

An Exposure Based Attribution Model for Balanced Portfolios.

A lot of attribution models are based on one asset class, pure equity or bond attribution models are very popular in the financial community. An increasing number of portfolios are managed globally, with the inclusion of different asset classes: equities, bonds and cash. This trend should continue as the post war baby boom population is reaching the life-stage that is at the heart of the traditional balanced portfolio allocations across asset classes. This paper gives the fund manager an attribution model based on a Top-Down investment process and different asset classes. The attribution is based on differences in weight exposures and returns, relative to a balanced benchmark; equities bonds and cash.

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Introduction

Numerous investment decision processes are based on a pre-specified, sequential order defined by the asset management firm. In the following example we will examine the top-down investment decision-making process, which comprises of the following three steps:

- 1 Strategic asset allocations are the first investment decisions.
Examples include Regional allocations or Asset Class allocations between Equities, Bonds and Cash. No Selection of individual securities occurs at this decision making level and the investment committee will only decide on the top level allocation classes.
- 2 A second set of asset allocation decisions are made following the strategic allocations.
Examples include Country and/or Sector allocations for Equities, or allocations based on exposures to duration bands. No Selection of individual securities occurs at this decision making level.
- 3 The final investment decisions are the security selections.
These investment decisions occur only after all group level asset allocations have been made. Examples include which securities to own and whether to over- or under- weight them relative to the Benchmark.

The number of investment decisions depends on the type of fund and the investment process. Also the grouping structure needs to match the investment decision process that the Asset Manager is following.

An Exposure Based Attribution Model in a Top-Down Investment Process.

1) Strategic Asset Allocation.

In a balanced fund the Asset Manager will take the asset allocation decisions first of all. One of the issues that needs to be answered at this point is what will his asset allocation split be between equities, bonds and cash compared to his balanced benchmark.

At this decision level the asset manager will not take any security level decision or even decide in what Equity sector or duration band he will invest in.

This strategic asset allocation decision must be translated into an attribution model. We will examine both the over and under weight in each of the asset allocation classes and then compare what effect these decisions have had in relation to the benchmark return.

In a one period attribution model the strategic asset allocation is equal to the following:

$(Portfolio\ weight\ in\ asset\ class\ i - Benchmark\ weight\ in\ asset\ class\ i) * (benchmark\ return\ in\ asset\ class\ i - total\ benchmark\ return)$	(1)
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This formula is equal to the Market Selection from Brinson Fachler's attribution model.

A Manager deciding to overweigh the bonds within his portfolio, coupled with an excess return from the bond benchmark return over the total benchmark return, will show a positive strategic asset allocation effect.

2) Tactical Asset Allocation

The next level of the decision making process is taken by the Equity and the Bond Manager, who will be looking to answer the following questions:

- What is the investment process in each respective asset group?
- Is it based on a pure security selection; a bottom up selection process or on a top down investment process where the portfolio manager takes first sector, country or curve positioning exposures?

Equity portfolios have either a bottom up or a top down approach depending on the investment process. In most cases Bond Portfolio Managers will have a more structured approach where they will decide where on the yield curve they will invest.

a) The Bottom-Up Approach.

The next step in the investment process is taken by over or under weighting individual securities in their respective asset group. The Portfolio Manager will decide which securities he will own and also whether to over or under weight those securities relative to the benchmark.

The Equity Portfolio Manager cannot be held accountable for a decision made at the strategic asset allocation level. We have to take into account how much weight the Equity Portfolio Manager has been allocated. The more weight he is responsible for the more he will influence the total portfolio return. Therefore we have to compare the relative weights within each asset class group.

In this case the Equity Portfolio Manager will then take security exposures compared to the benchmark weight. Therefore the appropriate question now becomes: “What should the manager have invested to be benchmark neutral, knowing that he has been allocated a different weight in his group?” This is known as the “normalised benchmark weight”.

The *normalised benchmark weight* is equal to the benchmark security level weight divided by the respective benchmark asset class weight and multiplied by the respective portfolio asset class weight.

Portfolio		Benchmark	
	Weight	Weight	Normalised Weight
Equities	80.00%	40.00%	40.00%
ICI	20.00%	10.00%	20.00%
HSBC	5.00%	5.00%	10.00%
Bayer	5.00%	5.00%	10.00%
Vodafone	20.00%	5.00%	10.00%
Alcatel	20.00%	10.00%	20.00%
Fiat	10.00%	5.00%	10.00%
Bonds	15.00%	50.00%	50.00%
Cash	5.00%	10.00%	10.00%
Total	100.00%	100.00%	100.00%

Table 1: Normalised benchmark weights.

Example: Vodafone normalised weight is equal to benchmark Vodafone weight / benchmark equity weight * portfolio equity weight.

In other words, “what should my portfolio Vodafone weight have been if I was benchmark neutral in the respective asset class?”

The return at security level needs then be compared to the return of the respective asset class group, thereby answering the question regarding how much return has been added to the respective group.

The return at stock level can be different between the portfolio and benchmark, we will add this difference in returns multiplied by the portfolio security weight at security selection effect.

In a bottom up approach we only have security selection. In a one period attribution model the security selection effect will be equal to:

$$(Security\ level\ weight - normalised\ benchmark\ weight) * (Benchmark\ security\ level\ return - respective\ Asset\ class\ return) + (Security\ level\ weight * (Portfolio\ security\ return - Benchmark\ security\ return)) \quad (2a)$$

Security level weight: security absolute weight in the portfolio.

Respective Asset class return: Benchmark return from one group level above.

This will give the added value per security relative to the benchmark within each asset class.

b) The Top Down Approach.

If the investment process is based on a top down investment process we will need to group at a subsequent level. (for example: First Equities followed by Sectors and Bonds followed by Duration Bands). The grouping level will depend on the investment process chosen which can be regional, country, sector, duration bands...to list a few.

Once the Portfolio Manager has made the second set of investment decisions, we can then analyse how his decisions have added value to the benchmark return.

But we must keep in mind that the above Portfolio Manager cannot be held accountable for decisions made at the strategic asset allocation level. We also have to take into account how much weight has been allocated to this particular Portfolio Manager, thereby leading us to also compare the relative weights within each asset class group. In this case the Portfolio Manager is exposed relative to the benchmark, and this exposure is the difference between group level portfolio weight and the normalised group level benchmark weight.

We also need to look at the return at group level which needs to be compared to the return of the respective asset class group and will therefore now look to compare the group level return with the return from the group above.

In a top down approach we have to consider tactical allocation effects. In a one period attribution model the tactical allocation effect will be equal to the following:

$$(Group\ level\ weight - normalised\ benchmark\ weight) * (Benchmark\ Group\ level\ return - respective\ Asset\ class\ return) \quad (2b)$$

Group level weight: Portfolio level weight in absolute terms.

The tactical allocation effect formula (2b) will be used at each subsequent grouping level. It is possible to have more than 2 grouping levels. An example of multiple grouping levels: Asset Classes, equities, bonds and cash, whereby the equities are then

subsequently subdivided into sectors and industries and the bonds are also subdivided into duration bands and type of bonds.

3) Security Selection Effect.

Once all the allocation decisions have been made, the Portfolio Manager will then decide which securities he will invest in, also taking into consideration the question of whether he will need to over or under weight the securities relative to the benchmark.

This brings us to the last level of the decision which will be the security selection. The principle of security selection is the same as the bottom-up approach as previously explained in the section titled the “*bottom up approach*” from tactical asset allocation (formula 2a).

The Interaction effect is included in the security selection effect. The Portfolio Manager is selecting securities based on the *portfolio weight* of the last level of asset allocations and not based on the *benchmark weight* of the last level of asset allocations. For this reason the interaction effect is included in the security selection effect.

An Example of an Exposure Based Model.

In the following example, we will examine an equity fund that invests in 3 different asset classes: Equities, Bonds and Cash. The Benchmark will hold the same asset classes.

See table 2 below.

The attribution model is based on a one period calculation with currency effects included into the allocations and selection effects.

The investment decision levels are defined in a top down investment process:

- **At the Portfolio Level**
Strategic asset allocation at asset class level
- **For Equities**
Equity sector allocation
Equity stock selection in its respective sector
- **For fixed income securities**
Curve positioning for the fixed income part
Exposure to corporate bonds versus governmental bonds
Selection of the individual fixed income securities
- **For Cash**
Market-timing effect.
Selection of money market instruments

Other investment processes can easily be implemented by using the exposure based method, for example, the classification into different regions (US, Europe, Asia) within the different asset classes. Or by analysing fixed income or equity only portfolios, as long as the investment process is top down. The investment process and decisions will therefore be reflected in the grouping structure.

	Portfolio		Benchmark			Exposure based attribution model				
	Weight	Total Return	Weight	Normalised Weight	Total Return	Strategic Asset Allocation	Sector Asset Allocation	Yield Curve Positioning	Bond Type Allocation	Security Selection
Equities	80.00%	13.69%	40.00%	40.00%	11.13%	2.78%				1.60%
Financials	20.00%	11.75%	10.00%	20.00%	9.00%		0.00%			0.55%
HSBC	5.00%	5.00%	5.00%	10.00%	5.00%					0.20%
AXA	10.00%	15.00%	3.00%	6.00%	15.00%					0.24%
Deutsche	5.00%	12.00%	2.00%	4.00%	10.00%					0.11%
Health Care	5.00%	10.00%	5.00%	10.00%	6.00%		0.26%			0.20%
Industrials	5.00%	8.00%	5.00%	10.00%	9.00%		0.11%			-0.05%
Utilities	20.00%	16.00%	5.00%	10.00%	12.00%		0.09%			0.80%
Telecommunications	20.00%	20.00%	10.00%	20.00%	18.00%		0.00%			0.40%
Energy	10.00%	5.00%	5.00%	10.00%	8.00%		0.00%			-0.30%
Bonds	15.00%	4.50%	50.00%	50.00%	-0.77%	1.73%				0.33%
Duration Band 0 - 1	10.00%	6.00%	10.00%	3.00%	2.50%			0.23%		
Government bonds	0.00%	2.00%	5.00%	5.00%	2.00%				0.03%	0.00%
Corporate bonds	10.00%	6.00%	5.00%	5.00%	3.00%				0.03%	0.30%
Duration Band 1 - 3	5.00%	1.50%	10.00%	3.00%	1.00%			0.04%		
Government bonds	5.00%	1.50%	5.00%	2.50%	1.00%				0.00%	0.03%
Corporate bonds	0.00%	1.00%	5.00%	2.50%	1.00%				0.00%	0.00%
Duration Band 3 - 5	0.00%	0.00%	10.00%	3.00%	0.40%			-0.04%		
Government bonds	0.00%	0.50%	5.00%	0.00%	0.50%				0.00%	0.00%
Corporate bonds	0.00%	0.30%	5.00%	0.00%	0.30%				0.00%	0.00%
Duration Band 5 - 7	0.00%	0.00%	10.00%	3.00%	-3.25%			0.07%		
Government bonds	0.00%	-3.50%	5.00%	0.00%	-3.50%				0.00%	0.00%
Corporate bonds	0.00%	-3.00%	5.00%	0.00%	-3.00%				0.00%	0.00%
Duration Band over 7	0.00%	0.00%	10.00%	3.00%	-4.50%			0.11%		
Government bonds	0.00%	-4.00%	5.00%	0.00%	-4.00%				0.00%	0.00%
Corporate bonds	0.00%	-5.00%	5.00%	0.00%	-5.00%				0.00%	0.00%
Cash	5.00%	1.50%	10.00%	10.00%	1.00%	0.16%				0.03%
Total	100.00%	11.70%	100.00%	100.00%	4.17%	4.67%	0.45%	0.42%	0.05%	1.95%
Total attribution effect =>										7.54%

Table 2: An exposure based attribution model with a Top-Down investment process for balanced portfolios.
Due to rounding the sum of the effects can show a 1bp difference to their totals.

1) Strategic Asset Allocation.

After having chosen the right benchmark 40% equities, 50% bonds and 10% cash the Asset Class Manager decides to do the following: overweight equities up to 80%, underweight bonds up to 15% and cash up to 5%. No other decisions are made at this point.

Due to equities having outperformed the global benchmark it was therefore a good decision to overweight equities.

This has added the following value to the global benchmark return:

$$(80\% - 40\%) * (11.13\% - 4.17\%) = 2.78\%$$

The under-weighting bonds also contributed 1.73% to the overall benchmark return:

$$(15\% - 50\%) * (-0.77\% - 4.17\%) = 1.73\%$$

As well as the under-weight cash also adding 0.16% to the overall benchmark return.

$$(5\% - 10\%) * (1\% - 4.17\%) = 0.16\%$$

Therefore the strategic asset allocation decisions have added a total increase of 4.67% to the fund:

$$2.78\% + 1.73\% + 0.16\% = 4.67\%.$$

2) Equity Sector Asset Allocation.

By having taken the decision to overweigh equities, the Equity Manager now has a larger responsibility in the overall portfolio return, leading to 80% of the assets under management falling under his scope of responsibility.

In the following example you can see how the Equity Manager has allocated the assets in the different sectors, at this level he decides only at sector allocations.

The Financial Sector is over-weighted in absolute terms by 20% versus 10% in the benchmark. Though when looking at it in terms of normalised weights the Equity Manager is equally weighted. In actual fact he should have invested 20% in the Financial Sector to be benchmark neutral in the Financial Sector. This therefore means that the sector asset allocation is equal to 0.00%

The Utilities Sector has a positive sector allocation because the equity Manager over-weighted the sector (using the normalised weights) that thereby over performing in comparison to the equity benchmark:

$$(20\% - 10\%) * (12\% - 11.13\%) = 0.09\%.$$

Note: Here we are comparing the benchmark sector performance against the equity benchmark performance and *not* the total benchmark performance.

By summing up all the sector allocations at equity level we get the total sector asset allocation contributed by the Equity Manager (0.45%) to the total benchmark return

3) Security Selection at Equity Level.

The Selection Effect can be looked at in two ways, either at the equity sector level (this is the last level of allocation decision), or alternatively by drilling down to stock level and adding up all stock level effects at stock level in the respective sector. Both ways will give us the same effect.

a. At the sector level.

Comparing the portfolio and benchmark returns for the Financial Sector.

The portfolio financial sector outperformed the benchmark by:

$$(11.75\% - 9\%) = 2.75\%.$$

By multiplying this with the portfolio weight (20%) we get the total security selection effect for the Financial Sector or 0.55%.

The total security selection for the equity part (1.60%) is equal to the sum of all security selection effects at sector level.

b. At stock level.

Here we are comparing how many benchmark points each stock has attributed to the total security selection.

Combining an over-weighted stock in Deutsche (using normalised weights) with Deutsche underperforming the Financial Sector + the difference in Deutsche return between portfolio and benchmark times the portfolio weight from Deutsche, gives the security selection:

$$(5\% - 4\%)*(10\% - 9\%) + 5\%*(12\% - 10\%) = 0.11\%.$$

Therefore, the result of adding all security selection in the Financial Sector will give the sum of the total security selection effect for the Financial Sector or 0.55% as calculated here above “at the last level of grouping”.

Therefore the summing of all individual security selection effects from the equity portfolio will give us the total equity selection effect.

4) Yield Curve Positioning.

In this scenario a Bond Manager has been allocated 15% of total portfolio market value. If he had wanted to be benchmark neutral at bond level he should have invested 3% in each duration band.

The Bond Portfolio Manager decides to under-weight the long side of the yield curve and over-weight the short side of the yield curve, which will therefore lead to a lower duration for the bond portfolio.

The duration band 0-1 added 0.23% over the total benchmark return. This is due to the Bond Portfolio Manager having over-weighted the segment by 7% (using normalised weights) and also due to the fact that the benchmark segment outperformed the benchmark bond portfolio by $(2.50\% - (-0.77\%)) = 3.27\%$.

In duration band 0-1 the allocation effect for this segment of the yield curve is equal to $(10.00\% - 3.00\%) * (2.50\% - (-0.77\%)) = 0.23\%$. The same calculation method will be used for each duration band.

By totalling all the duration bands' allocation effects the Bond Portfolio Manager added 0.42% to the total benchmark return. This is called "The Yield Curve Positioning Effect".

5) Selection the Type of Bond: Corporate versus Government Bonds.

In short duration band segment (0 -1), the Bond Portfolio Manager invested 10.00% in corporate bonds rather than investing 5.00% in corporate bonds and another 5.00% in government bonds.

This seems to be a good choice as the corporate bonds have performed better than the government bonds for that particular segment: 3% for corporate bonds versus 2% for government bonds.

The decision to invest completely in corporate bonds has added 0.03% to the overall benchmark return: $(10\% - 5\%) * (3\% - 2.5\%) = 0.03\%$

The addition of all the types of bond allocation effects within all the duration bands, leads to a 0.05% attribution effect for the Bond portfolio.

6) Security selection at Bond Level.

In the duration band 0-1, the Bond Manager has invested in corporate bonds only, having chosen different corporate bonds in comparison to the benchmark and this has given him a portfolio return for that segment of 6% compared to the 3% from the benchmark for the same segment.

This relative over-performance of 3%, added to the $10\% * 3\%$ gives us a 0.30% return over the benchmark.

If we sum up all the security level selection effects at bond level we have the total security selection effect at bond level equal to 0.33%.

7) Summary of Attribution Effects.

By regrouping the attribution effects at different levels we can explain the attribution effects from different investment decisions.

Total portfolio return	11.70%
Total benchmark return	4.17%
Total attribution effect	7.54%

Table 2: Total attribution effect.

Due to rounding the sum of the effects can show a 1bp difference to their totals.

Strategic asset allocation	4.67%
Equity attribution	
Equity sector allocation	0.45%
Equity selection	1.60%
Bond attribution	
Yield curve positioning	0.42%
Bond type allocation	0.05%
Bond selection	0.33%
Cash attribution	
Cash selection	0.03%
Total Attribution effect	7.54%

Table 3: attribution effects by investment decision.

Due to rounding the sum of the effects can show a 1bp difference to their totals.

8) Linking attribution effects over multiple time periods.

In this article we will not give a preference to one or another linking method. We leave it to the manager to use one or another compounding method. However in an exposure based attribution model as discussed in this article we need to link the attribution effects over different time periods with a compounding method with no residuals or smoothing method. Because in a multi-period attribution report we need to be able to sum up all the individual security selection effects up to the security selection effect from the level above.

We can use the following compounding method to link attribution effects over time that has the characteristics described here above

Attribution effects for two periods in an additive arithmetic attribution model can be defined as:

Portfolio return period 1 and 2 – Benchmark return period 1 and 2

$$[(1+Pr1)*(1+Pr2)-1] - [(1+Br1)*(1+Br2)-1] =$$

$$[1+Pr2+Pr1+Pr1*Pr2-1] - [1+Br2+Br1+Br1*Br2-1] =$$

$$[Pr1-Br1] + [Pr2-Br2] + Pr1*Pr2 - Br1*Br2 =$$

$$Pr1-Br1 = A1: \text{Total attribution effect period 1}$$

$$Pr2-Br2 = A2: \text{Total attribution effect period 2}$$

$$A1 + A2 + Pr1*Pr2 - Br1*Br2 =$$

$$\text{Add: } -Br1Pr2 + Pr2*Br1$$

$$A1 + A2 + Pr1*Pr2 - Br1Pr2 + Pr2*Br1 - Br1*Br2 =$$

$$A1 + A2 + (Pr1-Br1)*Pr2 + (Pr2-Br2)*Br1 =$$

$$A1 + A2 + A1*Pr2 + A2*Br1 =$$

$$\boxed{A1*(1+Pr2) + A2 (1+Br1)}$$

Pr1 = Total Portfolio return period 1

Pr2 = Total Portfolio return period 2

Br1 = Total Benchmark return period 1

Br2 = Total Benchmark return period 2

The attribution effect period 1 is compounded against 1+Portfolio return period 2 plus attribution effect period 2 compounded against benchmark return period 1.

In an arithmetic attribution model each attribution effect in period 1 gets reinvested in portfolio return period 2. Each attribution effect in period 2 will depend on how big the first period benchmark return was, it will have a multiplication effect coming from this benchmark period 1 return.

How to compound more than 2 periods?

The compounded effects of period 1 and 2 can be compounded with effects of period 3 etc.

Every single attribution effect can be compounded with this formula and used in the attribution model. No adjustments or smoothing needs to be done because the sum of all compounded effects equals the difference between portfolio return – benchmark return.

Conclusion.

The exposure based “top down attribution” gives the Balanced Fund Manager very good answers on where he added value over his benchmark. Fund Managers need to specify what top-down investment decisions levels are in place. The attribution model needs to follow this investment process by specifying the grouping structure in the attribution model.

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