Interpreting performance attribution reports

Advances in information technology for fund managers are both a blessing and a curse. It is now becoming increasingly common for managers to use attribution reports as part of their management reporting to clients and asset consultants. However, as DAMIEN LAKER points out, this is also creating a need for securities industry practitioners to build their skills in interpreting attribution reports.

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This article presents three different attribution reports, based on a hypothetical Australian share portfolio that bought and held nine different stocks over the year 1999. Each attribution report provides a different perspective on the fund's performance. Based on these different perspectives, we suggest some points that can help practitioners to interpret attribution reports.

Performance attribution explains the active "bets" that made the portfolio over-perform (or under-perform) its benchmark. For example, what other stocks could the portfolio have held in order to obtain a better return? Was the portfolio tilted too far toward small-cap stocks? Or was it tilted too far toward value stocks rather than growth stocks?

It is possible to answer all of these questions using different performance attribution analyses on a fund.

The best known attribution method is commonly called the Brinson method. It divides the active performance of a fund into three components:

1. Sector allocation: this consists of over-weighting sectors that outperform the overall benchmark (or under-weighting sectors that under-perform).

2. Stock selection: this consists of picking the best-performing stocks within a sector.

3. Interaction: as the name suggests, this is the interaction between the first two effects. The interaction term has a reputation of being hard to explain. This often leads fund managers and custodians to eliminate it in ad hoc ways (for example by adding it to stock selection). We suggest some alternative approaches.

BRINSON ATTRIBUTION USING RESOURCES AND INDUSTRIALS SECTORS

Table 1 shows the results from a Brinson attribution on the hypothetical portfolio using the Resources/Industrials classification scheme for the All Ordinaries Index.

The Brinson model is based on the assumption that the investment process contains both top-down and bottom-up processes. Specifically, the top-down process is sector allocation, in which the portfolio strategist attempts to tilt the portfolio toward sectors that are expected to outperform. In this case, the sector allocation between Resources

TABLE 1 **Brinson Attribution using Industrials/Resources sectors**

	Opening Index Weight	Opening Portfolio Weight	Index Return	Portfolio Return	Sector Allocation	Stock Selection	Interaction	Total Active Return
Total	100.00%	100.00%	16.10%	7.26%	6.43%	-12.98%	-2.28%	-8.84%
Resources	15.12%	33.33%	49.80%	25.22%	5.51%	-2.32%	-3.41%	-0.22%
Industrials	84.88%	66.67%	10.77%	-1.72%	0.91%	-10.66%	1.13%	-8.62%

and Industrials added 6.43% to the portfolio's performance, since the fund was tilted toward the Resources sector, which strongly out-performed Industrials.
The bottom-up process is stock selection within each sector. In this case, the portfolio return in both Resources and Industrials was lower than the benchmark return for each of those respective sectors, and therefore the stock selection term was negative for each of those sectors. The total value-added by stock selection was minus 12.98%.

What about the interaction term? It measures the inevitable side-effect that happens when a top-down process (sector allocation) collides with a bottom-up process (stock selection). In this attribution, the total interaction was –2.28%, comprising –3.41% for the Resources sector, and +1.13% for the Industrials sector.

Starting with Industrials, the sector portfolio was underweight in this sector, and at the same time, the sector under-performed its benchmark. These two separate performance effects (one top-down, and the other bottom-up) had a beneficial side-effect for the fund's performance.

The sector allocation attribute for the Industrials sector was positive, since the sector allocator had under-weighted Industrials, and the Industrials index under-performed the All Ordinaries. However, as an added bonus, the Industrials sector under-performed its index, which increased even further the benefit of being under-weight in Industrials. The +1.13% interaction term for Industrials measures the extent of that added bonus.Turning to the Resources sector, the portfolio was over-weight in this sector, which turned out to be a good sector allocation decision because Resources out-performed the All Ordinaries.

However, the benefit of this tilt toward Resources was diminished substantially because the Resources sector in this portfolio under-performed its benchmark by almost 25%. Once again, the interaction term measures this side-effect quite precisely.
A possible inference that one could draw from this analysis is that the benefits of this portfolio's tilt toward Resources were diminished substantially by the inability of the Resources sector to match its benchmark.

If fund managers held a view that they would be able to consistently add value through Industrials/Resources sector tilts, but were uncertain of their ability to add value within the Resources sector, they might wish to reduce the chance that poor Resources performance would undermine the value added by a tilt toward that sector. They could achieve this by indexing the Resources sector, or at least by tracking the index more closely in that sector.

Adding interaction to the other terms in a performance attribution can create confusion. For example, suppose that fund A and fund B have identical benchmarks. Suppose also that they both gain their exposure to international equities via a specialist international equities fund ("Fund C").

The stock selection attribute for the international equities sector of funds A and B will always be the same. However, if the attribution reports for funds A and B lump the interaction term in with stock selection, the reports will show different stock selection results for international equities in funds A and B, depending on the tactical asset allocation (TAA) of each fund. The managers of fund C may well feel aggrieved at this, since the TAA in funds A and B is completely beyond their control.

WHAT IS THE SOURCE OF INTERACTION?

This example illustrates the general principle behind interaction. Fund managers will generate a positive interaction effect when they over-weight a sector that beats its benchmark, or when they under-weight a sector that under-performs its benchmark. By its very nature, interaction depends on both the asset allocator and the stock selectors. It follows inevitably from the assumption behind the Brinson model: that a strategist is making "top down" sector bets, while the sector managers are picking stocks within each sector.

What about funds that mainly use a "stock-picking" or "bottom-up" management process? One approach to attributing these funds would be to use a Brinson model, and then attempt to re-jig the results. However, a more natural solution is to use a stock-level attribution model that is specifically designed to measure the success of stock-picking.

STOCK-LEVEL ("BOTTOM UP") ATTRIBUTION

Since the decision to not hold a stock is in itself an active decision, a stock attribution will contain one line for every stock in the benchmark, plus a line for any stocks that were held in the portfolio despite not being in the benchmark. At any one time during 1999, the All Ordinaries contained about 270 stocks. However, different stocks moved into and out of the benchmark during 1999. As a result, the total number of stocks that were in the All Ordinaries at some stage during 1999 was in fact 348. To conduct an accurate analysis, it is necessary to perform the attribution on each day during 1999, using the stocks that were in the index on that day. The attribution report can then combine the daily results to obtain a result for the full year.

The following table shows the 10 best and 10 worst active bets for the hypothetical portfolio over 1999 (there are about 300 missing lines in the middle of this table): Out of the nine stocks in the portfolio, seven stocks are on the list of the 10 worst active bets. Another (BHP) was the best

TABLE 2 **Stock-level (Bottom-up) Attribution**

	Opening Index Weight	Closing Index Weight	Opening Index Weight	Closing Index Weight	Index Return	Value Added
TOTAL	100%	100%	100%	100%	16.10%	-8.84%
BHP	5.08%	5.86%	11.11%	17.77%	71.56%	3.79%
AMP	4.52%	3.09%	0%	0%	-16.69%	1.26%
NAB	7.25%	5.82%	0%	0%	-0.87%	0.98%
Westpac	4.18%	3.25%	0%	0%	0.59%	0.52%
Coca Cola Amatil	0.94%	0.54%	0%	0%	-30.13%	0.35%
GIO	0.68%	0.00%	0%	0%	N/A	0.35%
Coles Myer	2.00%	1.54%	0%	0%	-5.14%	0.35%
Lend Lease	2.25%	1.82%	0%	0%	-0.09%	0.31%
Telstra	6.65%	8.95%	0%	0%	12.96%	0.28%
Westfield Trust	0.92%	0.76%	0%	0%	-11.59%	0.24%
…	…	…	…	…	…	…
Cable & Wireless	1.31%	3.23%	0%	0%	48.40%	-0.77%
Boral	0.53%	0.45%	11.11%	11.21%	8.20%	-0.84%
News Corp	4.42%	5.03%	0%	0%	37.56%	-0.87%
Ashton Mining	0.03%	0.05%	11.11%	10.85%	4.70%	-0.96%
Rio Tinto	2.37%	3.24%	0%	0%	75.22%	-1.17%
Central Norseman	0.02%	0.02%	11.11%	10.30%	-0.59%	-1.61%
Austrim Nylex	0.14%	0.11%	11.11%	10.32%	-0.40%	-1.78%
Adelaide Brighton	0.03%	0.06%	11.11%	9.37%	-9.59%	-2.94%
Biota	0.10%	0.08%	11.11%	9.17%	-11.51%	-2.97%
Brierley	0.10%	0.07%	11.11%	8.72%	-15.79%	-3.19%

active bet in the portfolio by a wide margin. In fact, the only holding in the portfolio that didn't make the "top ten" or "bottom ten" lists was Commonwealth Bank. It is instructive to see that nine of the ten best bets in the portfolio were decisions not to hold stocks that under-performed the benchmark, and which also had a significant weight in the benchmark. GIO left the benchmark ten days before the end of the year, but in the period up to that date, its return was –51.9%.

The stock attribution model does not produce an interaction term, since it assumes a pure bottom-up process of selecting stocks. It is therefore a very suitable model for fund managers who use a bottom-up management style. Indeed, when people express dissatisfaction with the existence of an interaction term, it's possible that the real source of their dissatisfaction is that they conceptualise the investment process in bottom-up terms. When that is the case, the most straight-forward solution would seem to be to use a stock attribution model.

BRINSON ATTRIBUTION USING ASX SECTORS

Another very standard analysis would be to do a Brinson attribution using the standard ASX sector scheme. This uses exactly the same calculation method as the Industrials/Resources attribution, except that the ASX sector scheme has been used instead of the Industrials/Resources scheme.

At the total fund level, these results seem to bear no resemblance to the results in Table 1, except for the fact that the total active return is still minus 8.84%. Specifically:

- the total sector allocation effect was significantly higher in the Industrials/Resources attribution;
- the Industrials/Resources attribution showed that stock selection subtracted almost 13% from the portfolio's return, while this attribution shows that stock selection added more than 1% of performance; and
- the Industrials/Resources attribution showed a relatively small interaction effect (minus 2.28%), while the ASX sector attribution includes a hugely negative interaction term (minus 14.45%).

At first glance, a natural response to these attribution reports would be "what has gone wrong?" They paint very different pictures even though the only difference is that they are based on different sector schemes. However, there are good reasons for the differences, and understanding these reasons reveals a lot about how performance attribution works.

The easiest way to understand an attribution report is by "drilling down" to the sector level and to the stock level. For example, the portfolio held Central Norseman Gold. This stock strongly out-performed the gold index, which (as shown in Table 3) added 0.37% to the portfolio's performance through stock selection.

However, in 1999, the Resources sector strongly out-performed the All Ordinaries, but the gold sector under-performed both. This helps to explain the conundrum of why the results are so different if we use the ASX sector scheme rather than Industrials/Resources.

From the standpoint of Industrials/Resources, the allocation to Central Norseman helped to overweight Resources, which was a good sector allocation decision. By the same token, Central Norseman under-performed the resources index, which was measured as a bad stock selection decision.

However, from the standpoint of ASX sectors, the allocation to Central Norseman constituted a poor sector allocation choice (towards gold), but a good stock selection choice (since Central Norseman beat the gold index).

This comparison makes it easy to see that the choice of sector scheme can make a big difference to the results that a Brinson model produces. Of course, if the portfolio actually had been managed bottom-up, all of these considerations would be of secondary importance. The vital issue would be to use a bottom-up attribution (Table 2) rather than the Brinson model.

How can we understand the enormous negative interaction term in Table 3? Apparently the stock selection was good, and the sector allocation was good, but the interaction effect was absolutely terrible. Does this mean anything?

Indeed it does. The under-performing sectors were principally those that the sector allocator had over-weighted, leading to a very poor result for the interaction attribute. Specific examples of this are Other Metals (8% overweight combined with 53% under-performance) and Health Care & Biotech (10% overweight combined with 36% under-performance).

TABLE 3 **Brinson Attribution using ASX Sectors**

	Opening Index Weight	Opening Portfolio Weight	Index Return	Portfolio Return	Sector Allocation	Stock Selection	Interaction	Total Active Return
Total	100.00%	100.00%	16.10%	7.26%	4.38%	1.23%	-14.45%	-8.84%
Gold	1.76%	11.11%	-11.99%	-0.59%	-2.41%	0.37%	0.90%	-1.14%
Other Metals	2.97%	11.11%	57.52%	4.70%	1.92%	-0.64%	-3.42%	-2.14%
Diversified resources	8.00%	11.11%	69.78%	71.56%	2.55%	0.13%	0.03%	2.71%
Energy	2.39%	0.00%	23.92%	N/A	-0.15%	0.00%	0.00%	-0.15%
Infrastructure and Utilities	1.76%	0.00%	-2.00%	N/A	0.31%	0.00%	0.00%	0.31%
Developers and Contractors	3.48%	0.00%	2.31%	N/A	0.44%	0.00%	0.00%	0.44%
Building Materials	2.53%	22.22%	12.84%	-0.69%	-0.54%	-0.24%	-3.26%	-4.05%
Alcohol and Tobacco	2.18%	0.00%	6.50%	N/A	0.19%	0.00%	0.00%	0.19%
Food and Household Goods	2.09%	0.00%	-16.23%	N/A	0.59%	0.00%	0.00%	0.59%
Chemicals	0.55%	0.00%	0.46%	N/A	0.08%	0.00%	0.00%	0.08%
Engineering	0.43%	0.00%	-9.85%	N/A	0.04%	0.00%	0.00%	0.04%
Paper and Packaging	1.11%	0.00%	10.28%	N/A	0.05%	0.00%	0.00%	0.05%
Retails	4.32%	0.00%	1.26%	N/A	0.57%	0.00%	0.00%	0.57%
Transport	2.69%	0.00%	12.92%	N/A	0.05%	0.00%	0.00%	0.05%
Media	10.34%	0.00%	34.24%	N/A	-1.66%	0.00%	0.00%	-1.66%
Banks	21.95%	11.11%	7.84%	18.75%	0.67%	2.21%	-1.17%	1.71%
Insurance	8.16%	0.00%	-11.66%	N/A	2.02%	0.00%	0.00%	2.02%
Telecommunications	8.78%	0.00%	24.00%	N/A	-0.73%	0.00%	0.00%	-0.73%
Investment and Financial Services	1.31%	11.11%	20.81%	-15.79%	0.36%	-0.55%	-3.35%	-3.54%
Property Trusts	5.76%	0.00%	-4.97%	N/A	1.16%	0.00%	0.00%	1.16%
Health Care and Biotech	1.48%	11.11%	24.89%	-11.51%	0.51%	-0.07%	-3.74%	-3.30%
Miscellaneous Industrials	0.97%	0.00%	94.08%	N/A	-0.54%	0.00%	0.00%	-0.54%
Diversified Industrials	3.02%	11.11%	1.15%	-0.40%	-0.94%	0.02%	-0.44%	-1.35%
Tourism and Leisure	1.96%	0.00%	26.30%	N/A	-0.16%	0.00%	0.00%	-0.16%

So interaction is not the "inexplicable" or "meaningless" phenomenon that is frequently suggested. Indeed, in this case, it provides a sound explanation for why this portfolio under-performed.

Many Australian equities fund managers do indeed operate a combined top-down and bottom-up process, where a sector allocator picks the ASX sector tilts, and analysts pick stocks in each ASX sector. If a fund manager with that investment process produced the attribution report shown in Table 3, it would be possible to make a completely intelligible explanation of why the interaction term was so bad. A number of fund managers and custodians take the liberty of adding the interaction term to stock selection or sector allocation. That can be an appropriate interpretation of the results under certain circumstances.

However, it is just that – an interpretation. If a fund manager added the interaction term to stock selection in this case, would that make the report more informative or less informative? I suggest that it would be a good practice for fund managers and custodians to at least disclose the interaction term to consumers of their attribution reports, since this example demonstrates that it is by no means always negligible.

APPROXIMATIONS AND ERRORS

There is (in practice) no perfectly accurate way to measure investment performance. An element of approximation arises from assumptions about cashflow timing. For example, suppose that fund XYZ has a market value of $100 at the start of the day. During the day, it receives a contribution of $2. At the end of the day, fund XYZ has a market value of $103. What was its return? Clearly, the fund increased in value by $1. However, if we assume the cashflow happened at start of day, the return will be $1 / $102 = 0.98 %. On the other hand, if we assume the cashflow happened at end of day, the return will be $1 / $100 = 1.00 %. If the performance calculations are monthly rather than daily, the extent of this approximation becomes much larger (it will typically be in the order of 10 basis points per month, but in some months it can be much more than this).

Furthermore, monthly attribution is also blind to intra-month re-weighting in the benchmark or the portfolio.daily attribution is much more desirable than monthly attribution.

Also, the process of calculating the attribution results is a possible source of errors. It is generally accepted that manually calculating the results in a spreadsheet (still a common practice) entails a much higher risk of errors than using a properly automated system. If you are presented with an attribution report, it is reasonable to ask whether it was produced by a spreadsheet or an automated system.

INTERPRETING ATTRIBUTION REPORTS

The examples in this article have shown that different approaches to attributing performance can produce very different sets of results. It is important for practitioners to be aware of these differences and why they occur.

Here are some key points to consider when interpreting an attribution report:

- The most relevant attribution report is one that is congruent with the investment process. This means that a stock-level attribution report would be most appropriate for a bottom-up manager. Similarly, if a top-down fund manager does not use ASX sectors as the basis of their sector allocation decisions, an attribution against ASX sectors would not be of prime relevance.
- Notwithstanding the previous point, other attribution reports may shed light on the portfolio's performance. For example, in this case, even if the manager had been using a bottom-up style, it would have been interesting to see the large sector bets that the manager was (perhaps inadvertently) taking as a consequence of their stock selection.
- When you are interpreting a report from the Brinson model, bear in mind that different sector schemes may produce very different results.
- The ability to drill-down to sectors and stocks is essential for understanding attribution results. This can be the most useful tool in making sense of the results.
- Performance measurement involves some degree of approximation. The approximation is much larger for monthly rather than daily calculations.
- If you are shown an attribution report that includes stock selection and sector allocation, ask to see the interaction term also. Table 3 demonstrates that interaction can sometimes be vital to understanding the portfolio's performance.

NOTE

This article draws some material from a paper by the same author that appeared in the Journal of Performance Measurement (Fall 2000). That paper is available at http://www.laker.com.au/interaction101.htm J