Specifying and Managing Tail Risk in Multi-Asset Portfolios (a summary)

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Presentation at the 12th Annual Research for the Practitioner Workshop, 19 May 2013
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One of the most prominent problems in multi-asset portfolio management is the management of tail risk, which arises at each step in the investment process. In general, all multi-asset investment processes follow three steps, each of which contributes to overall tail risk and each of which raises a question:

1. *allocating assets or risk into buckets*—can we design a multi-asset allocation process that helps minimize tail risk?
2. *selecting strategies*, active or passive, to fulfill the allocation chosen—at what level of underperformance should one liquidate an underperforming manager?
3. *selecting securities within each investment strategy*—can we design a portfolio construction process to manage the tail contribution from each asset?

This presentation proposes improved methodologies for Steps 1 and 3.

Individual Asset Classes

Eight common liquid asset classes are used in most allocation processes: equities (US, European, Japanese, and Asian), fixed income (sovereigns, credits, and high yield), and gold, which is used more commonly in wealth management than commodities. For the moment, I have excluded both alternative and illiquid assets.

Each of these individual asset classes has poor tail risk characteristics. As an example, from 2000 to 2012, all equity asset classes had maximum drawdowns of more than 50%, fixed-income asset classes had a drawdown of 33%, and gold, 26%. Sovereigns had a maximum drawdown of only 4%, but this number arguably might have been much larger over a full interest rate cycle. Furthermore, diversification benefits are in reality quite minimal because correlations between the equity asset classes (including high yield because it has equity-like behavior) averaged more than 80% recently and those between fixed-income instruments (ex credit risk) were around 93% over this period.

Thus, the asset allocation process devolves from allocating to eight asset classes to allocating only to two (equities and credits). Effectively, the investor

has to try to time the market, which we know cannot be done sustainably with skill. Even with a full look-ahead portfolio (i.e., perfect investment skill), if an investor had invested in the two top-performing asset classes, with quarterly rebalancing, the portfolio would have incurred a maximum drawdown of –12% at a 10% confidence level in this period.

This level of drawdown is more than what asset owners expect, given the average asset class premium earned—hence the need for an improved asset allocation and tail risk management process.

Improved Allocation Framework

The ubiquitous approach followed in multi-asset investing is to have a single allocation process that allocates assets or risk to specified buckets. Alpha risk is then diversified by deploying a large number of managers. This is odd because in any multi-asset portfolio, the majority of portfolio risk and return comes from the beta allocation decision, not the alpha decision. I would, therefore, argue that a better portfolio results from following a multi-strategy approach to asset allocation. For instance, Gupta and Straatman (2006) show that using a multi-strategy investment process can create strategy diversification and decrease portfolio risk. The same concept is applied here to the allocation process. In multi-asset investing, the allocation processes are grouped into five main categories:

1. *economic view based*—traditional macro view–based forecasting of asset markets.
2. *risk based*—including risk parity, minimum variance, and risk budgeting.
3. *fundamental systematic*—economic/fundamental weighted, thematic, and factor-based approaches.
4. *long-term risk premium*—long-term studies, as well as balanced and target date strategies.
5. *alpha only*—shorter-term strategies, such as macro hedge funds, commodity trading advisers, and managed futures.

By incorporating all five types of allocation processes in a portfolio, strategy risk is decreased. And because these processes have different biases as to when they are effective and when they are not, an additional strategy allocation layer can enable tilting the portfolio toward the style in vogue.

Although seemingly a logical and simple concept, this allocation approach has dramatic implications for the asset management structure:

- Plan sponsors will need to modify their allocation structure by having multiple allocation groups, each using a different process of allocating assets, which are then invested appropriately.

- The debate surrounding the superiority of asset allocation versus risk allocation can be resolved because both can co-exist in the same portfolio, with each part working to a different degree of efficacy at different points in the market cycle.
- The choice of buckets (asset classes, geographical areas, or factors) can also be made such that all can co-exist because the bucket choice is determined by each allocation method independently.

Furthermore, using all five allocation processes enables the allocation to be made at different investment horizons within the same portfolio, which, as detailed later, allows us to manage tail risk considerably better.

Redefining Tail Risk

Conventional literature often uses the end-of-horizon asset return distribution to measure tail risk. In practice, however, the governance structure of all asset owners and asset managers forces the review of performance periodically within the investment horizon. Thus, I propose that tail risk should not be measured using only an end-of-horizon estimation but should be a composite of two drawdown risks:

- *end-of-horizon risk*—the probability of the target return not being met at the end of the investment horizon, and
- *intra-horizon risk*—the probability of breaching a given maximum drawdown threshold at any time within the investment horizon.

Using such a composite represents portfolio risk more accurately and is more likely to lead to a portfolio that does not suffer unexpected outcomes, as compared with using only an end-of-horizon risk estimation.

Impact of a Long-Term Investment Horizon

A standard lognormal process can be used to model a portfolio construction process. Defined parameters include the universe from which assets can be selected as well as the investment process (or manager) Sharpe ratio. Parameters that can be chosen by the portfolio manager are the number of assets in the portfolio and their volatilities, the investment horizon of each asset, and the stop loss imposed for each asset.

The parameterized model concludes that end-of-horizon risk decreases as investment horizon increases. This finding substantiates conventional logic as to why one should have a long investment horizon: You are more likely to reach your desired investment objective in the long run.

At the same time, intra-horizon risk increases quite dramatically as investment horizon increases. That is, if an investor chooses a longer horizon

as advocated, the investor is more likely to breach the tolerance for maximum drawdown at some point during the investment horizon.

If an investor truly did not want to observe mark-to-market returns periodically, or was unable to observe them (as with illiquid investments), then a long-term investment horizon would indeed make sense. In practice, however, because performance reviews are possible at any time, it might not be appropriate for all asset owners to have a long-term investment horizon. Instead, a portfolio's optimal investment horizon should be determined based on the asset owner's tolerance threshold for intra-horizon risk.

Using Investment Horizon to Manage Tail Risk

The standard model can be extended to incorporate uncertainty about the mean return, similar to the Black–Litterman model (1992). But doing so has nontrivial implications because the standard deviation no longer grows with the square root of time and the Sharpe ratio is no longer time homogenous.

Although the basic result of tail risk increasing as return uncertainty increases is an expected one, this framework can then be used to construct a portfolio that explicitly incorporates the asset owner's intra-horizon risk aversion. Specifically, the portfolio manager can choose the combination of investment horizon and uncertainty of expected return (skill) for each asset so as to stay within intra-horizon risk limits. It then follows that for a given maximum intra-horizon risk threshold, long-term fundamental managers need to be much more certain of their skill compared with short-term traders.

Defining Optimal Stop-Loss Levels

A portfolio manager buys stocks in a portfolio based on positive expected return. A stock is replaced when the target return is reached, or when a maximum holding period is reached, or when the stock hits a defined stop-loss level. The question thus arises that given a maximum drawdown threshold for the overall portfolio, can customized stop-loss levels be defined for each stock based on its individual characteristics? If the stop loss is set too tight, increased transaction costs will negatively affect portfolio return, and if set too loose, large drawdowns may occur.

The parameterized model is used to determine the impact of implementing varying stop-loss levels on different portfolio assets. Results show that stop-loss levels need to be tighter when mean uncertainty increases, investment horizons are longer, and transaction costs are lower. This finding then leads to a framework that can be applied to determine optimal stop losses at the asset level and to a framework that can be aligned with the asset owner's tolerance threshold for intra-horizon drawdown. This approach can be used

for stocks in a stock portfolio, asset classes in a multi-asset portfolio, or strategies in a fund of managers.

Conclusion

Constructing a multi-asset portfolio with a constraint of tail risk aversion is challenging because (1) the individual asset classes have poor tail risk characteristics and (2) diversification between asset classes is minimal. A better portfolio can be achieved using a multi-strategy framework for the allocation process, whereby different methods of asset and risk allocation co-exist as independent strategies within the same portfolio. This framework creates strategy diversification, allows allocation to be done at multiple investment horizons, and helps to manage tail risk of the portfolio.

Conventional tail risk measures, which use only the end-of-horizon return distribution, fail to capture the real risk that an asset owner has of intra-horizon drawdown. Thus, a tail risk measure that is a composite of intra-horizon and end-of-horizon risk should lead to a portfolio with fewer unexpected outcomes.

Finally, a better and more aligned portfolio is created if intra-horizon risk is incorporated into the portfolio construction process, the investment horizon of each asset in the portfolio is chosen, and customized stop-loss levels are implemented at the asset level.

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