Introducing the Multi-Portfolio Attribution Model in BarraOne

Attributing Performance Across Multiple Asset Classes, Strategies and Managers

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Executive Summary

This Product Insight introduces the Multi-Portfolio Attribution (MPA) model for asset owners and asset managers, available within BarraOne's Performance Analytics solution. The MPA model attributes the performance of a hierarchical investment portfolio to tactical allocation and manager selection decisions, benchmark mismatch, and currency effects. Each step in the investment decision process is incorporated through a tree structure which precisely maps to the hierarchical investment portfolio together with the corresponding policy or blended benchmarks.

The tree can be structured across any number of asset classes (including alternative asset classes), strategies and managers. It incorporates the impact of changing investment decisions through time, either due to shifts in long term asset allocation strategies or short-term shifts to capture tactical opportunities. The model can easily apply a time series of policy, blended benchmark and portfolio weights to reflect the portfolio's history of strategic asset allocation (SAA) decisions, periodic rebalancing and proportional ownership. It can also capture weight drift between restatement or rebalancing dates, as well as the value added over a number of different asset allocation steps. This is important as tactical and strategic asset allocation decisions may go through numerous stages before being approved and implemented.

The paper goes on to illustrate, through a practical case study, how the Visualization tool within BarraOne's Performance Analytics solution can be used interactively in combination with the MPA model to understand the drivers of performance at each step in the investment process. A series of graphical dashboards which are interactive, available on-demand and updated automatically each day, allow trends and outliers to be efficiently identified. Finally, we provide numerous ex post risk and risk-adjusted return measures to evaluate the risk-adjusted performance based on the realized returns of the hierarchical investment portfolio.

The MPA model is very useful as it can answer the following questions in a single analysis:

- How did the strategic asset allocation perform?
- How did the investment portfolio perform?
- What was the impact of tactically deviating from the long term strategy?
- What was the impact of selecting managers investing in non-base currencies?
- What was the impact of any benchmark (or style) mismatch?
- Did managers outperform their benchmarks?
- Did we add value by selecting the right managers?

Introduction

BarraOne

BarraOne, MSCI's multi-asset class, multi-currency, risk and performance platform, has a multitude of uses across all asset classes and multiple investment styles. This breadth and flexibility helps investment managers make more informed decisions, as our tool can be perfectly aligned with the way they invest.

Multi-Portfolio Attribution (MPA) Model

This Product Insight introduces the Multi-Portfolio Attribution (MPA) model, available within BarraOne's Performance Analytics solution. The model addresses the following needs of asset owners and asset managers:

- For asset owners - such as plan sponsors of pension funds, sovereign wealth funds, central banks, insurance companies, endowments, foundations and family offices - it is critical to attribute performance to their tactical asset allocation (TAA) versus their strategic asset allocation (SAA), first of all for their investment across asset classes, then within asset classes to different strategies and finally by selecting individual managers.[1]
- For asset managers, it is equally important to attribute the performance of asset allocation portfolios and multi-manager (fund-of-fund) portfolios in alignment with the corresponding investment process.

The MPA model addresses these needs by attributing the performance of a hierarchical investment portfolio to tactical allocation and manager selection decisions, to benchmark (or style) mismatch and to currency effects. The model provides both arithmetical and geometrical analyses, and can show attribution effects in the base currency if currency effects do not need to be considered. Each step in the investment decision process is incorporated in an analysis tree which precisely maps the hierarchical investment portfolio and corresponding policy or blended benchmarks. The tree can be structured across any number of asset classes, strategies and managers, including those invested in alternative asset classes.[2] The model incorporates the impact of changing investment decisions over time, either due to shifts in long term asset allocation strategies or short-term shifts intended to capture tactical opportunities. The following kinds of conditions can easily be applied within the model:

[1] A strategy refers to collection of investment portfolios or sub-strategies with a common theme. For example a "US Equity" strategy might contain a small cap portfolio and a large cap portfolio that are both invested in US stocks.

[2] The MPA model retains the structure of the portfolio tree, whereas analysis using the Classic, Factor, and Fixed Income attribution models is carried out by "flattening" the tree to create a single portfolio which contains the aggregation of asset exposures across all manager portfolios.

- A time series of policy weights for a set of investment universes that represent the history of SAA decisions while also capturing the effect of tactical strategies via weight drift between restatement dates.
- A time series of blended benchmark weights to capture the periodic rebalancing of the components of a blended benchmark while incorporating the drift in weights between rebalancing dates.
- A time series of portfolio weights to capture proportional ownership of other portfolios including the drift in weights over time.[3]

It is also possible to capture the value added over a number of different asset allocation steps. This is important as the tactical and strategic allocation may go through numerous stages before being approved and implemented. The model makes it simple to analyze the steps in pairs for the purpose of capturing and decomposing the relative value added by each set of decisions.

The paper goes on to illustrate, through a practical case study, how the Visualization tool within BarraOne's Performance Analytics solution can be used interactively in combination with the MPA model to understand the drivers of performance at each step in the investment process. A series of graphical dashboards, which are interactive, available on-demand and updated automatically each day, allows trends and outliers to be efficiently identified.

The MPA model is available to BarraOne Performance Analytics users on a permission-only basis. There are two supported options which differ depending on the availability of manager returns:

1. Analytics driven by weights, corresponding to investment decisions, and manager-level returns (or NAVs), both of which are supplied by the user for all portfolios.
2. Analytics driven by user-supplied weights, corresponding to investment decisions, and manager-level returns, which are calculated bottom-up from constituents or supplied by the user.

The most granular results provided for each approach are at the manager level; results are not provided at the constituent level. The second option may be the more practical approach, since it may not be feasible to provide manager-level returns.

The next section describes the MPA model in detail. The case study is presented in the following section, while the final section summarizes the paper. Finally, the Appendix shows examples of the calculations used.

The MPA Model

[3] Depending on the point of reference, a universe relates to a particular asset class, strategy or manager, in the hierarchical investment portfolio.

The MPA model captures benchmark-relative attribution effects (if benchmarks are specified), as well as return contributions for a standalone portfolio and benchmark. These results are reported for each point of the structure which represents the hierarchical investment portfolio. This is of paramount importance as insightful reporting is only possible if the attribution model is precisely aligned with the investment process.

Attribution Effects from Asset Classes, Strategies and Managers

The MPA model allows analysis to be carried out on a hierarchical investment portfolio using a modified Brinson-Fachler style attribution approach.[4] The attribution effects captured by the MPA model tie back to investment decisions relevant to each asset class, strategy and manager, as follows, where "local" refers to the performance in the currency of each manager's portfolio:

Tactical Allocation Effect: Active local return due to overweighting/underweighting an asset class, strategy or manager, compared to its weight in the corresponding policy benchmark (when relevant) or blended composite benchmark which over or underperforms compared to its own benchmark.[5]

Manager Selection Effect: Active local return due to an investment in an asset class, strategy or manager which over or underperforms compared to its blended composite benchmark.

Interaction Effect: Active local return due to the inevitable interaction of top-down tactical allocation decisions and bottom-up manager selection decisions. This is due to the implicit active bet on a portfolio universe outperforming its composite benchmark; it can optionally be included in the manager selection effect.

Benchmark Mismatch Effect: Active local return due to the performance of manager benchmarks differing from the performance of strategy benchmarks. This is due to an implicit bet on a blended composite benchmark outperforming the corresponding policy benchmark (when relevant).

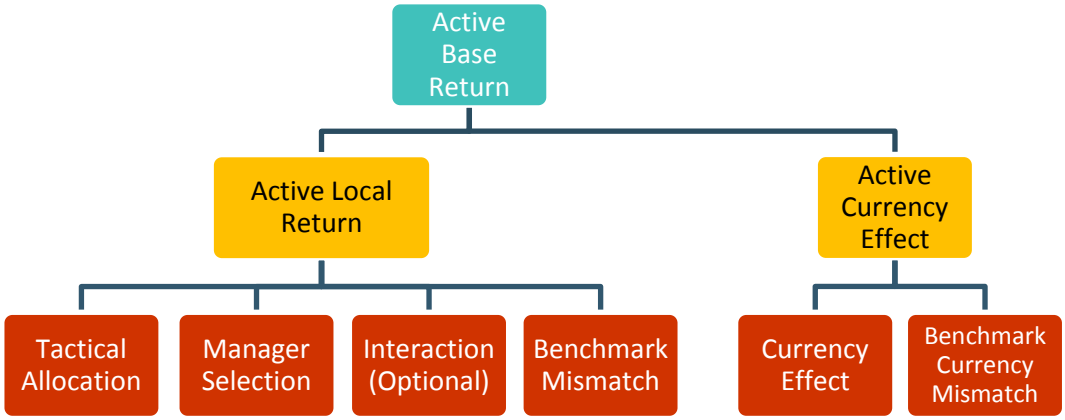
Currency Effect: Active base return due to the currency of each manager's portfolio differing from the base currency of the analysis, which leads to a difference in the currency return contributions from a portfolio universe relative to the corresponding composite benchmark universe.

Benchmark Currency Mismatch Effect: Active base return due to the currency performance of manager benchmarks differing from the currency performance of strategy benchmarks, which leads to a difference in the currency return contributions from a blended composite benchmark universe relative to the corresponding benchmark universe.

4 The original Garry Brinson & Nimrod Fachler model has been in use since 1985 and is a very popular and simple way to attribute active return to allocation and selection decisions. However, this is rigid in that it can only account for a top-down investment process consisting of a single allocation decision, and only applies to arithmetic attribution.

5 A blended composite benchmark is a benchmark blended from one or more benchmark universe.

Exhibit 1: Attribution Diagram for the Multi-Portfolio Attribution Model



The attribution diagram for the MPA model, shown in Exhibit 1, begins with the active base return which is attributed to the active local return and the active currency return; then, the active local return is attributed to the tactical allocation, manager selection, interaction, and the benchmark mismatch effects, while the active currency return is attributed to the currency effect and the benchmark currency mismatch effect.

The attribution analytics for the MPA model are based on the Brinson-Fachler approach, but are modified in two main ways:

1. Incorporating blended and policy benchmarks to account for the possibility of a benchmark mismatch between strategy and manager benchmarks.
2. Supporting cascading attribution effects to incorporate the allocator's view of the benchmark at each level in the hierarchical investment process.

Base Currency Analysis

It is also possible to run the MPA model using the base currency of the portfolio tree when determining all attribution effects. This results in there being no currency attribution effects.

Return Contribution from Asset Classes, Strategies and Managers

The MPA model captures the contribution to return for the standalone portfolio and benchmark from each asset class, strategy and manager. The return contributions captured by the model are as follows:

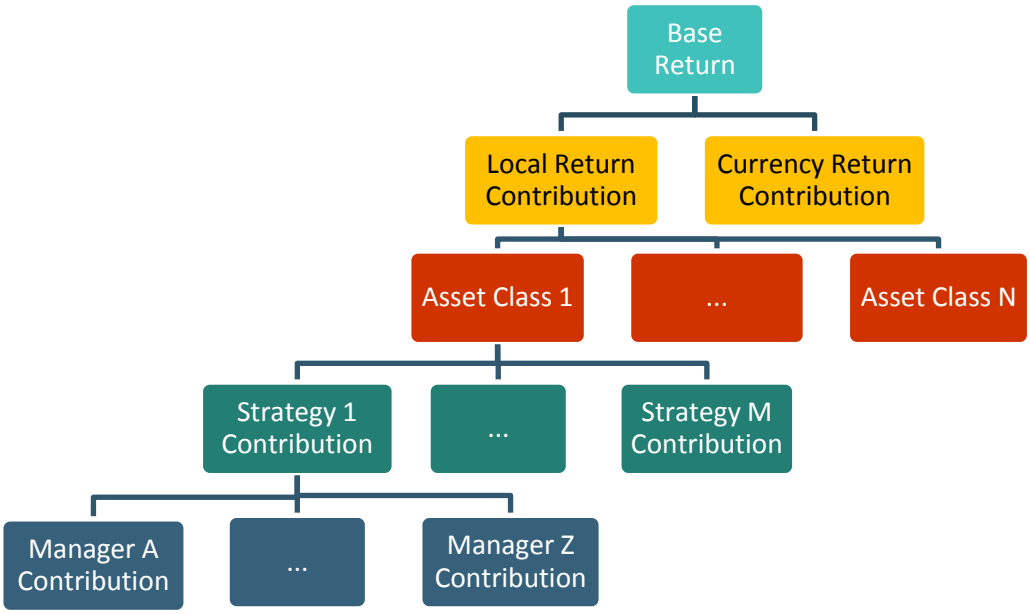
Asset Class Return Contribution: Return contribution of a particular asset class in the currency of the asset class.

Strategy Return Contribution: Return contribution of a particular strategy in the currency of the strategy.

Manager Return Contribution: Return contribution of a particular manager's portfolio in the currency of the manager's portfolio.

Currency Return Contribution: Return due to the currency of a portfolio universe differing from the base currency of the analysis.

Exhibit 2: Contribution Diagram for the Multi-Portfolio Attribution Model



The contribution diagram, shown in Exhibit 2, is applicable to the hierarchical investment portfolio and separately to the corresponding benchmark structure (if applicable), and illustrates that the base return is attributed to a local return contribution and a currency return contribution; then, the local return contribution is attributed to a return contribution for the various asset classes (Asset Classes 1 through to N are shown for illustration purposes); within each asset class to a return contribution for each strategy (this is illustrated only for Asset Class 1, but is relevant to all asset classes); and within each strategy to a return contribution for each manager (this is illustrated only for Strategy 1, but it is relevant to all strategies). "Local" refers to the performance in the currency of each manager's portfolio.

Base Currency Analysis

It is also possible to run the MPA model using the base currency of the portfolio tree when determining all return contributions. This results in there being no currency attribution effects.

Case study

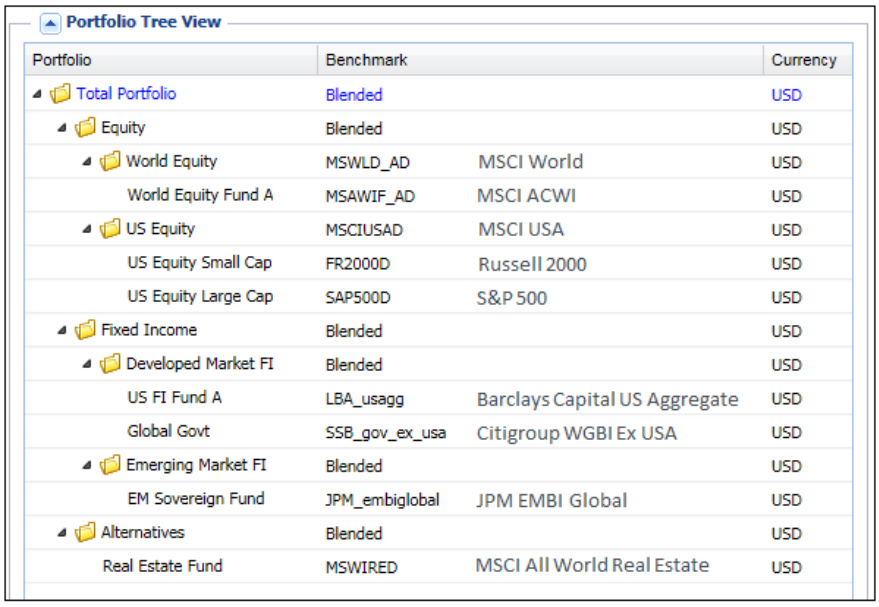
The case study demonstrates how the MPA model can be used to attribute the performance of a hierarchical investment portfolio. The example presented is relatively straightforward and focuses on a U.S. asset owner who invests across four strategies, over three asset classes, and ultimately selects seven managers who invest in U.S. dollar. This example allows many concepts to be illustrated without unnecessary complications. The pension plan in the case study was benchmarked against over 30,000 securities, so is certainly much more than a basic case. However, the example is applicable to any globally invested asset owner, asset allocation portfolio or multi-manager portfolio. BarraOne has an extremely robust infrastructure which can support much larger and more complex hierarchical investment portfolios, with complete flexibility to carry out MPA analysis involving any number of asset classes, strategies and managers, to match any specific investment portfolio.

Investment Structure and Benchmarks

For asset owners analyzing a pension plan and for asset managers analyzing an asset allocation portfolio, the strategic, long term allocation is represented by the asset class benchmarks and strategy benchmarks. The actual allocation across the pension plan (or asset allocation portfolio) at any point in time indicates the tactical view.

The investment structure and benchmarks corresponding to the pension plan are shown in Exhibit 3, which is a screenshot taken from the MPA model setup in BarraOne. The first column gives the hierarchy of the pension plan's investment across equity, fixed income and alternative asset classes. There is a World and U.S. strategy within the equity asset class, a Developed Market and Emerging Market strategy within the Fixed Income asset class, and then there are various managers selected (shown at the leaf nodes) following different investment styles within the different strategies. The second column shows the benchmarks relevant to the different asset classes and strategies, which correspond to the asset owner's strategic allocation, as well as the manager benchmarks. The benchmarks either correspond directly to a particular asset class, strategy, or manager, or are blended together from other benchmarks. For example, the "US Equity" strategy has the MSCI USA index as its policy benchmark, whereas the "World Equity" strategy has a benchmark which is a blend of MSCI World and MSCI ACWI. This introduces a benchmark mismatch which occurs when strategy benchmarks differ from manager benchmarks within a strategy.

Exhibit 3: BarraOne Screenshot of the Pension Plan's Investment Structure and Benchmarks



Portfolio Tree View

Portfolio	Benchmark		Currency
Total Portfolio	Blended		USD
Equity	Blended		USD
World Equity	MSWLD_AD	MSCI World	USD
World Equity Fund A	MSAWIF_AD	MSCI ACWI	USD
US Equity	MSCIUSAD	MSCI USA	USD
US Equity Small Cap	FR2000D	Russell 2000	USD
US Equity Large Cap	SAP500D	S&P 500	USD
Fixed Income	Blended		USD
Developed Market FI	Blended		USD
US FI Fund A	LBA_usagg	Barclays Capital US Aggregate	USD
Global Govt	SSB_gov_ex_usa	Citigroup WGBI Ex USA	USD
Emerging Market FI	Blended		USD
EM Sovereign Fund	JPM_embiglobal	JPM EMBI Global	USD
Alternatives	Blended		USD
Real Estate Fund	MSWIRED	MSCI All World Real Estate	USD

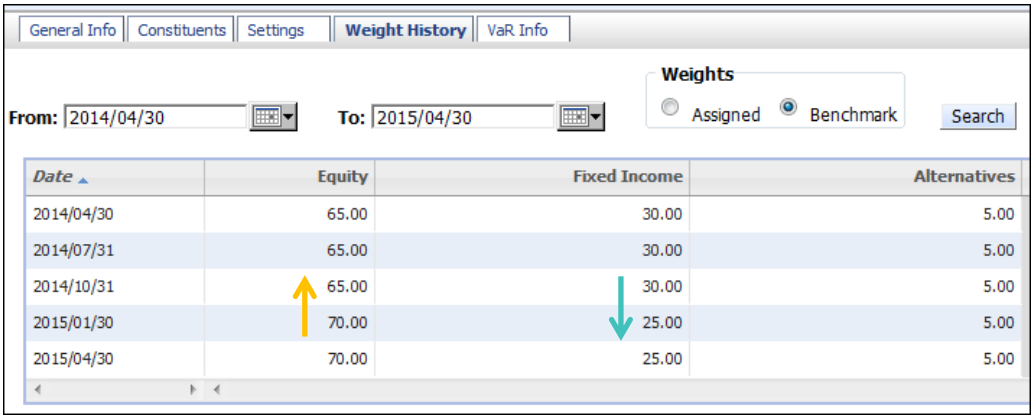
Reviewing the benchmarks used in this straightforward example gives a sense of the broad coverage of index data available in BarraOne, with index families such as Russell and S&P chosen for the equity benchmarks; then Barclays, Citigroup, and JP Morgan chosen for the fixed income benchmarks; and then MSCI for both equity and real estate. There are over 20,000 benchmarks available in BarraOne for use in our Performance Analytics, obtained from more than 15 index vendors. They are reconciled every day to ensure the necessary data integrity, such that constituent-level weights and the asset returns supplied by index vendors reconcile with the published index levels derived using each vendor's own index calculation methodology.

Tactical and Strategic Asset Allocation

Across Asset Classes

The analysis was carried out between May 2014 and April 2015, during which time the pension plan's SAA was periodically rebalanced across the different asset classes. This is shown in Exhibit 4, which displays the weights used to rebalance the asset class benchmarks every three months. This illustrates how the high-level SAA is applied in BarraOne. It is possible to specify the SAA for any level in the hierarchy and at any point in time.

Exhibit 4: Strategic Asset Allocation



Date	Equity	Fixed Income	Alternatives
2014/04/30	65.00	30.00	5.00
2014/07/31	65.00	30.00	5.00
2014/10/31	65.00	30.00	5.00
2015/01/30	70.00	25.00	5.00
2015/04/30	70.00	25.00	5.00

The policy committee began with an allocation of 65, 30 and 5 per cent allocated across equity, fixed income and alternative asset classes. There was a change in the SAA in January 2015, when the policy committee is assumed to have decided to increase the pension plan's SAA to equity by 5 per cent, decreasing the allocation to fixed income by the same amount.

Exhibit 5: Tactical Asset Allocation

	Equity	Fixed Income	Alternatives
Plan Average Wt.	61 %	29 %	10 %

In Exhibit 5, an indication of the pension plan's TAA is given by the average weight for each asset class during the analysis. This reflects allocation bets to deviate from the policy by being underweight in equities, neutral for fixed income and overweight in alternatives throughout the reporting period.

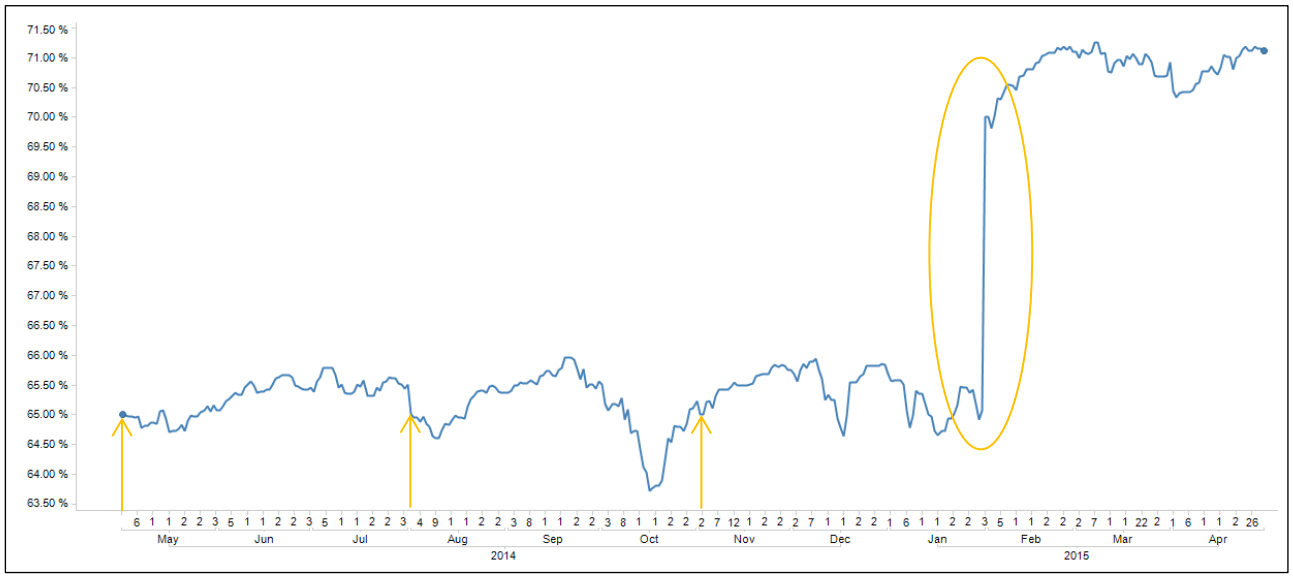
Asset Allocation

In BarraOne, it is straightforward to enter historical time series of policy weights corresponding to a set of investment universes, at any level in the investment hierarchy, to represent the history of TAA and SAA decisions. The MPA model captures the effect of a drift away from rebalancing weights between restatement dates according to each portfolio or benchmark universe's daily return.

The daily drift between rebalancing for the SAA to the equity asset class is illustrated in Exhibit 6, which is a screenshot from the daily performance dashboard in BarraOne. The arrows correspond to the equity asset class being rebalanced periodically, as described in Exhibit 4, to 65 per cent. The impact of the decision to increase the allocation to equity from 65 per cent to 70 per cent, applied on January 30th, is circled.

The remaining exhibits are taken from different dashboards supplied with BarraOne Performance Analytics' Visualization solution.

Exhibit 6: Drift and Rebalancing in Strategic Asset Allocation to the Equity Asset Class



Blended Benchmarks

A time series of weights can be supplied to incorporate the periodic rebalancing of the components of a blended benchmark for any level in the investment hierarchy, while the MPA model captures the effect of weights drifting between rebalancing dates.

Fund-of-fund investment portfolios

For fund-of-fund investment portfolios, a time series of portfolio weights can be incorporated to capture the proportional ownership of other portfolios for any level in the investment hierarchy, while the MPA model captures the effect of weights drifting between rebalancing dates.

Strategy Level

The average allocation over the reporting period is available for review in the exposure analysis dashboard for any level in the investment hierarchy; this is illustrated by a screenshot in Exhibit 7, for the different strategies within each asset class (asset class and manager exposures can also be displayed). The green bars show that the largest SAA was to the World Equity strategy, at over 40 per cent, with the smallest to the Emerging Market FI strategy, at less than 2 per cent. The tactical allocation bets to deviate from the SAA implemented in the pension plan are shown in orange. The largest strategy bets were to overweight the Emerging Market FI strategy by more than 8 per cent, and to underweight the Developed Market FI

strategy by a similar amount, with reasonably small bets placed to underweight the SAA for the equity strategies.

In another dashboard, time series of SAA bets are displayed for review. These are illustrated by the orange bars in Exhibit 8 for the Emerging Market FI strategy, and are seen to be consistent month-to-month. This dashboard makes it particularly easy to keep track of changes in allocation bets. The tree map can be used to drill into the monthly exposures across the portfolio (shown in blue), the SAA (shown in green) and the allocation bets (shown in orange) at any point in the investment hierarchy, for any asset class, strategy or manager.

Exhibit 7: Strategy Level Allocations

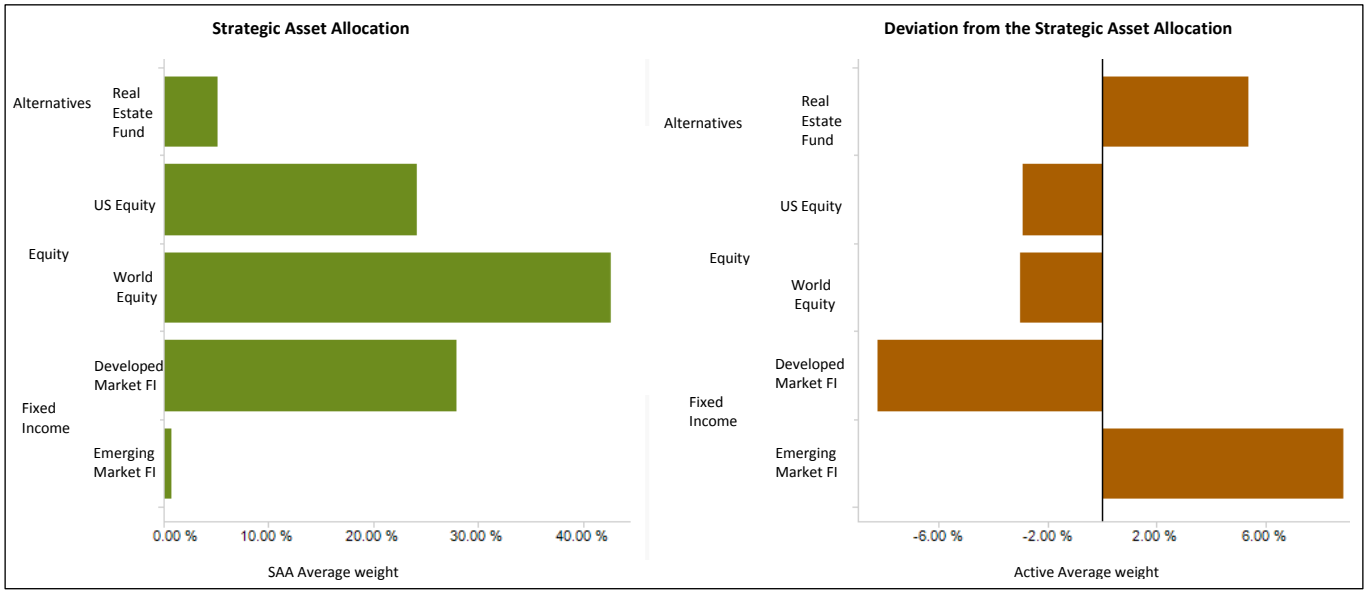
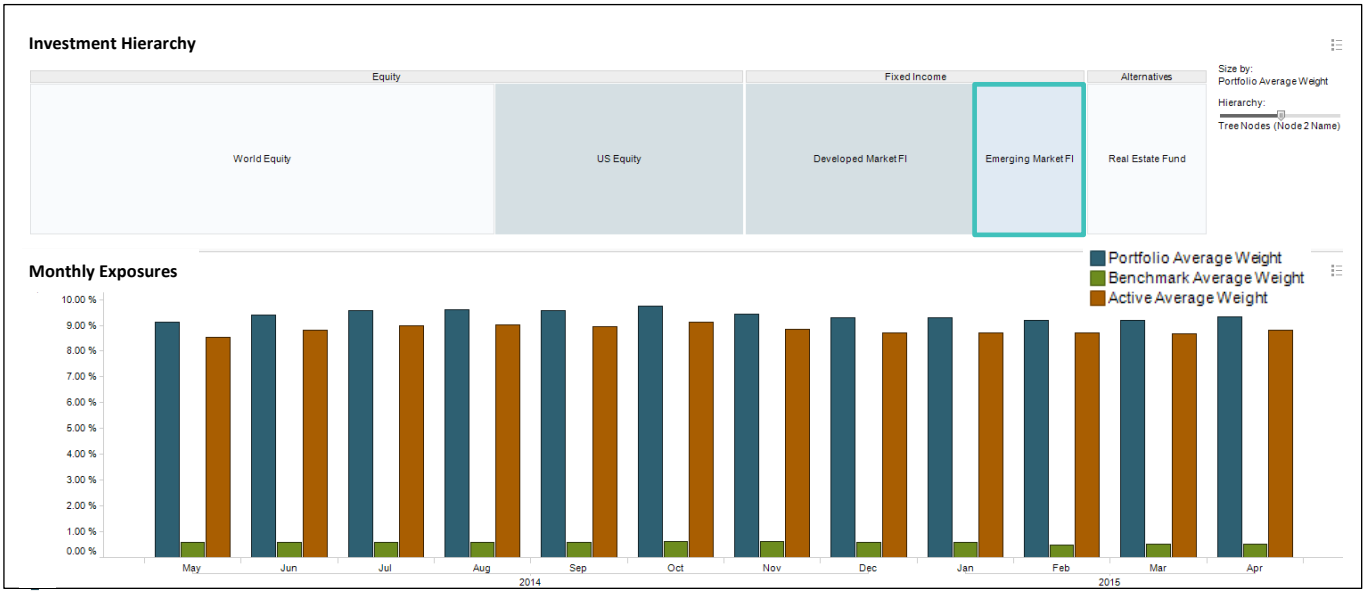


Exhibit 8: Exposures for the Plan, the SAA and Allocation Bets for the Emerging Market FI Strategy



Performance Attribution

This section illustrates how the MPA model captures key results in a single analysis:

- The performance of both the SAA and the investment portfolio.
- The value added by tactically deviating from the SAA.
- The impact of selecting managers investing in non-base currencies.
- The impact of any benchmark mismatch.
- Whether managers outperformed their benchmarks.
- Whether there was value added by selecting the right managers.

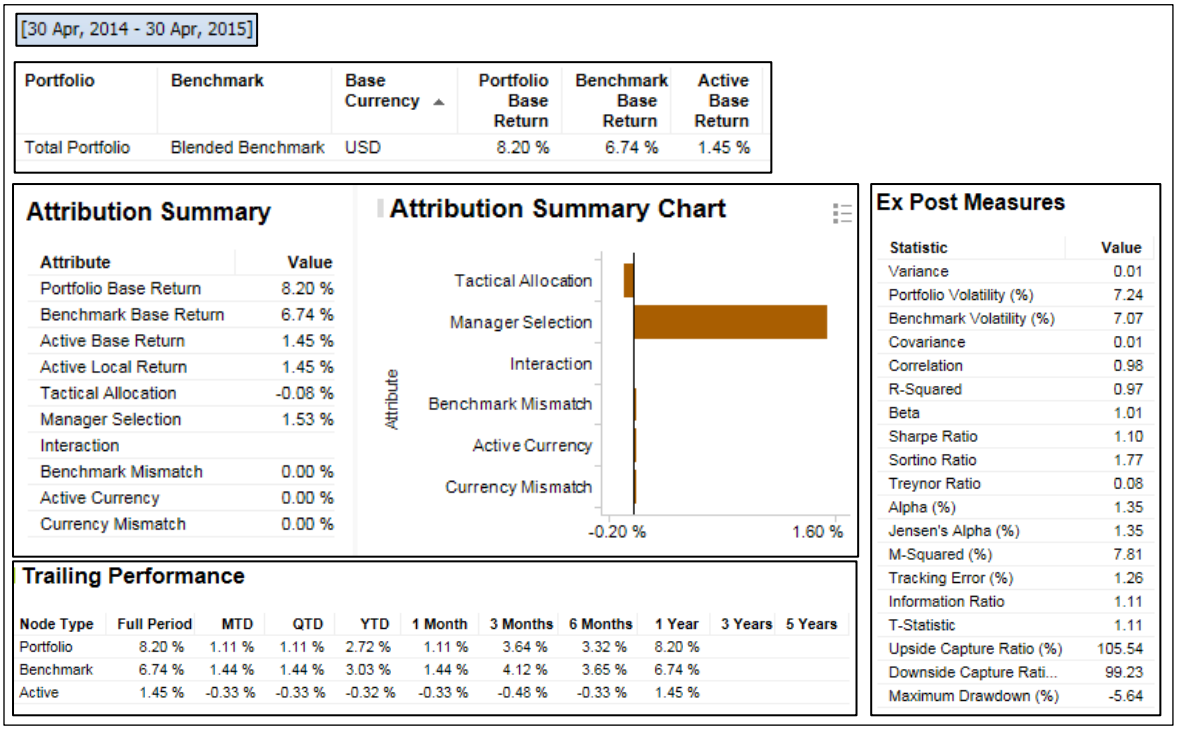
Performance overview of the investment portfolio and SAA

We begin by reviewing the performance of the investment portfolio - which is a pension plan in our example but could equally be any asset allocation portfolio - and the SAA, namely the overall benchmark, from May 2014 to April 2015. Exhibit 9 presents a sample of the results from the Summary dashboard. This executive summary style dashboard provides high level performance attribution results, as well as ex post risk and risk-adjusted return measures which can support the performance appraisal process.

The investment decisions used to construct the SAA resulted in a return of 6.74 per cent during the reporting period. The investment decisions used to construct the pension plan led to a return of 8.20 per

cent, resulting in 145 basis points of outperformance (i.e. the arithmetic active return) due to the TAA deviating from the SAA.[6] Of the 145 basis points of outperformance, 8 basis points were lost due to unsuccessful tactical allocation decisions, but that was more than compensated for by 153 basis points gained from manager selection decisions. There were no currency effects since all managers invested in the base currency of the pension plan.[7]

Exhibit 9: Sample Results from the Summary Dashboard



[30 Apr, 2014 - 30 Apr, 2015]

Portfolio	Benchmark	Base Currency	Portfolio Base Return	Benchmark Base Return	Active Base Return
Total Portfolio	Blended Benchmark	USD	8.20 %	6.74 %	1.45 %

Attribution Summary

Attribute	Value
Portfolio Base Return	8.20 %
Benchmark Base Return	6.74 %
Active Base Return	1.45 %
Active Local Return	1.45 %
Tactical Allocation	-0.08 %
Manager Selection	1.53 %
Interaction	
Benchmark Mismatch	0.00 %
Active Currency	0.00 %
Currency Mismatch	0.00 %

Attribution Summary Chart

Ex Post Measures

Statistic	Value
Variance	0.01
Portfolio Volatility (%)	7.24
Benchmark Volatility (%)	7.07
Covariance	0.01
Correlation	0.98
R-Squared	0.97
Beta	1.01
Sharpe Ratio	1.10
Sortino Ratio	1.77
Treynor Ratio	0.08
Alpha (%)	1.35
Jensen's Alpha (%)	1.35
M-Squared (%)	7.81
Tracking Error (%)	1.26
Information Ratio	1.11
T-Statistic	1.11
Upside Capture Ratio (%)	105.54
Downside Capture Rati...	99.23
Maximum Drawdown (%)	-5.64

Trailing Performance

Node Type	Full Period	MTD	QTD	YTD	1 Month	3 Months	6 Months	1 Year	3 Years	5 Years
Portfolio	8.20 %	1.11 %	1.11 %	2.72 %	1.11 %	3.64 %	3.32 %	8.20 %		
Benchmark	6.74 %	1.44 %	1.44 %	3.03 %	1.44 %	4.12 %	3.65 %	6.74 %		
Active	1.45 %	-0.33 %	-0.33 %	-0.32 %	-0.33 %	-0.48 %	-0.33 %	1.45 %		

The pension plan's return and the performance of the SAA were achieved with a very similar but reasonably high level of realized volatility of about 7 per cent, which can be seen from the "Ex Post Measures" presented in Exhibit 9. Also, the Sharpe ratio, information ratio and T-statistic are not

[6] Active performance can also be calculated geometrically in the BarraOne Performance Analytics solution.

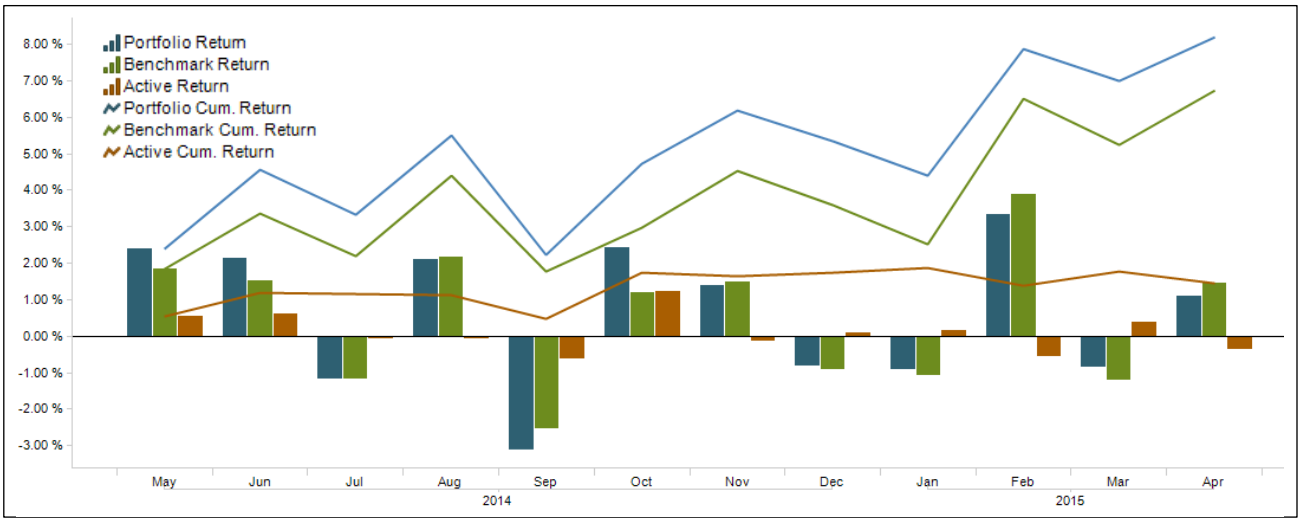
[7] The MPA model is applicable to any globally invested pension plan, a single currency example is used for ease of exposition.

particularly high, all around 1.1, indicating that the active performance was not particularly high on a risk-adjusted basis.[8]

Having seen how the pension plan and the SAA performed at a high level, we will now go into much more detail in order to understand the drivers of performance across the different asset classes, strategies and managers.

Exhibit 10 presents the monthly and cumulative trend in performance from May 2014 to April 2015. It can be seen that the pension plan (shown in blue) led the SAA (shown in green) from the outset and continued generally to outperform (shown in orange) over the whole year.

Exhibit 10: Monthly Trend in Performance



Attribution Across Asset Classes, Strategies and Managers

The outperformance across the reporting period and the trend over time due to deviating from the SAA was illustrated in the last section. In this section we go into further detail, attributing the achieved return to investment decisions made across the various asset classes, strategies and managers.

Attribution Across Asset Classes

Exhibit 11 illustrates a breakdown of the overall outperformance (145 basis points) over the different asset classes, with the total attribution effects for alternatives, equity and fixed Income - shown by the line - to be 8, 111 and 27 basis points, respectively. Tactical allocation (shown in blue) to the alternatives asset class provided 30 basis points, but this was more than offset by poor tactical allocation to the Equity

[8] A Sharpe ratio above 1 but less that 5 is considered acceptable, an information ratio above 0.5 is only just considered adequate, and typically the T-statistic should be above 2 to imply that the active return is statistically significant.

and Fixed Income asset classes, which resulted in effects of -24 and -14 basis points, respectively. Fortunately, the manager selection decisions across the various asset classes compensated for the disappointing tactical allocation results, with 153 basis points deriving from manager selection decisions (shown in green) relative to the Equity (135), Fixed Income (41) and Alternatives (-23) asset classes.

Exhibit 11: Drilldown into Asset Class Attribution Effects

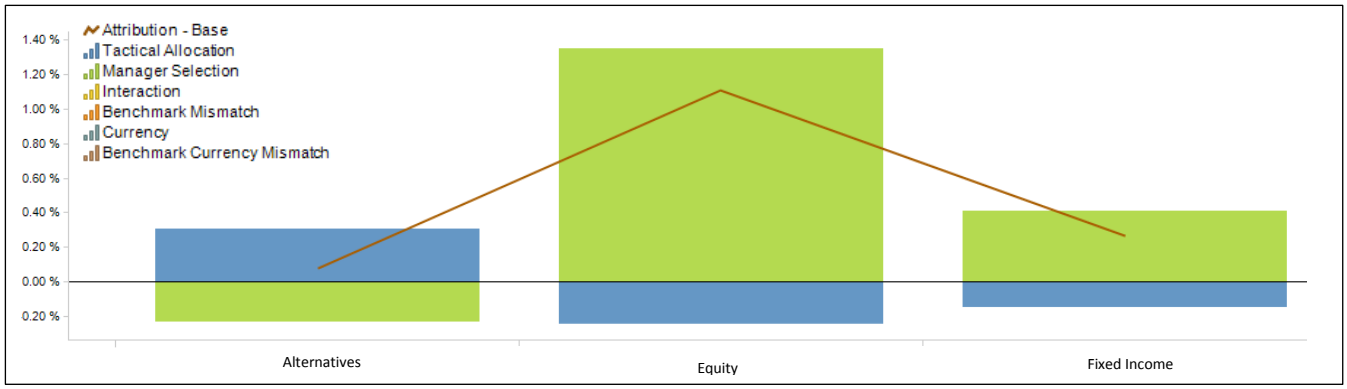


Exhibit 12 provides an understanding of the drivers behind the attribution effects across the asset classes. In the top chart, for example, it can be seen that the bet to overweight the alternatives asset class (shown under "Active Avg weight" combined with this asset class outperforming the overall blended benchmark by more than 6 per cent (shown by the BM Group Local Relative Ret chart) to produce a tactical allocation effect of 30 basis points. The equity asset class also outperformed the overall blended benchmark, but as the pension plan was underweight equity this led to the negative tactical allocation effect of -24 basis points.

The second chart in Exhibit 12 provides further analysis of the manager selection effects across each asset class. For example, the 135 basis points of manager selection for the equity asset class can be clearly seen to be due to the large exposure (over 60 per cent on average) to an asset class which returned over 2 per cent more than its benchmark.

Further insight can be gained by examining a time series of attribution effects for any asset class, strategy or manager. This is shown for the alternatives asset class in Exhibit 13, with the blue bars indicating the tactical allocation effect for each month, accumulating to 30 basis points during the reporting period, while the green bars illustrate the manager selection effect for each month, totaling -23 basis points over the reporting period.

Using the dashboards in combination can provide additional illumination., Reviewing average allocations followed by time series of allocations, as in Exhibits 6 and 7, then the drivers of outperformance, as in Exhibits 9, 11 and 12, and finally time series of attribution effects, as in Exhibits 10 and 13, provides a comprehensive analysis of realized performance across the asset classes. This process can be carried out

at increasingly granular levels by interacting with the dashboards to focus on strategies within asset classes and then drilling down to manager-level analysis.

Exhibit 12: Drivers of Asset Class Attribution Effects

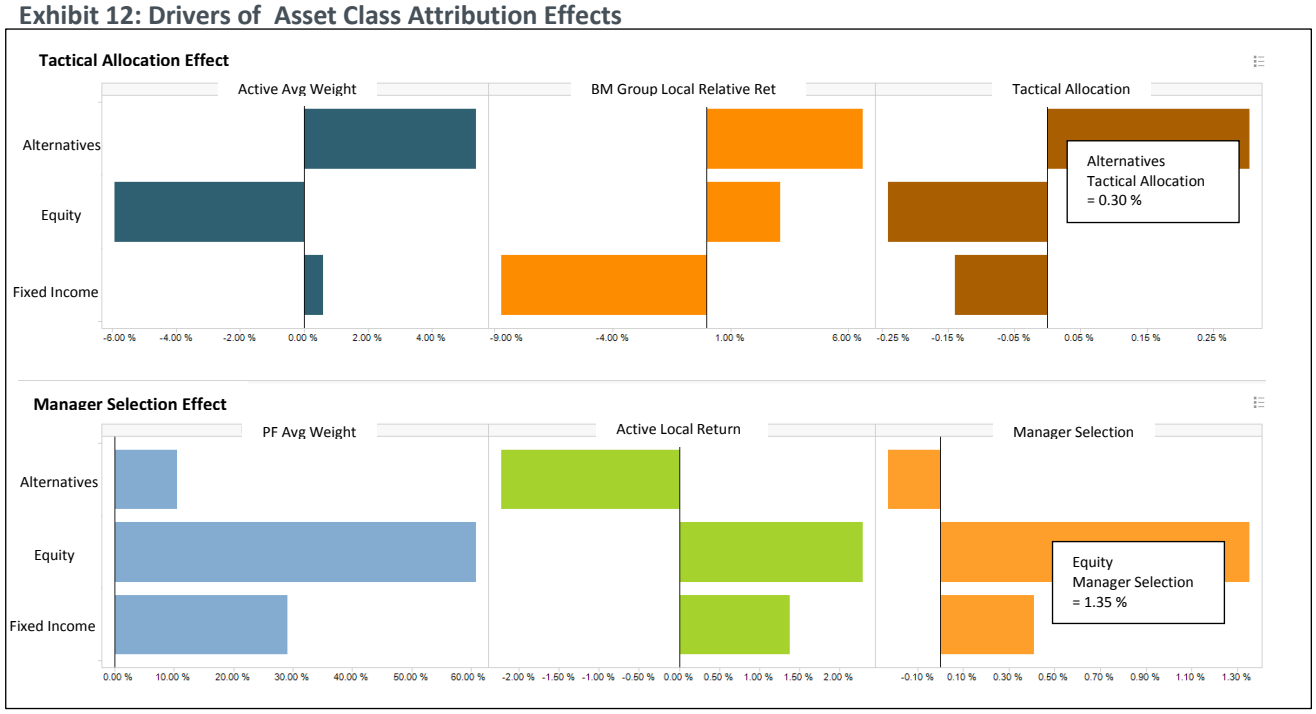
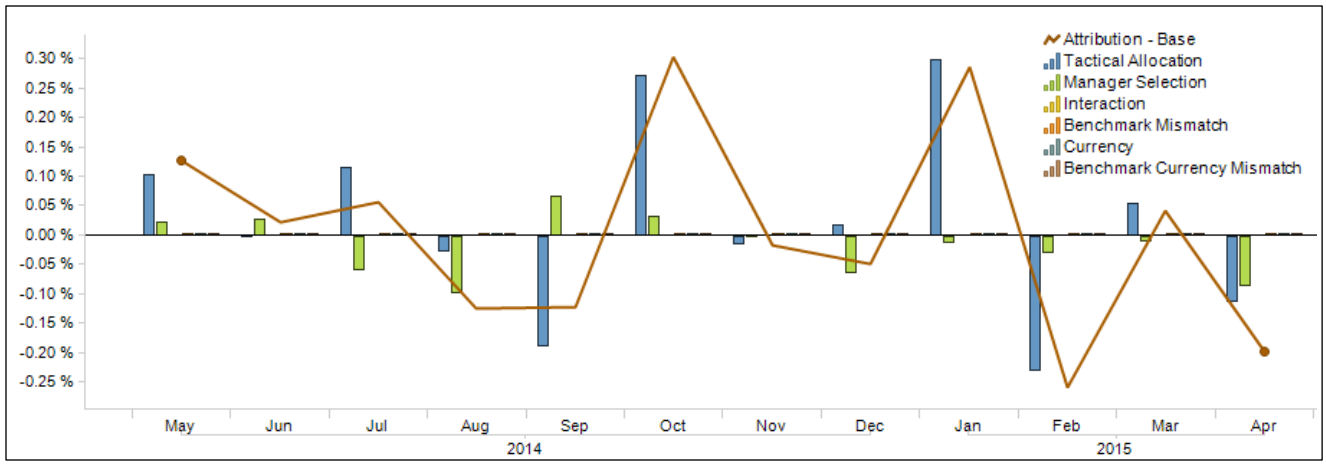


Exhibit 13: Time Series of Attribution Effects for the Alternatives Asset Class



Attribution Across Strategies

In this example, the main driver of return across each asset class was seen to be manager selection. We now examine the strategies within each asset class to understand the attribution effects at this deeper level of investment decision-making. From Exhibit 14, it can be seen that the strategy contributing most to the 153 basis points of manager selection was World Equity, with a total attribution effect of 93 basis points (shown by the line), coming mainly from manager selection (shown in green). Other than the Emerging Markets FI strategy, which contributed 57 basis points due to successful tactical allocation (shown in blue), there were no other successful TAA bets across the strategies.

Exhibit 14: Drilldown into Strategy Attribution Effects

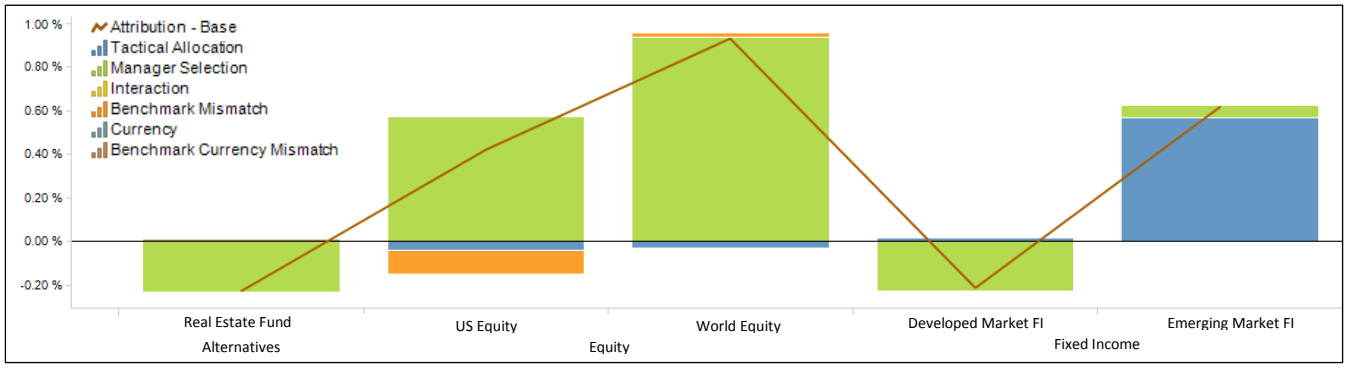


Exhibit 15 shows that the successful TAA bet on the Emerging Markets FI strategy resulted from allocating over 8 per cent more on average in the investment portfolio than in the benchmark, for a strategy which outperformed relative to the fixed income benchmark by over 6 per cent. Exhibit 16, showing a time series view of the Emerging Markets FI strategy attribution effects, indicates that this tactical allocation bet paid off (as shown by the blue bars), in all months except December.

Exhibit 15: Drivers of Strategy Tactical Allocation Effects

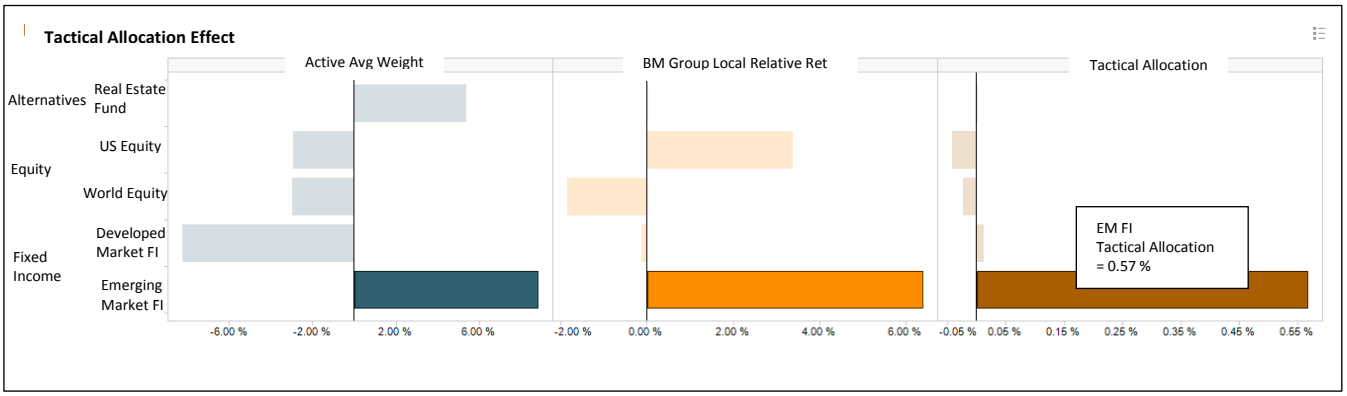
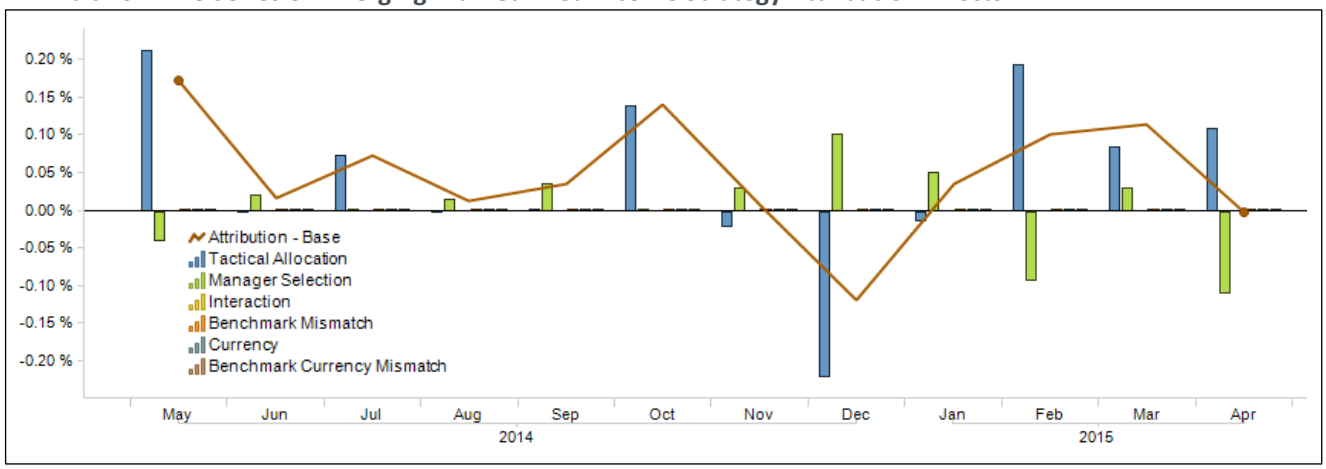


Exhibit 16: Time Series of Emerging Market Fixed Income Strategy Attribution Effects



Interestingly, the orange bars in Exhibit 14 show that a mismatch between policy and strategy benchmarks resulted in a benchmark mismatch effect of 1 basis point for the World Equity strategy and -10 basis points for the US Equity strategy. The benchmark mismatch for the US Equity strategy, stems from the SAA across the S&P 500 and Russell 2000 within the Equity asset class underperforming the SAA to MSCI USA by 10 basis points. Any return due to benchmark mismatch indicates that this is a source of risk which should not be ignored. The benchmark mismatch effect is relatively small over the full period, particularly for the World Equity strategy. However, when we review the time series of attribution effects for World Equity in Exhibit 17, a large range in the benchmark mismatch effect - more than 40 bps - is evident over the analysis period. This shows the importance of reviewing trends in attribution effects to reveal otherwise hidden drivers of return.

Benchmark mismatch will increase as the style of manager benchmarks deviates further from the SAA. It should be noted that benchmark mismatch does not occur for strategies where the benchmark is blended from lower level benchmarks.

Exhibit 17: Time Series of Attribution Effects for World Equity Strategy

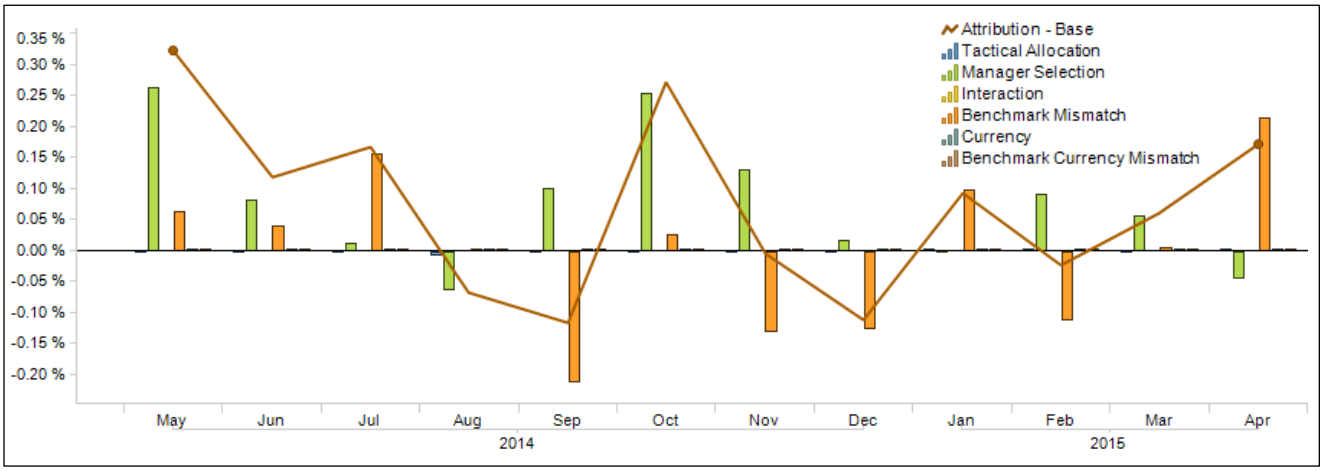
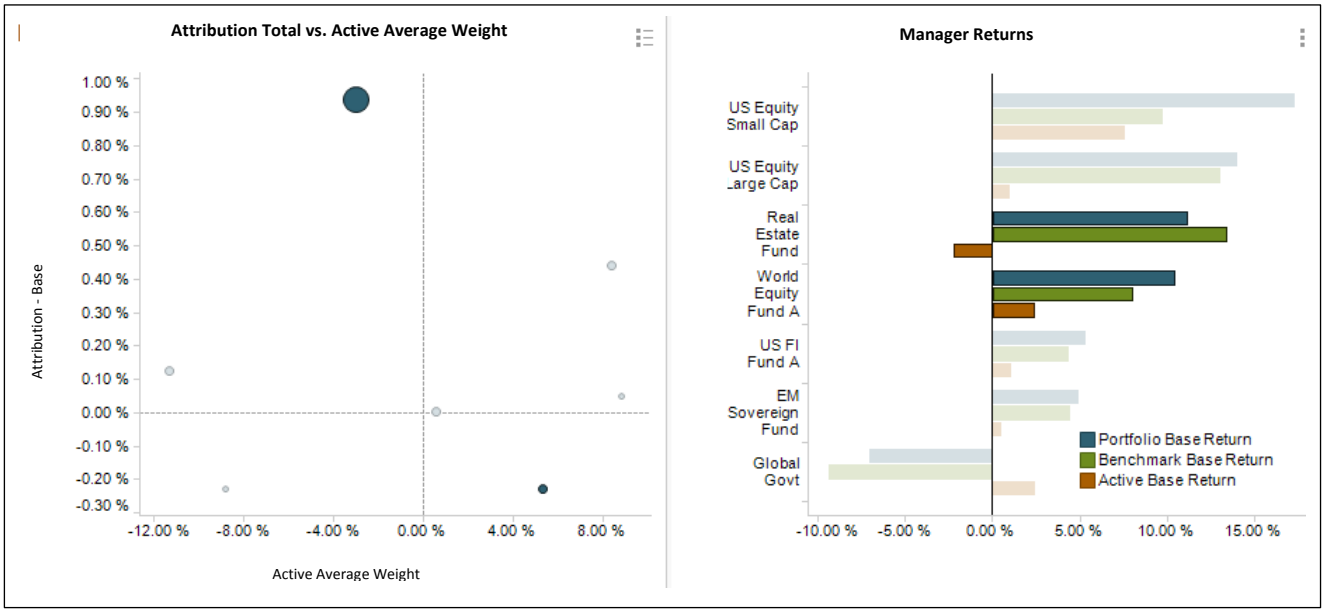


Exhibit 18: Manager Performance Attribution



Attribution Across Managers

The question of which managers outperformed their benchmarks is resolved by the manager performance attribution shown in Exhibit 18. The bar chart shows the portfolio return (in blue), benchmark return (in green) and active return (in orange) for each manager, information which can be used to assist in manager

review. The scatter plot shows the active exposure to each manager against the total attribution effect they provided. It is easy to identify the main contributor (World Equity Fund A) and detractor (the Real Estate Fund), and also, importantly, to detect outliers. The usefulness of this kind of analysis grows when the number of managers increases from seven as in this analysis to 20, 30 or 40.

Exhibit 19 drills down into the attribution effects related to each manager. This shows whether we added value by selecting managers which outperformed their benchmark. It is clear that the largest manager selection effect (shown in green) came from the World Equity Fund A manager's portfolio. For completeness this is shown in a monthly time series view in Exhibit 20.

Exhibit 19: Drilldown into Manager Attribution Effects

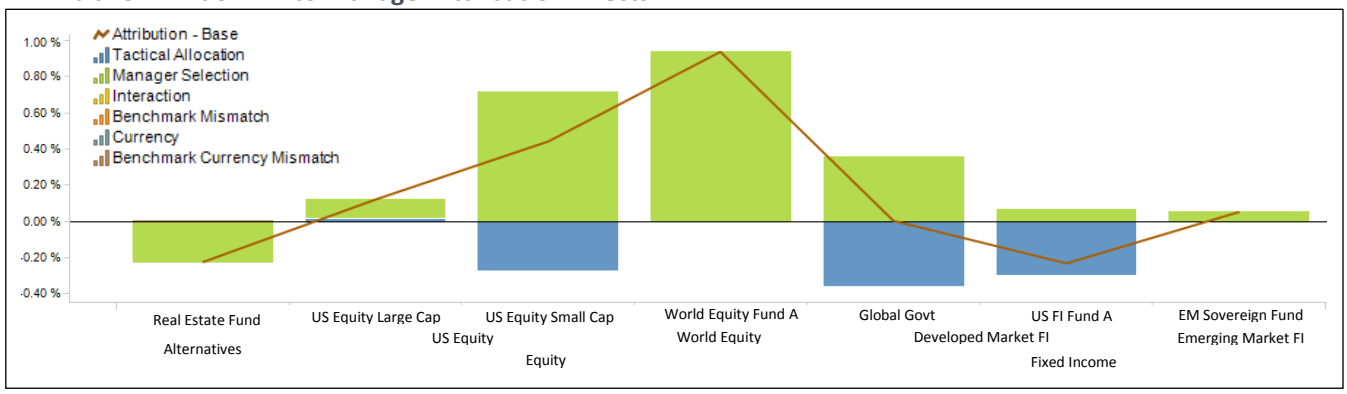
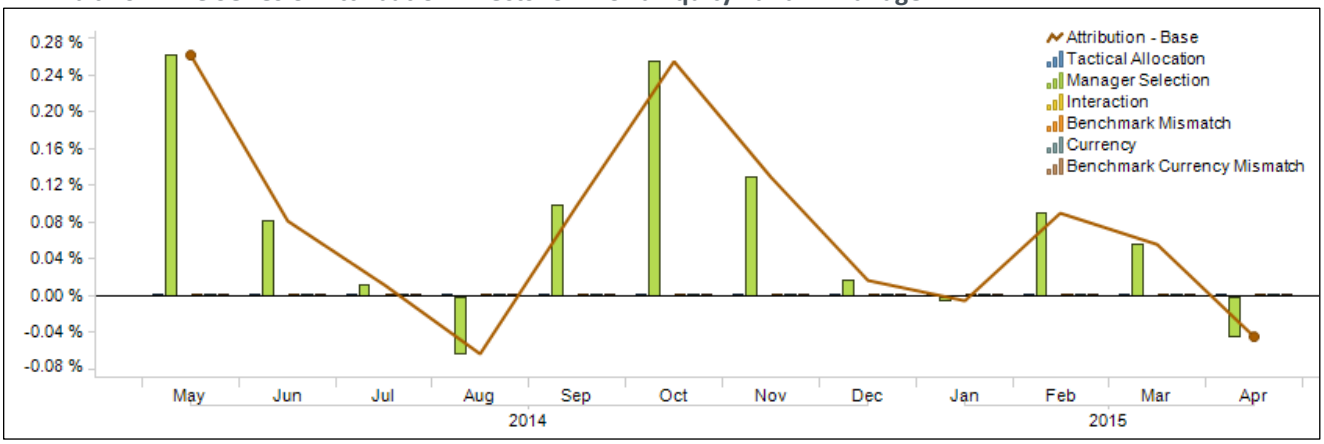


Exhibit 20: Time Series of Attribution Effects for World Equity Fund A Manager



Understanding Attribution effects

When determining attribution effects, each asset class, each strategy within an asset class, and each group of managers within a strategy, are treated as independent carve-outs within the investment portfolio. This is a necessary part of the process known as cascading attribution, as it ensures attribution effects are

calculated relative to the appropriate benchmark.[9] In this context, cascading allocation effects capture the return due to allocation decisions made at different levels within an investment hierarchy. Therefore, cascading benchmark-relative returns are calculated relative to the level above in the investment hierarchy, rather than to the overall benchmark, which is the case in the traditional Brinson-Fachler approach. The overall benchmark would not be an appropriate benchmark for individual strategies and managers.

To understand the attribution effects in the MPA model, it is necessary to refer to the level in the investment portfolio and the corresponding benchmark.

It should be noted that the interaction effect (see Page 6) is zero in the example as the option to include this item within the manager selection effect was chosen. Also, the currency effects are zero as all managers in the example invested in the base currency of the pension plan. Once again, although the MPA model is applicable to any globally invested pension plan, a single currency example was used for ease of explanation.

Top Level

The active base return for the investment portfolio, which is 1.45 per cent in our example, is attributed to the total tactical allocation, manager selection, interaction, benchmark mismatch, currency, and benchmark currency mismatch effects. The highlighting in Exhibit 21 illustrates how these attribution effects aggregate to, and thus explain, the active base return.[10]

Exhibit 21: Understanding Top-level Attribution Effects

Level	Asset Class	Investment Portfolio	Benchmark Description	Attribution Total	Tactical Allocation	Manager Selection	Interaction	Benchmark Mismatch	Currency Effect	Benchmark Currency Mismatch
0	Total Portfolio	Total Portfolio	Blended Benchmark	1.45%	-0.08%	1.53%	0.00%	0.00%	0.00%	0.00%

The highlighting in Exhibit 22 illustrates how attribution effects at the asset class level aggregate to, and thus explain, the top-level attribution effects.

- The total tactical allocation effect (at level 0) can be aggregated from of the tactical allocation effects across the asset classes at level 1.
- The total manager selection effect (at level 0) can be aggregated from the manager selection, interaction and benchmark mismatch effects across the asset classes at level 1.

[9] For a detailed explanation of cascading attribution see Performance Attribution of Multi-Asset Class Portfolios using BarraOne or the BarraOne Performance Analytics Handbook.

[10] Aggregation for arithmetic attribution is additive, while for geometric attribution aggregation is multiplicative according to the compound sum.

- The total currency effect (at level 0) can be aggregated from the currency and benchmark currency mismatch effects across the asset classes at level 1.

Exhibit 22: Aggregating Asset Class Attribution Effects

Level	Asset Class	Investment Portfolio	Benchmark Description	Attribution Total	Tactical Allocation	Manager Selection	Interaction	Benchmark Mismatch	Currency Effect	Benchmark Currency Mismatch
0	**Total Portfolio**	**Total Portfolio**	**Blended Benchmark**	**1.45%**	**-0.08%**	**1.53%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
1	Equity	Equity	Blended Benchmark	1.11%	-0.24%	1.35%	0.00%	0.00%	0.00%	0.00%
1	Fixed Income	Fixed Income	Blended Benchmark	0.27%	-0.14%	0.41%	0.00%	0.00%	0.00%	0.00%
1	Alternatives	Alternatives	Blended Benchmark	0.08%	0.30%	-0.23%	0.00%	0.00%	0.00%	0.00%

In our example, the total tactical allocation effect of -0.08 per cent for the pension plan can be aggregated from the tactical allocation for the equity, fixed income, and alternative asset classes. The total manager selection effect of 1.53 per cent can be aggregated from the manager selection, interaction and benchmark mismatch effects across the equity, fixed income and alternatives asset classes. The currency effect for the pension plan can be aggregated from the currency effects (currency and benchmark currency mismatch) across the equity, fixed income and alternatives asset classes.

Asset Class Level

The highlighting in Exhibit 23 illustrates how strategy attribution effects aggregate to, and thus explains, higher strategy-level attribution effects.

- The manager selection effect for a particular strategy can be aggregated from the tactical allocation, manager selection, interaction and benchmark mismatch effects from the strategies one level lower.
- The currency effect for a particular strategy can be aggregated from of the currency and benchmark currency mismatch effects from the strategies one level lower.

Exhibit 23: Aggregating Strategy Attribution Effects

Level	Asset Class	Investment Portfolio	Benchmark Description	Attribution Total	Tactical Allocation	Manager Selection	Interaction	Benchmark Mismatch	Currency Effect	Benchmark Currency Mismatch
0	**Total Portfolio**	**Total Portfolio**	**Blended Benchmark**	**1.45%**	**-0.08%**	**1.53%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
1	Equity	Equity	Blended Benchmark	1.11%	-0.24%	1.35%	0.00%	0.00%	0.00%	0.00%
2	Equity	World Equity	MSCI WORLD	0.93%	-0.02%	0.94%	0.00%	0.01%	0.00%	0.00%
2	Equity	US Equity	MSCI USA	0.42%	-0.04%	0.57%	0.00%	-0.10%	0.00%	0.00%
1	Fixed Income	Fixed Income	Blended Benchmark	0.27%	-0.14%	0.41%	0.00%	0.00%	0.00%	0.00%
2	Fixed Income	Developed Market FI	Blended Benchmark	-0.21%	0.01%	-0.22%	0.00%	0.00%	0.00%	0.00%
2	Fixed Income	Emerging Market FI	Blended Benchmark	0.62%	0.57%	0.05%	0.00%	0.00%	0.00%	0.00%
1	Alternatives	Alternatives	Blended Benchmark	0.08%	0.30%	-0.23%	0.00%	0.00%	0.00%	0.00%
3	Alternatives	Real Estate Fund	MSCI All World Real Estate	-0.23%	0.00%	-0.23%	0.00%		0.00%	

For example, in Exhibit 23, for the fixed Income asset class, the tactical allocation effect of -0.14 per cent is determined from the allocation weight in fixed income and the performance of the fixed income asset class's blended benchmark compared to the performance of the total benchmark. The manager selection effect of 0.41 per cent for fixed income depends on the active performance of the Developed Market FI and Emerging Marker FI strategies, and can be aggregated from the attribution effects (tactical allocation, manager selection, interaction and benchmark mismatch) across the Developed Market FI and Emerging Marker FI strategies. The currency effect for the fixed income asset class is the aggregation of the currency effects (currency and benchmark currency mismatch) across the Developed Market FI and Emerging Marker FI strategies.

Manager Level

The highlighting in Exhibit 24 illustrates how manager attribution effects aggregate to, and thus explains, the strategy-level attribution effects at the level above.

- The manager selection effect for a strategy immediately above the manager level can be aggregated from the tactical allocation, manager selection and interaction effects across the managers within the strategy.
- The currency effect for a particular strategy immediately above the manager level can be aggregated from the currency and benchmark currency mismatch effects across the managers within the strategy.

Exhibit 24: Aggregating Manager Attribution Effects

Level	Asset Class	Investment Portfolio	Benchmark Description	Attribution Total	Tactical Allocation	Manager Selection	Interaction	Benchmark Mismatch	Currency Effect	Benchmark Currency Mismatch
0	**Total Portfolio**	**Total Portfolio**	**Blended Benchmark**	**1.45%**	**-0.08%**	**1.53%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
1	Equity	Equity	Blended Benchmark	1.11%	-0.24%	1.35%	0.00%	0.00%	0.00%	0.00%
2	Equity	World Equity	MSCI WORLD	0.93%	-0.02%	0.94%	0.00%	0.01%	0.00%	0.00%
3	Equity	World Equity Fund A	MSCI ACWI	0.94%	0.00%	0.94%	0.00%		0.00%	
2	Equity	US Equity	MSCI USA	0.42%	-0.04%	0.57%	0.00%	-0.10%	0.00%	0.00%
3	Equity	US Equity Small Cap	Russell 2000	0.44%	-0.27%	0.71%	0.00%		0.00%	
3	Equity	US Equity Large Cap	S&P 500 Index	0.12%	0.02%	0.10%	0.00%		0.00%	
1	Fixed Income	Fixed Income	Blended Benchmark	0.27%	-0.14%	0.41%	0.00%	0.00%	0.00%	0.00%
2	Fixed Income	Developed Market FI	Blended Benchmark	-0.21%	0.01%	-0.22%	0.00%	0.00%	0.00%	0.00%
3	Fixed Income	US FI Fund A	Bar. Cap. US Agg.	-0.23%	-0.29%	0.07%	0.00%		0.00%	
3	Fixed Income	Global Govt	Citigroup WGBI Ex USA	0.00%	-0.35%	0.36%	0.00%		0.00%	
2	Fixed Income	Emerging Market FI	Blended Benchmark	0.62%	0.57%	0.05%	0.00%	0.00%	0.00%	0.00%
3	Fixed Income	EM Sovereign Fund	JPM EMBI Global	0.05%	0.00%	0.05%	0.00%		0.00%	
1	Alternatives	Alternatives	Blended Benchmark	0.08%	0.30%	-0.23%	0.00%	0.00%	0.00%	0.00%
3	Alternatives	Real Estate Fund	MSCI All World Real Estate	-0.23%	0.00%	-0.23%	0.00%		0.00%	

For example, in Exhibit 24, for the US Equity strategy the tactical allocation effect of -0.04 per cent is determined from the allocation weight in US Equity and the performance of MSCI USA compared to the performance of the equity asset class blended benchmark. Then, the manager selection effect of 0.57 per

cent for US Equity depends on the active performance of the US Equity Small Cap manager's portfolio and the US Equity Large Cap manager's portfolio, and can be aggregated from the attribution effects (tactical allocation, manager selection and interaction) for the US Equity Small Cap manager and the US Equity Large Cap manager. The currency effect for International Equity can be aggregated from the currency effects for the US Equity Small Cap manager and the US Equity Large Cap manager.

This section has shown how attribution effects over the reporting period aggregate to other attribution effects. However, all results are calculated directly each day and then linked together over time across the reporting period. The Appendix on attribution analytics provides an example of daily attribution calculations.

Contribution Analysis

A set of dashboards for return contribution analysis is also available, similar to those already described. These focus on the performance of either the investment portfolio (without the impact of any benchmarks) or the benchmarks in isolation. High-level, detailed and time series views are provided in this way for the return contributions from each asset class, strategy and manager.

Conclusion

MPA answers multiple questions in a single analysis

This paper introduced the Multi-Portfolio Attribution (MPA) model for Asset Owners and Asset Managers, available within BarraOne's Performance Analytics solution. The paper was centered on a case study which illustrated how the MPA model can capture a number of important questions in a single analysis, including:

- the performance of both the SAA and the investment portfolio;
- how much value was added by tactically deviating from the strategy;
- the impact of selecting managers investing in non-base currencies;
- the impact of any benchmark (or style) mismatch;
- whether managers outperformed their benchmarks;
- and how much value was added by selecting the right managers.

The case study used a straightforward pension plan example to illustrate these points, producing illuminating results from a relatively simple investment portfolio. However, the model is applicable to any globally invested pension plan, asset allocation portfolio or multi-manager portfolio. BarraOne has an extremely robust infrastructure which can support large and complex hierarchical investment portfolios, with the flexibility required for MPA analysis across any number of asset classes, strategies and managers,

including those invested in alternative asset classes, to match your investment portfolio. It is easy to apply a time series of policy, blended benchmark and portfolio weights to incorporate the history of SAA decisions, periodic rebalancing and proportional ownership, and where weight drift between restatement or rebalancing dates is captured. The model makes it is possible to capture the value added at each different asset allocation step, which is important as tactical and strategic asset allocation may take place in numerous stages before being approved and implemented.

Visualization of the Results

The results from the Visualization tool, part of BarraOne's Performance Analytics solution, showed how it is possible to gain deep insight into the drivers of performance at each step in the investment process while analyzing outliers and trends very efficiently. Most notably, it was shown how time series of exposures and attribution effects can be investigated at any level within the hierarchy of the investment portfolio. This is very useful for analyzing the impact on performance of changing investment decisions over time, either due to shifts in long term asset allocation strategies or short-term shifts to capture tactical opportunities. The series of graphical dashboards corresponding to the analysis are interactive, available on-demand and updated automatically each day.

Learn More About the Model

To find out more and see a demonstration of a Multi-Portfolio Attribution analysis using the Visualization tool within the BarraOne Performance Analytics Solution, a recorded webinar corresponding to this paper can be found here:

Multi-Portfolio Attribution Across all Asset Classes, Strategies, Managers and Fund-of-Funds using BarraOne Webinar

Multi-Portfolio Attribution Across all Asset Classes, Strategies, Managers and Fund-of-Funds using BarraOne Webinar Slides

Other Attribution Models

There are also other attribution models available in the BarraOne Performance Analytics solution, each dedicated to a specific investment style, which can be tailored according to the investment process. Separate models are available for:

- Classic Attribution, tying back return to top-down allocation and bottom-up selection decisions for equity or multi-asset class portfolios.
- Fixed Income Attribution, tying back return to term-structure and spread-bets as well as capturing income, paydown and rolldown.
- Factor Attribution, tying back return to Barra equity, equity implied volatility and commodity factors.

Finally, in the future we plan to extend our Factor Attribution model to support fixed income factors, forming a truly multi-asset class Factor Attribution model.

Appendix

Attribution Analytics

Definitions of the attribution effects captured by the MPA model are set out in the section on the MPA model, and some sample calculations are presented in this Appendix. The BarraOne Performance Analytics Handbook provides the equations for all attribution effects, including those presented here together with those for separate manager selection and interaction effects, as well as the geometric variations of all attribution effects.

MPA Attribution Effects

The arithmetic, raw (unadjusted) attribution effects for the MPA model at the top level, the strategy level, and at the manager level are defined as follows:

Top-Level Attribution Effects

At the top level in the investment structure, the following attribution effects are applicable: tactical allocation, manager selection including interaction, manager selection, interaction, and benchmark mismatch.

Tactical Allocation Effect

The arithmetic, raw tactical allocation effect $Q_t^{ari,raw,allocation}$ for the top node in the tree is the difference between the return of the tactical allocation portfolio and the local currency return of the composite benchmark, and is calculated as follows:

$$Q_t^{ari,raw,allocation} = R_t^{Not\ A} - R_t^{local,CB} \quad (1)$$

where the notional portfolio $R_t^{Not\ A}$, called the tactical allocation portfolio, comprises portfolio relative weights $\widetilde{w}_{i,t}^{P}$ and local benchmark strategy returns $R_{i,t}^{local,B}$,and is calculated as follows:

$$R_t^{Not\ A} = \sum_{i=0}^{n} (\widetilde{w}_{i,t}^{P} * R_{i,t}^{local,B}) \quad (2)$$

where i denotes the particular level in the tree, and the portfolio relative weight $\widetilde{w}_{i,t}^{P}$ is the weight of a particular strategy relative to the weight of the strategy at the next level up in the portfolio tree, and is calculated as follows:

$$\widetilde{w}_{i,t}^{P} = \frac{w_{i,t}^{P}}{w_{i-1,t}^{P}} \tag{3}$$

and the composite benchmark return $R_t^{local,CB}$, which comprises benchmark weights $w_{i,t}^{B}$ and local benchmark strategy returns $R_{i,t}^{local,B}$, and is calculated as follows:

$$R_t^{local,CB} = \sum_{i=0}^{n} (w_{i,t}^{B} * R_{i,t}^{local,B}) \tag{4}$$

Manager Selection Effect Including Interaction

The arithmetic, raw manager selection effect, which includes Interaction $Q_t^{ari,raw,selection+interaction}$ for the top node in the tree, is the difference between the investment portfolio's local return $R_t^{local,P}$ and the return of the tactical allocation portfolio $R_t^{Not\ A}$, and is calculated as follows:

$$Q_t^{ari,raw,selection+interaction} = R_t^{local,P} - R_t^{Not\ A} \tag{5}$$

Benchmark Mismatch Effect

The arithmetic, raw benchmark mismatch effect $Q_t^{ari,raw,benchmark\ mismatch}$ is the difference between the local currency composite benchmark return $R_t^{local,CB}$ and the local currency return of the overall benchmark $R_t^{local,B}$, and is calculated as follows:

$$Q_t^{ari,raw,benchmark\ mismatch} = R_t^{local,CB} - R_t^{local,B} \tag{6}$$

Strategy Level Attribution Effects

For each strategy in the investment structure (intermediate nodes in the tree), the following attribution effects are applicable: tactical allocation, manager selection including interaction, manager selection, interaction, and benchmark mismatch.

Tactical Allocation Effect

The arithmetic, raw tactical allocation effect $Q_{i,t}^{ari,raw,allocation}$ for strategy i is the cascading benchmark-relative return scaled by the relative (carve-out) allocation weight in strategy i, and is calculated as follows:

$$Q_{i,t}^{ari,raw,allocation} = w_{i-1,t}^{P} * \left(\widetilde{w}_{i,t}^{P} - \widetilde{w}_{i,t}^{B}\right)\left(R_{i,t}^{local,B} - R_{i-1,t}^{local,B}\right) \quad (7)$$

where the cascading benchmark-relative return is the difference between the benchmark local return $R_{i,t}^{local,B}$ for strategy i and the benchmark local return $R_{i-1,t}^{local,B}$ for strategy $i-1$, i.e., at the level above.

Manager Selection Effect Including Interaction

The arithmetic, raw Manager Selection effect, which includes Interaction $Q_{i,t}^{ari,raw,selection+interaction}$ for strategy i, is the difference between the portfolio local return $R_{i,t}^{local,P}$ for strategy i and the composite benchmark local return $R_{i,t}^{local,CB}$ for strategy i, scaled by the relative (carve-out) selection (including interaction) weight in strategy i, and is calculated as follows:

$$Q_{i,t}^{ari,raw,selection+interaction} = w_{i-1,t}^{P} * \widetilde{w}_{i,t}^{P}\left(R_{i,t}^{local,P} - R_{i,t}^{local,CB}\right) \quad (8)$$

where the local currency composite benchmark return $R_{i,t}^{local,CB}$ of strategy i is the return contribution for the local currency composite benchmark returns $R_{i+1,t}^{local,CB}$ from the level below, i.e., at level $i+1$, adjusted by the weight of the benchmark in strategy i, which is calculated as follows:

$$R_{i,t}^{local,CB} = \frac{\sum\left(w_{i+1,t}^{B} * R_{i+1}^{local,CB}\right)}{w_{i,t}^{B}} \quad (9)$$

Benchmark Mismatch Effect

The arithmetic, raw benchmark mismatch effect, which includes Interaction $Q_{i,t}^{ari,raw,benchmark\ mismatch}$ for strategy i, is the difference between the local currency composite benchmark return $R_{i,t}^{local,CB}$ for strategy i and the local currency benchmark return $R_{i,t}^{local,B}$ for strategy i, scaled by the relative (carve-out) mismatch weight in strategy i, and is calculated as follows:

$$Q_{i,t}^{ari,raw,benchmark\ mismatch} = w_{i-1,t}^{P} * \widetilde{w}_{i,t}^{P}\left(R_{i,t}^{local,CB} - R_{i,t}^{local,B}\right) \quad (10)$$

Manager Level Attribution Effects

For each manager in the investment structure (the leaf nodes in the tree), the following attribution effects are applicable: tactical allocation, manager selection including interaction, manager selection, and interaction. Benchmark mismatch is not applicable.

Tactical Allocation Effect

The arithmetic, raw tactical allocation effect $Q_{j,t}^{ari,raw,allocation}$ for manager j is the cascading benchmark-relative return, which is the difference between the local currency benchmark return $R_{j,t}^{local,B}$ for manager j and the local currency benchmark return $R_{i-1,t}^{local,B}$ for strategy $i-1$, i.e., at the level above, scaled by the relative (carve-out) allocation weight for manager j, and is calculated as follows:

$$Q_{j,t}^{ari,raw,allocation} = w_{i-1,t}^{P} * \left(\widetilde{w}_{j,t}^{P} - \widetilde{w}_{j,t}^{B}\right)\left(R_{j,t}^{local,B} - R_{i-1,t}^{local,B}\right) \quad (11)$$

Manager Selection Effect including Interaction

The arithmetic, raw manager selection effect, which includes Interaction $Q_{j,t}^{ari,raw,selection+interaction}$ for manager j, is the difference between the local currency portfolio return $R_{j,t}^{local,P}$ for manager j and the local currency benchmark return $R_{j,t}^{local,B}$ for manager j, scaled by the relative (carve-out) selection (including interaction) weight for manager j, and is calculated as follows:

$$Q_{j,t}^{ari,raw,selection+interaction} = w_{i-1,t}^{P} * \widetilde{w}_{j,t}^{P}\left(R_{j,t}^{local,P} - R_{j,t}^{local,B}\right) \quad (12)$$

The geometric versions of the attribution effects use the same formulation for weights as the arithmetic attribution effects, capturing the same investment decisions but applying geometric differences between returns, rather than arithmetic differences.

Currency Attribution Effects

The currency attribution approach for the MPA model follows the Classic attribution model, using the simple currency approach but modified to include the benchmark currency mismatch effect.

The arithmetic, raw (unadjusted) currency attribution effects for the MPA model at the top level, the strategy level, and at the manager level are as follows:

Top-Level Currency Attribution Effects

At the top level, the currency and benchmark currency mismatch attribution effects are applicable.

Currency Effect

The arithmetic, raw (unadjusted) currency attribution effect $Q_t^{ari,raw,currency}$ for the MPA model is the difference between the currency return for the portfolio tree $R_t^{currency,P}$ and the currency return for the composite benchmark $R_t^{currency,CB}$, and is calculated as follows:

$$Q_t^{ari,raw,currency} = R_t^{currency,P} - R_t^{currency,CB} \quad (13)$$

where the currency return for the composite benchmark $R_t^{currency,CB}$ comprises benchmark weights $w_{i,t}^B$ and the currency return $R_{i,t}^{currency,B}$ for a benchmark strategy i and is calculated as follows:

$$R_t^{local,CB} = \sum_{i=0}^{n} (w_{i,t}^B * R_{i,t}^{currency,B}) \quad (14)$$

Benchmark Currency Mismatch Effect

The arithmetic, raw (unadjusted) benchmark currency mismatch attribution effect $Q_t^{ari,raw,benchmark\ currency\ mismatch}$ for the MPA model is the difference between the composite benchmark currency return $R_t^{currency,CB}$ and the benchmark currency return $R_t^{currency,B}$, and is calculated as follows:

$$Q_t^{ari,raw,benchmark\ currency\ mismatch} = R_t^{currency,CB} - R_t^{currency,B} \quad (15)$$

Strategy Level Currency Attribution Effect

For each strategy in the investment structure (intermediate nodes in the tree), the currency and benchmark currency mismatch attribution effects are applicable.

Currency Effect

The arithmetic, raw (unadjusted) currency attribution effect $Q_{i,t}^{ari,raw,currency}$ for strategy i is the difference between the currency return contribution from the portfolio tree in strategy i and the composite benchmark currency return contribution for strategy i, and is calculated as follows:

$$Q_{i,t}^{ari,raw,currency} = \left(w_{i,t}^P * R_{i,t}^{currency,P} - w_{i,t}^B * R_{i,t}^{currency,CB}\right) \quad (16)$$

where the composite benchmark currency return $R_{i,t}^{currency,CB}$ of strategy i is the return contribution of the composite benchmark currency returns $R_{i+1,t}^{currency,CB}$ from one level below, i.e., level $i+1$, adjusted by the weight of the benchmark in strategy i , and is calculated as follows:

$$R_{i,t}^{currency,CB} = \frac{\sum\left(w_{i+1,t}^{B} * R_{i+1}^{currency,CB}\right)}{w_{i,t}^{B}} \quad (17)$$

Benchmark Currency Mismatch Effect

The arithmetic, raw (unadjusted) benchmark currency mismatch effect for strategy i is the difference between the composite benchmark currency return for strategy i and the benchmark currency return for strategy i, scaled by the benchmark weight in strategy i , and is calculated as follows:

$$Q_{i,t}^{ari,raw,benchmark\ currency\ mismatch} = w_{i,t}^{B} * \left(R_{i,t}^{currency,CB} - R_{i,t}^{currency,B}\right) \quad (18)$$

Manager Level Currency Attribution Effect

For each manager in the investment structure (leaf nodes in the tree), the currency attribution effect is applicable.

Currency effect:

The arithmetic, raw (unadjusted) currency attribution effect $Q_{j,t}^{ari,raw,currency}$ for manager j is the difference between the currency return contribution from the portfolio tree for manager j and the composite benchmark currency return contribution for manager j, and is calculated as follows:

$$Q_{j,t}^{ari,raw,currency} = \left(w_{j,t}^{P} * R_{j,t}^{currency,P} - w_{i,t}^{B} * R_{j,t}^{currency,B}\right) \quad (19)$$

Adjusting Attribution Effects

Multi-period raw arithmetic attribution effects must be adjusted so they link over multiple periods and tie back to the multi-period active return without producing an unexplained residual. Carino logarithmic linking coefficients are used to adjust raw arithmetic attribution effects, such that the aggregations described on Pages 24 to 26 hold for the arithmetic version of the MPA model.

Single-period raw geometric attribution effects must be adjusted so that they aggregate within a single period and tie back to the single-period active return without producing an unexplained residual. A geometric single-period adjustment formula is used to adjust raw geometric attribution effects, such that the aggregations discussed on Pages 24 to 26 hold for the geometric version of the MPA model.

Base Currency Analysis

For the base currency version of the MPA model, local currency returns are replaced by base currency returns in all formulas in the Appendix, and the currency attribution effects are not applicable.

References

BarraOne Performance Analytics Handbook; https://support.msci.com/docs/DOC-4040

BarraOne Performance Analytics Visualization Handbook; https://support.msci.com/docs/DOC-8651

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Performance Attribution of Multi-Asset Class Portfolios using BarraOne; https://support.msci.com/docs/DOC-11062

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