# Process Diversification – Ensemble Methods

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The investment world is predominately relying on a reductionist approach to finding exposure to the true underlying return drivers of financial markets as well as to understanding the behavior and causal relationship among these. Very often reductionism is resulting in simple, explainable linear models. We are big believers in Occam's razor, but we also believe that a certain degree of complexity can be necessary in order to avoid specification risk. Diversification is the only free lunch in finance and wherever we don't have strong beliefs in the true and correct process, we should exploit diversification.

## Diversification in Theory

Diversification is a concept that most investors know and claim to take advantage of. However, most investors use diversification only along the axis of what they invest in, trying to reduce the impact of idiosyncratic risks in individual investments by allocating capital across a number of less than perfect correlated securities. Preferably all the selected securities exhibit positive future return expectations and by using diversification the investor can preserve the long term expected mean of the individual securities while smoothing the trajectory towards terminal wealth. The diversified portfolio will always underperform the best part of its constituents, but ensure that the true long term expected mean of the portfolio will materialize.

The "what to invest in" dimension of diversification is only one part of the investment process, where we can take advantage of correlation benefits. In our whitepaper on rebalancing risk we explore the when dimension and here we will address the how dimension or process diversification.

## Ensemble Methods

The investment decision is associated with a high degree of uncertainty and as a result, financial models and investment processes exhibit low signal-to-noise. Return estimation is suffering from large error terms and investors can only have vague reliance on the prediction of future performance. As stated earlier, when faced with a high degree of uncertainty investors should approach the selection of securities as general as possible, in order to get exposure to the concept and not a certain specification. Ensemble methods is an advanced signal extraction technique that generalizes solutions to specific problems. Ensemble methods combines a wide range

of models and specifications to give the most robust estimate. When the direct source of an edge is hidden from view, the best we can hope is to capture a portion of the signal with any single specification. Ensembles view an endogenous investment edge from many perspectives. This advanced signal extraction technique makes a portfolio robust to a wide spectrum of future market conditions through the generalization to signal extraction producing superior risk adjusted performance.

**Factor Investing**

Factor investing and stock picking are primarily based on parametric models trying to mimic the true return drivers in the market. They are rooted in how we believe markets should behave and rationalized through linear economic theory, most of which has failed to be practically applied to investing. These models adhere to our desire for simple linear explanations and intuitions, but are rarely significant in their explanatory efforts. Factors are by most practitioners and academics defined rather narrowly in their specification of the relevant factor, their rebalancing frequency and holding period. Interestingly, a broad spectrum of specifications on measurement period, rebalance time and rebalance frequency can produce long-term Sharpe ratios similar to standard definitions. However, on shorter time horizons, they produce very different risk adjusted performance.

As a result, we can allocate across many specifications of a factor and get similar long-term returns, but much more stable performance in the short run, simply due to process diversification. Specificity risk is a major contribution to the time-varying relative performance of most active managers and factor indices.

*Investing is about being vaguely right, and not precisely wrong!*

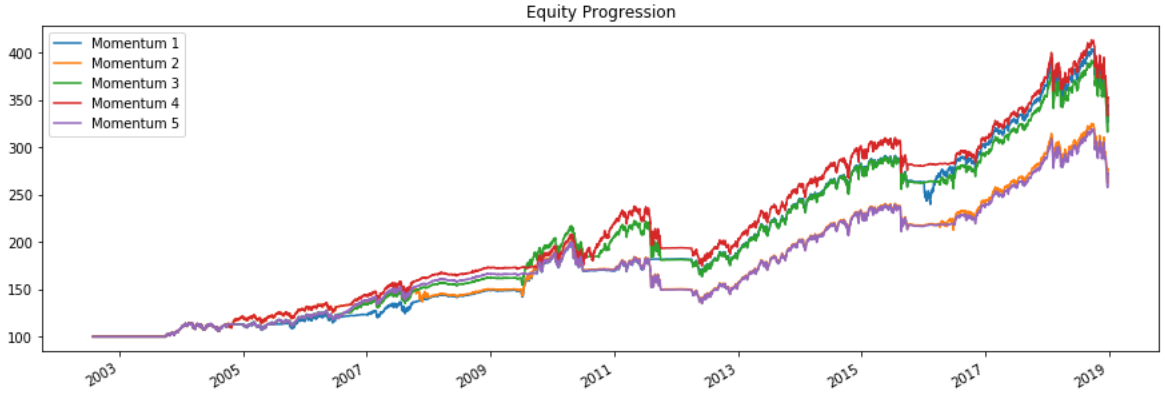
**"Average of portfolios" not "portfolio of average signals"**

When applying ensembles to signal extraction it is important to notice that ensembles should be implemented as averages of portfolios and not averages of signals. This distinction arises from the math of Jensen's Inequality, saying that the convex transformation of a mean is less than or equal to the mean applied after convex transformation. In layman terms, imagine two signals used to make all-in or all-out calls on the market. The signals range from 0 to 10 and if the individual score is above 5, we invest. If each of these signals is used to build a portfolio and we then average the portfolio weights, the resulting allocation can be all-in, all-out or 50/50 exposed. However, if we first average the signals together and then apply our rule, we can only be all-in or all-out. The first approach represents diversification of signals whereas the latter simply represents the construction of a single new signal.

## Reducing specification risk with an ensemble strategy

A simple way to minimize uncompensated specification risk is to take signals from all specifications at once by building an ensemble strategy. The ensemble takes advantage of a surprising amount of diversity in monthly returns across the different strategy specifications.

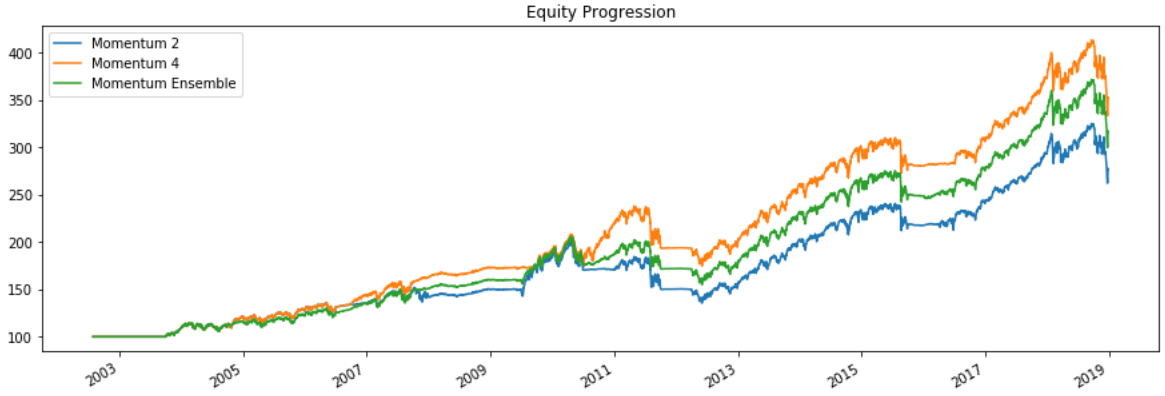
If the specifications have equal expected performance but offer diversification benefits we should expect an ensemble strategy to preserve the expected performance of any single specification, but produce those returns with greater stability. This means that investors with finite investment horizons and random inception and termination dates will probably come closer to realizing their target return, with a much smaller risk of adverse outcomes. Below is a simulation of five momentum strategies with identical monthly rebalancing and holding period, but different in their exact measurement of momentum. All portfolio's measure momentum as the difference between todays price and the price x days ago. The specific momentum lengths are 160, 180, 200, 220 and 240 days respectively and the individual equity curves are shown below.




The subtle differences between the portfolios from month to month can produce very significant economic consequences over intermediate horizons and over the entire period of 15 years the total annual return difference between the best and worst offset portfolio is 150 basis points!

This represents a surprisingly large potential difference in terminal wealth over a time horizon that most investors would find quite meaningful.

By employing an ensemble approach allocating an equal amount to each momentum portfolio we can get a meta-momentum strategy that delivers the highest Sharpe ratio, and lowest volatility and max drawdown, while offering similar compound returns (see chart below). At the same time we don't need to guess ex ante which specification is the best.




*Specification risk is a large and uncompensated source of risk*

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*It is emphasized that investment returns shown are simulated and do not represent actual performance of assets during a period. If the simulated strategy had been implemented during the period, the actual returns may have differed significantly from the simulated returns presented. Past performance, whether actual or simulated, is not a reliable indicator of future results and the return on investments may vary as a result of currency fluctuations.*

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