonds with maturities of 1-10 years. The index is a bond index. The index is calculated by JP Morgan (index sponsor).

The MSCI Emerging Markets tracks the performance of equity markets in emerging markets worldwide. The index does not take into account the dividends of the index components (price index). The index is calculated by MSCI Inc. (index sponsor).

The MSCI World is a global stock index that reflects the development of stocks in 23 industrialized countries worldwide.

USD is the currency code for the U.S. Dollar.

A strategic asset allocation process involves setting preferred allocations for asset classes on a medium to long-term horizon.

Systematic market risk is the risk affecting the whole market (not just a particular stock, industry or asset class) and is largely unpredictable.

The S&P 500 Index includes 500 leading U.S. companies capturing approximately 80% coverage of available U.S. market capitalization.

TOPIX refers to the Tokyo Stock Price Index.

Volatility is the degree of variation of an asset class or a trading-price series over time.

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