

## APPENDIX 2: Interpreting the Output

### Recommended Portfolio Review Sequence

#### 1. General Risk Analysis

##### Tracking Error

Tracking Error (or Active Risk) is an estimate of the expected *relative volatility* of the portfolio versus the benchmark and is expressed as an annualized percentage. Tracking Error is best thought of as an indicator of overall aggressiveness of a portfolio versus its benchmark or simply as a measure of “difference” between portfolio and benchmark.

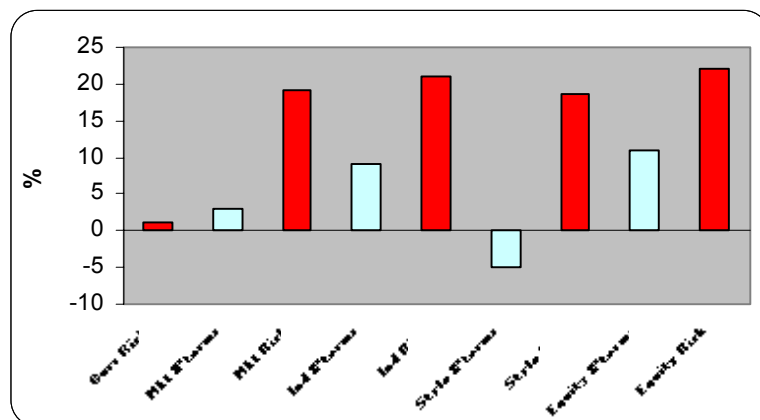
The Style Research Portfolio Analyzer calculates an annualized active risk based on the current set of active weights (i.e. snapshot of portfolio versus benchmark at recent month end) and a covariance matrix based on the historic relationships over the past 5 years between Currencies, Markets, Sectors, Style (Large, Small, Value, Growth) and also Stock Specific returns.

Because of the potential trending in portfolio monthly relative returns it is also recommended to view the *Tracking Error Report* from the *Persistence* sheet after viewing the *Risk Report*. (See **Persistence**, below.)

Portfolio Tracking Error is calculated versus the selected benchmark or, if no benchmark is specified, against the total market region in which the portfolio is analyzed. If “Is Hedge Fund” is selected the Tracking Error will be relative to Cash.

##### Sources of Risk

Tracking Variance (the square of Tracking Error) is decomposed into contributions from Stock Selection (“Equity Risk”), Style Tilt, Sector Allocation and, for multi-currency portfolios Market Allocation and Currency Allocation. These are also displayed as percentages. The decomposition of Tracking Error provides further insights into the sources of risk in a portfolio. ( See **3. Further Risk Attribution** for further detail, including stock level risk attribution.)



Because the Style Research analysis explores intuitive and stable factors, rather than linear combinations of factors designed to be orthogonal (at the cost of stability and transparency), the risk decomposition frequently reveals significant “cross terms”. These cross terms carry the impact of the covariances between the principal risk elements. For example the cross term between currency and market carries the way in which the portfolio’s holdings in currencies and markets covary. For example, if a US dollar based portfolio was overweight in The Netherlands then, all other things equal, the currency/market cross term (“Mkt X Terms”) would be negative since when the guilder, now the euro, goes down the equity market usually goes up (many large companies are international in The Netherlands). Japan is the other way around since, other things equal, US dollar-based portfolios overweight in Japan would show a positive currency/market cross term.

Carrying this over to the Style/Equity cross term, a positive cross term would indicate that the stocks held react positively, on average, relative to their Style (within each Sector) as the Style performs positively, and negatively as the Style falls. This means that the stocks held are clear examples of the Styles they represent; if they tended to move against the relative performance of the Styles they would result in a negative cross term. Portfolios which show a positive Style/Equity cross term are often associated with managers who choose stocks which clearly perform as representatives of their Styles – above the performance of the average of all other stocks in the same Style (and Sector).

Although Tracking Error is a well established feature of portfolio risk analysis, there are some well known difficulties with the statistic:

- \* Tracking Error is generally calculated from monthly data yet it is quoted at an annual rate which implicitly assumes that there is no persistence in returns or risk patterns beyond monthly data. This is inconsistent with most experience and may result in significant underestimation of risk, particularly when portfolios have systematic tilts in respect of Factors (or Styles) which are expected to offer persistent patterns of rewards.
- \* Ex ante Tracking Error is calculated on an implicit constant proportions assumption which implies that the active weights of all securities in the portfolio remain constant throughout the risk assessment horizon (usually one year). Since this would require almost continuous trading (a very impractical and unlikely strategy) it would, in the vast majority of cases, result in a biased estimate of Tracking Error.
- \* Optimized portfolios, and even portfolios constructed by managers with an understanding of historic trading patterns, are generally structured to accommodate the measured security performance patterns and risks of the past. Fitting the past, however, often results in artificially low estimates of forward looking risk.

To broaden the appreciation of portfolio risk, it is advisable to review the number of securities in the portfolio, the portfolio “coverage”, and

to calculate the impact of any “persistence” in the portfolio’s recent pattern of returns. These terms are explained below.

### **Portfolio Beta**

The portfolio beta, shown below the Tracking Error on the Risk Report, is a measure of the portfolio’s sensitivity to benchmark movements or “benchmark timing” risk. The more a beta differs from 1 the more benchmark timing risk will contribute to the portfolio Tracking Error. In practice, benchmark-timing risk is not usually significant in actively managed institutional (long-only) equity portfolios where betas are typically between 0.9 and 1.1. Betas which are significantly higher or lower tend to be associated with portfolios with high cash or high gearing or sometimes where portfolios are not strictly being managed against the benchmark defined in the analysis.

The Portfolio Beta is calculated as the covariance of the portfolio versus the benchmark, divided by the variance of the benchmark. The covariance and variance are the “ex ante” calculations based on *current weights* and historic patterns of return measured over 60 months.

#### *Technical Note – Portfolio Beta versus Skyline Betas*

The Portfolio Beta is based on the current structure of the portfolio and the current structure of the benchmark. The Betas described in the Style Skylines are based on regressions of the individual security returns against the historic returns of the stock’s local market and so this implicitly includes changes in the weights structure of the market over 36 months. The shorter time frame is necessary so that new stocks have betas - and it is the performance against the market that is the standard definition. This means that the weighted average of the individual (Skyline) betas will differ from the Portfolio Beta for three reasons:

1. Different time periods of assessment.
2. The individual Betas are against the stock’s total market not the benchmark.

But even if the time periods were aligned and the Betas were all calculated against a common benchmark the results would still be different because:

3. The calculations of the individual betas use the historic total market returns - with all the changing proportions that occur through time; whereas, the Portfolio Beta returns use the “ex ante” constant proportions assumptions that is implicit in the algebra of the calculation of the benchmark variance and the portfolio/benchmark covariance.

### **Number of Shares**

The portfolio listing provides details of the number of securities within the portfolio and the number of securities within the market or relevant benchmark. The listing also provides detail at the individual sector level.

## Coverage

A stock's coverage is defined as the lower of the % weight in the portfolio and the % weight in the benchmark. Summing these numbers for every stock in the portfolio gives a number for the overall Portfolio Coverage, simply referred to as *Coverage*. Portfolio Coverage describes the extent to which the benchmark is represented in the portfolio and as such is an objective and practical measure of portfolio diversification.

The individual stock coverage numbers can also be aggregated across any portfolio subgrouping such as by sector, country, or Style category.

Since Coverage figures describe the stock commonality between portfolio and benchmark they can highlight the "stock selection" risks within the portfolio, and also within subgroupings of the portfolio, in a way which is objective and easy to communicate.

If, for example, the benchmark has only two stocks, equally weighted (50% stock A; 50% stock B), and the portfolio holds only stock A (i.e. 100% in stock A), then the coverage would be 50% - the portfolio has covered the benchmark proportion of stock A, but stock B, 50% of the benchmark, is entirely missing. If on the other hand the portfolio holds two stocks, A and C (weighted 20% in stock A and 80% in stock C) then the coverage would be only 20% - the portfolio fails to match the benchmark proportion of stock A.

## Persistence

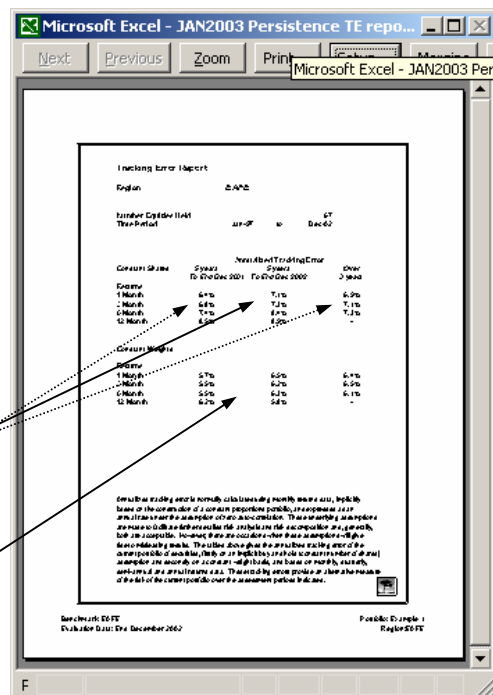
Historic Tracking Errors of portfolio returns against a benchmark are often significantly different from the predictions given by risk models. There are many reasons why this can occur but there are two methodological reasons which are important. Firstly, annualized Tracking Error, which is normally calculated using monthly returns data, is (i) implicitly based on the construction of a *constant proportions* portfolio, and (ii) then expressed at an annual rate under the *assumption of zero auto-correlation*. These underlying assumptions are made to facilitate further detailed risk analysis and risk decomposition and, generally, both are acceptable. However, there are occasions when these assumptions will give rise to misleading results. Therefore the Portfolio Analyzer also calculates the annualized Tracking Error of the current portfolio of securities on an implicit buy and hold, *constant number of shares*, assumption (over 3 or 5 years); and based on monthly, quarterly, semi-annual and annual returns data. These Tracking Errors, shown on the Tracking Error Report (in the Persistence sheet of the output) provide an alternative measure of the risk of the current portfolio over the assessment periods indicated.

The same calculations are also repeated, but using constant weights, on the lower part of the Tracking Error report. This may be suitable for analyzing portfolios of managers who frequently rebalance their portfolios in a disciplined fashion, perhaps with explicit weight constraints. The analysis can still show the potential for returns trending over longer time periods in these portfolios.

The benchmark returns are also calculated using a constant number of shares methodology, and the Tracking Errors quoted are annualized (using simple  $\sqrt{12}$ ,  $\sqrt{4}$ ,  $\sqrt{2}$ , 1 conversion multiples) from monthly, quarterly, semi-annual and annual assessment interval calculations.

The impact of persistence is measured from the standpoint of the current analysis as well as from the perspective that would have been available 12 months before. This helps to detect whether the impact of the persistence could have been anticipated a year earlier. The persistence over the past 3 years is also measured for a shorter term view.

The calculations are also repeated, but using constant weights. This may be useful for analyzing portfolios of managers who frequently rebalance their portfolios in a disciplined fashion, perhaps with explicit weight constraints.



The *Persistence Ratio* is a measure which can be easily derived from the Tracking Errors shown on the Tracking Error Report. For any column of Tracking Errors we can take an average of the 3, 6 and 12 month Tracking Errors and divide this by the 1 month Tracking Error. So, for example, if the annualized Tracking Errors calculated from 1, 3, 6 and 12 month intervals (from, say the most recent 5 year history) are 4.0, 5.0, 6.0 and 7.0 respectively, the Persistence Ratio would be  $(5.0+6.0+7.0)/3 = 6.0$ , divided by 4.0 = 1.50. This ratio can be a *practical* indicator of the extent to which a forecast Tracking Error may be underestimated due to time-varying weights and trending in returns. Using our last example, if the ex-ante Tracking Error was 3.0% p.a., then a "Persistence Adjusted" Tracking Error estimate could be described as 3.0% p.a. x 1.50 = 4.5 % p.a. The Persistence Adjusted Tracking Error can be a guide to the softness of conventional "predicted" Tracking Error estimates.

*Note : Persistence Ratios are calculated and shown graphically within the League Table analysis.*

It should also be noted that the Persistence Ratio is not always greater than 1. Some portfolio return patterns show mean reversion over quarterly, six monthly and annual periods and so it is also possible for annualized Tracking Error estimates to be overestimated.

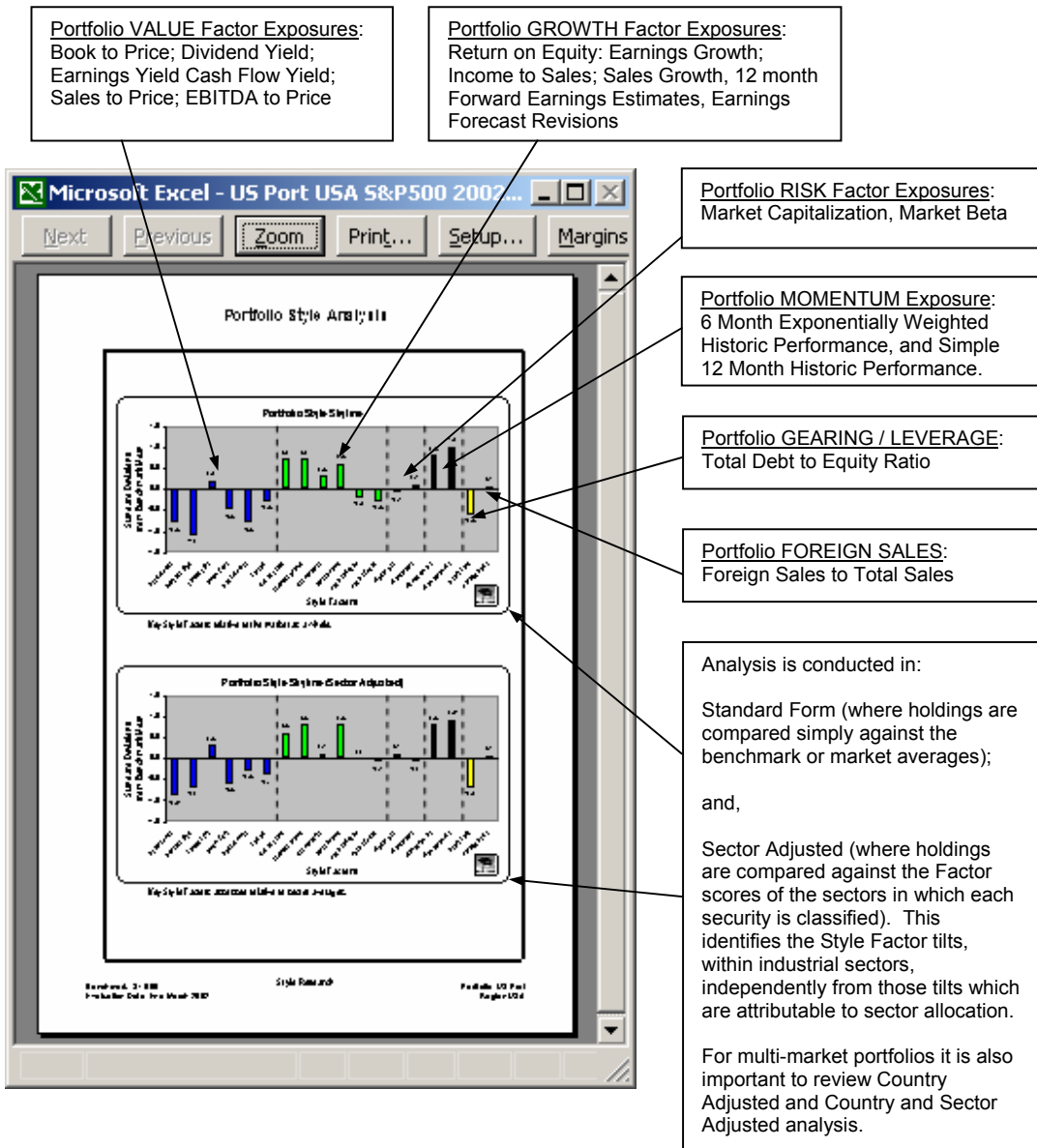
*Of course, there are also limitations to the buy and hold, constant shares approach. For example, if the portfolio or benchmark has a holding in a stock which has collapsed in price, the holding may dominate historic buy and hold analysis. This could lead to very high Tracking Errors in the Tracking Error Report where in practice a*

*manager is unlikely to have maintained a buy & hold strategy with such a position. For this reason we also provide the same analysis, but maintaining constant weights, on the lower part of the Tracking Error report (on the Persistence Sheet). This may also be suitable for analyzing portfolios of managers who frequently rebalance their portfolios in a disciplined fashion, perhaps with explicit weight constraints. The analysis often shows there is still strong potential for returns trending over longer time periods in these portfolios.*

In general, for active equity portfolios, it may be more useful to think of forecast Tracking Errors simply as a guide metric to the “level of aggressiveness” of a portfolio and for comparing levels of active risk between portfolios rather than to take them as accurate forecasts of ex-post realizations.

## 2. Style Analysis – Tilts & Distributions

### Portfolio Tilts



The Style Skylines are designed to answer the question “How significantly different is the portfolio from the benchmark?” in respect of Style factors which are *important* and *relevant* in equity markets.

In each Style Skyline, the first six bars from the left are Value factors (shown as blue bars in the output). The next six bars are the Growth factors (green bars) and include four current/historic measures as well as two forward-looking Growth factors (incorporating IBES consensus earnings estimates and earnings revisions). The remaining bars on the right cover Size, Beta, Momentum, Gearing/Leverage and Foreign Sales.

The Style factors in the Skyline can be selected by the user. The example above shows the initial default selection.

However, to understand Style orientation properly we also need to repeat the Style Skyline analysis on a Sector Adjusted (SA), Country Adjusted (CA) and Country and Sector Adjusted basis (CASA). This will allow us to understand whether there is *genuine* Style orientation or whether tilts are mostly due to Sector or Country characteristics. For example, suppose we select Book to Price as a Style factor and sort all companies in the world by this factor. Using this Style factor as a proxy for Value, we could say that the top 50% of companies (by market cap) represents a Global Value portfolio. However, we know that industries and markets have different Book to Price characteristics. As a result it is likely that our portfolio of Value companies will have some significant market and industrial sector biases. The performance characteristics of the Value portfolio constructed in this way may tell us more about country and industry trends rather than about genuine Value companies *within* Sectors and *within* Countries. For example we may just be picking up an overweight in Financial companies or an underweight in the USA. Our Value portfolio may even be simply picking up differences in various accounting conventions across the world.

In addition the tilts need to be able to be compared between different portfolios with different numbers of holdings and across different market regions i.e. we want to be able to compare the significance of tilts from a 200 stock US domestic equity portfolio benchmarked against the S&P500 as well as a 30 stock emerging markets portfolio benchmarked against a customized equity region. And we have to do this for measures ranging from Book to Price, to Earnings Growth, to local market Beta.

We achieve this by standardizing the Style tilts using a normalization process which is also "Sample Size Adjusted" so that the tilts are standard deviations from the mean of the selected benchmark (or total market, if no benchmark is selected). The bars can then be interpreted more easily as indicators of how significantly different the portfolio is from the benchmark in respect of each Style factor.

Note that the Sample Size Adjustment option *can* also be turned off; but then the results are more difficult to analyze and compare. In effect, portfolio tilts would then have to be interpreted as if they had been generated from a *one stock* portfolio with those particular attributes rather than from a portfolio which in reality has been constructed from a typically much larger sample of companies. Whether tilts are intentional or not, their significance should not be underestimated.

As a general rule of thumb, for any individual Style tilt (Standard or Adjusted) :

- Style tilts less than -0.5 or more than +0.5 indicate a tilt is observable.
- Style tilts less than -1 or more than +1 are statistically significant.
- Style tilts less than -2 or more than +2 are statistically very significant.

There is a further interpretation when we compare across similar factors such as the Value factors (blue bars in the Style Skyline) or the Growth factors (green bars). If most of the Value factors are positive and, say, between 0.4 to 0.6 this suggests that there is a significant Value tilt even though no individual tilt is very significant i.e. multiple tilts in a similar direction within Value or within Growth can reinforce our interpretation of a Style orientation.

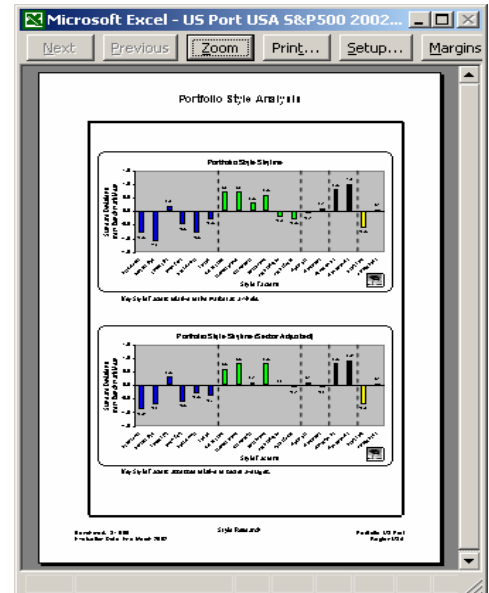
It is possible that more extreme tilts can be produced when portfolios and benchmarks are themselves *narrowly defined* against the market e.g. it is not unusual for Small Cap portfolios to show tilts of 3, 4 or even much larger in magnitude against a Small Cap benchmark. In these cases the significance of the tilts should not be overemphasized.

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In any case, the Data Listing sheet in the output workbook will always show the actual or “raw” portfolio and benchmark exposures for all of the selected Style Factors e.g. dividend yield or earnings growth % p.a.

Referring again to the earlier example output (shown again on the right), this US equity portfolio is initially identified in the top Skyline (unadjusted analysis) as tilted positively towards the Growth Style Factors and negatively towards the Value Style Factors; there is no Size bias, but positive Momentum on both medium and short term measures. The portfolio is tilted to companies with lower Gearing / Leverage than the benchmark average and the Foreign Sales exposure is neutral with respect to the benchmark. Interestingly, Growth tilts can be seen on the current/historic growth measures but not on the forward-looking measures which are based on consensus earnings forecasts and estimate revisions.

Sector Adjustment (the bottom Skyline) confirms that overall these Value and Growth tilts were not simply due to Sector allocations (since the tilts are generally preserved after the Sector Adjustment), and so the Style orientations also apply within Sectors.



This portfolio is a typical Growth portfolio with strong and consistent tilts towards Growth factors, particularly historic Growth factors, and negative tilts towards Value factors (indicating that the manager is paying premium prices for the portfolio’s Growth attributes).

There is little purity of definition, but in general the various Value and Growth tilt possibilities can be initially interpreted as follows:

<u>Value Factors</u>	<u>Growth Factors</u>	<u>Interpretation</u>
Positive	Negative	Traditional Value
Positive	Positive	Growth at the Right Price
Negative	Positive	Traditional Growth
Negative	Negative	Popular Recovery Situations

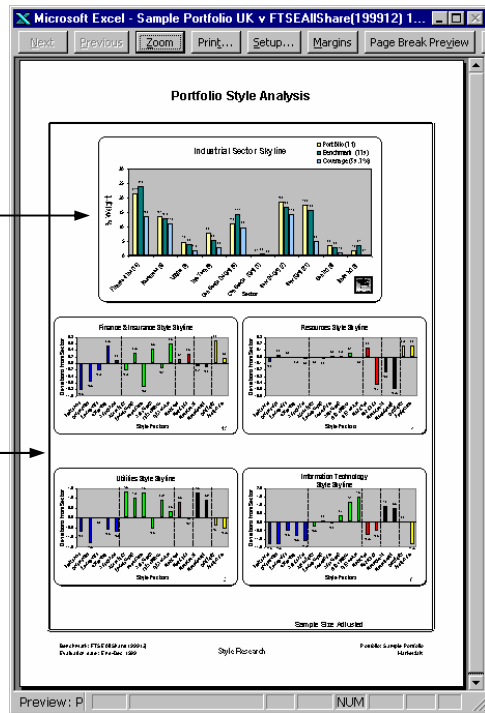
## Sector and Country Allocations

Sector Allocations can be compared against the Sector distributions of the benchmark.

Coverage is reported at both the total portfolio level as well as within each individual Sector.

Style Skylines are shown for each Sector.

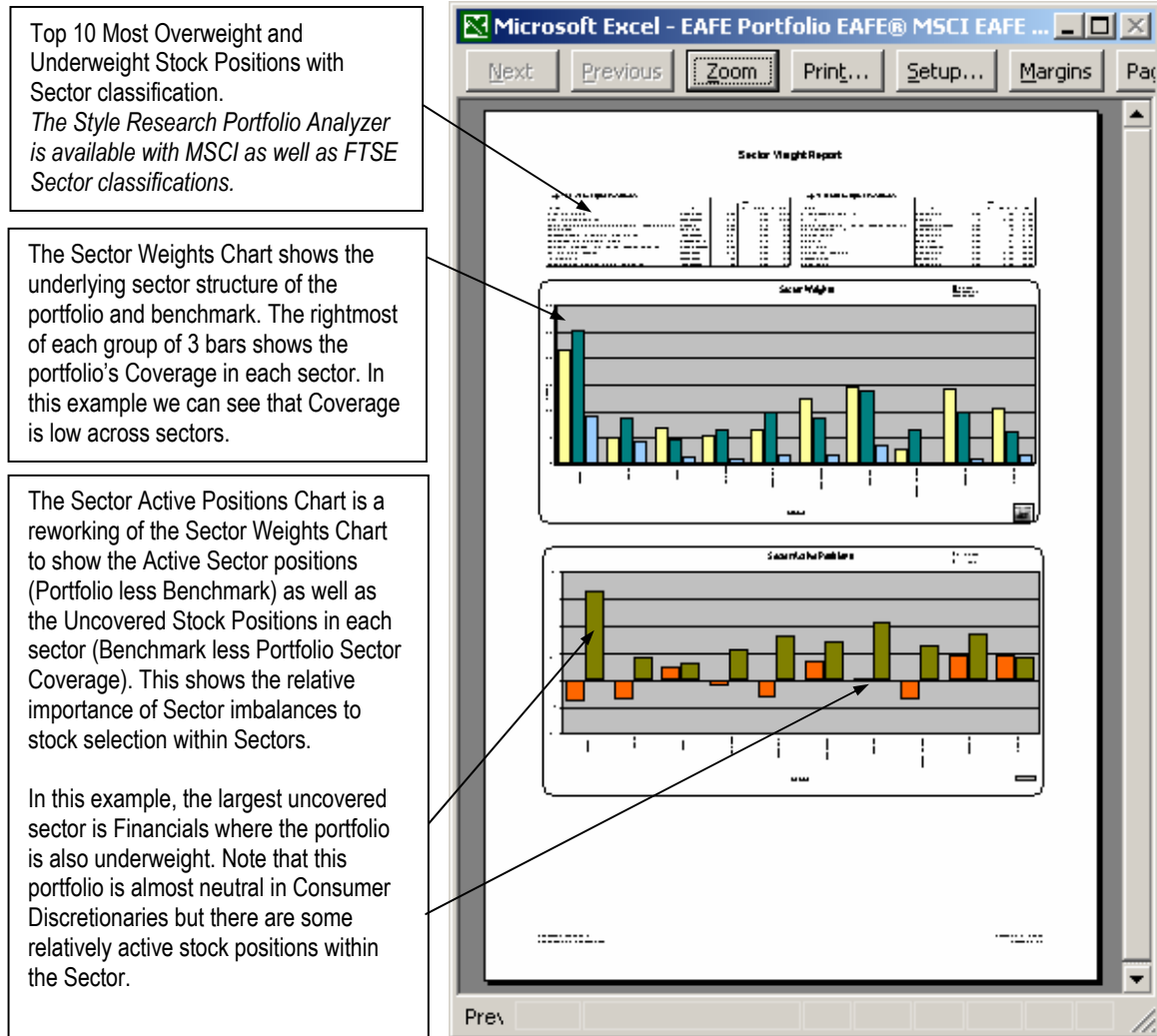
A Country Adjusted version is also shown for multi-country portfolio analyses, which is useful for understanding tilts within Sectors on a Regional basis.



For multi-country analyses, it is also useful to review the distribution of investments in various industrial sectors across the geographical region. The *Region Info* sheet in the output provides a detailed description of the Country, Sector, and Sector-within-Country allocations of the portfolio which are also compared against the benchmark, or the total market if no benchmark is specified. The *Region Info* sheet also shows the Coverage in Countries and Sectors-within-Countries.

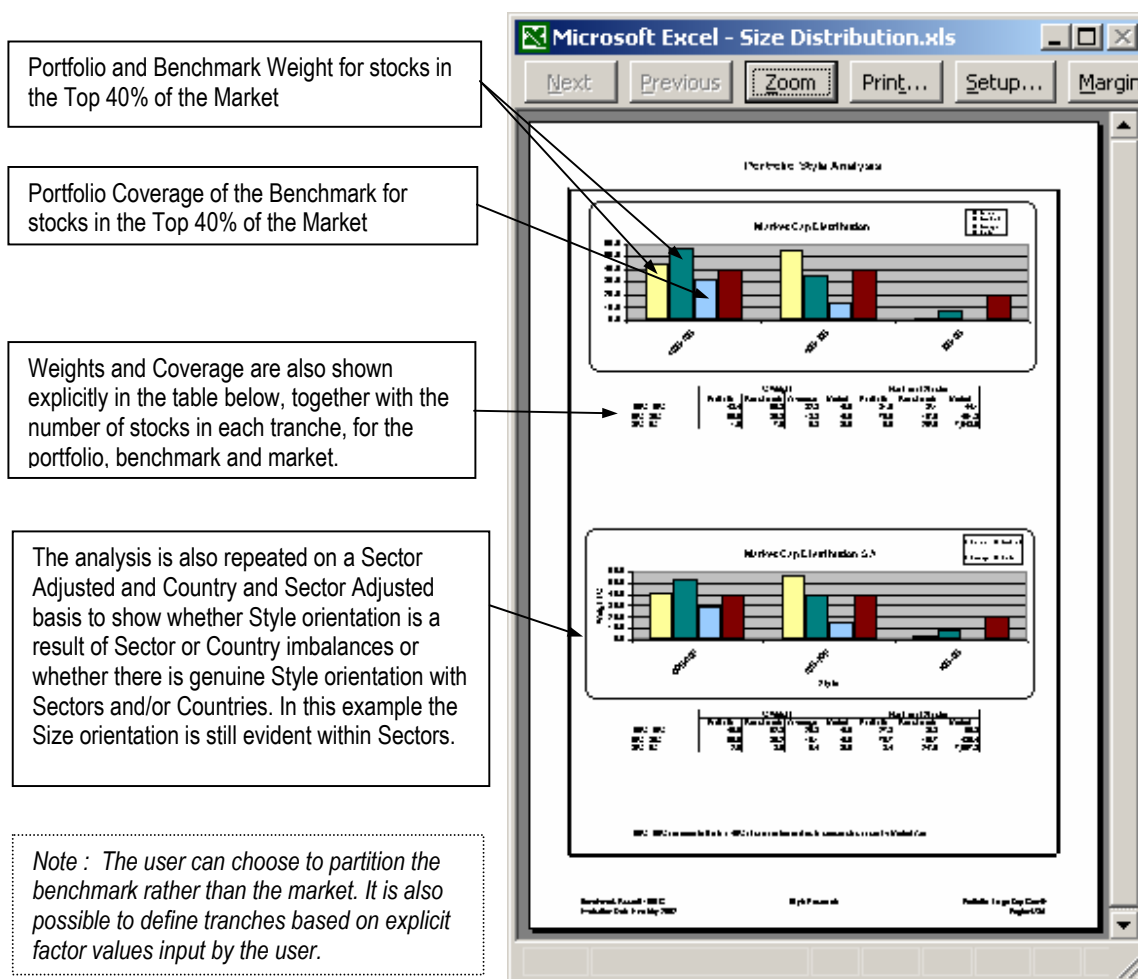
## Active Sector / Country Reports

The example below shows an Active Sector Report. The Active Country report is defined in exactly the same way as the Active Sector Report and has the same layout.



## Style Analysis - Size Distribution (Single Factor)

If we sort all of the companies in an equity market (or region) on a Style factor such as Dividend Yield, and use the market capitalization weight of each stock, we can partition the market to form subportfolios. For example, we could divide the Developed World into three portfolios (or slices or tranches) : 40% highest Dividend Yield, next 40%, and lowest 20%. For any portfolio or benchmark we can determine the percentage weight within each tranche by simply adding up the portfolio weights for each stock in each subgroup. The Size Distribution report does exactly this, but defaults to using Market Capitalization as the Style factor of interest. The software allows any of 18 Style Factors, e.g. Book-to-Price or Earnings Growth, and not just Market Capitalization, so that the Size Distribution report can be more generally described as a Single Factor Distribution Report. The Portfolio Coverage of the benchmark is also shown within each tranche. The example below shows the default Size Distribution Report.



In this example the portfolio is underweight relative to the benchmark in the Top 40% (largest) companies in the market with an overweight in the Mid 40%. The benchmark distribution is concentrated in the largest companies and the portfolio has the highest stock coverage in this segment. This portfolio is making most of its stock selection statements in the Mid 40%. The Sector Adjusted analysis shows that the Style orientation was not just because of Sector imbalances or, equivalently that the Style orientation is consistent within Sectors. Similar interpretations can be made for the Country and Sector adjustment for multi-country analyses.

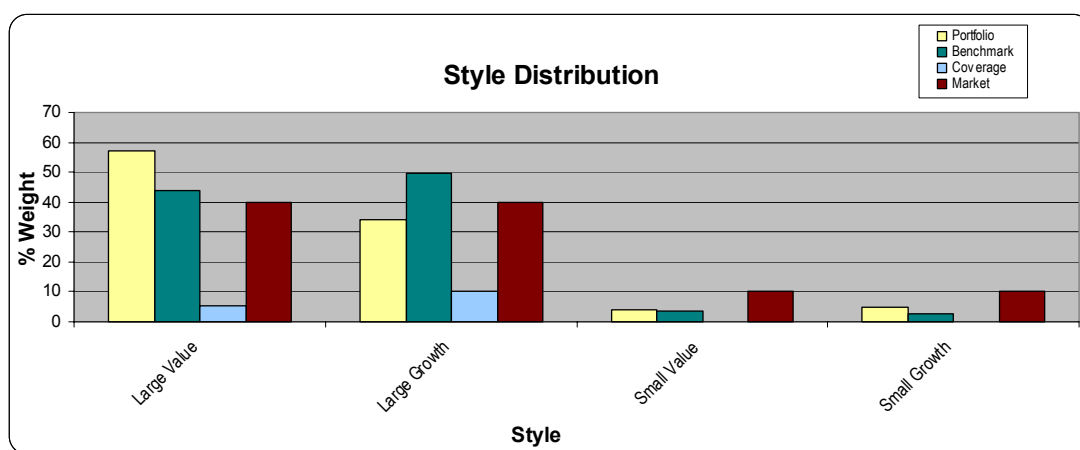
## Style Analysis - Style Distribution (Two Factor)

The Style Distribution is a natural extension to the Single Factor analysis described above. The Style Distribution analysis segments the market, the benchmark and the portfolio into Style Distribution cells according to Two Factor sorts. For each Factor the user can choose how to partition the market e.g. Factor 1 with 3 cuts and Factor 2 with 2 cuts. Combining these choices will subdivide or “dice” the market into 6 subportfolios or cells. (Note : The maximum number of cells is 12).

So, for example using Market Cap with an 80/20 cut (labelled as Large/Small) and Book to Price with a 50/50 cut (labelled as Value/Growth), it is possible to analyze a portfolio according to, say, Large Value, Large Growth, Small Value, Small Growth based simply on "where the portfolio is invested" compared with the benchmark and the total market. The two factors can be chosen from any of the 18 factors available within the Portfolio Analyzer.

It is also useful to compare the Size Distribution and Style Distribution analyses with the Style Skylines as the Skyline Tilts are based on averaged factor scores which can occasionally be misleading when the average is dominated by one or more outliers (a generic problem of any averaged statistics). So if a Large Growth manager wanted to be identified as such but was concerned that a number of rogue ratios were giving misleading averages then a 80/20 initial sort on Market Cap followed by a 40/20/40 sort on RoE, Sales Growth, Earnings Growth - or some Value factors, would partition the market, benchmark, and portfolio in a way that the scale of the factor scores themselves would have practically no bearing on the resulting decompositional analysis.

In the example below, both the portfolio and benchmark are oriented to Larger companies than the broader market. The portfolio has a very large overweight in Large Value companies with a corresponding underweight in Large Growth. Of course, the Country and Sector Style Distribution should also be examined to see whether this is consistent within Countries and Sectors (not shown here). Also note that the Coverage is very low in this portfolio and so stock (or Sector or Country) positions may be just as important in the broader description of this portfolio along with the strong Value orientation. Other reports such as the Risk Report and the Active Sector and Active Country reports can also be used to help build a more complete picture.

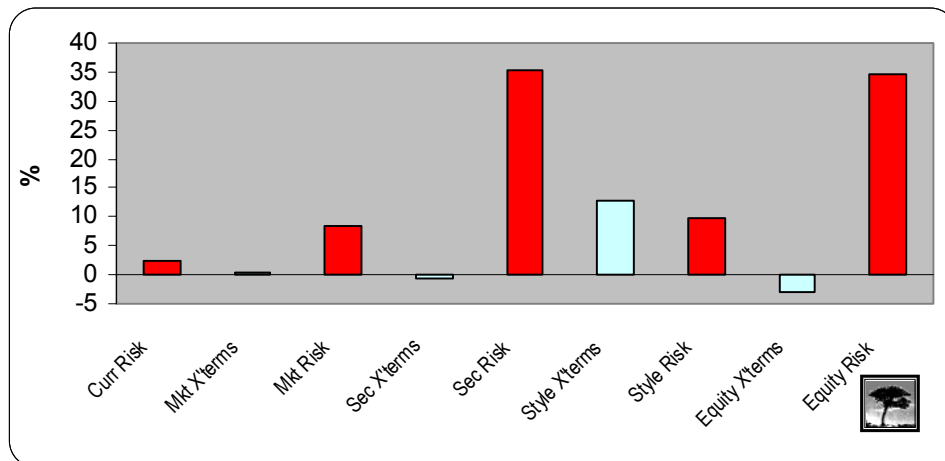


**Market Selected = All World Developed**  
**Large, Small = Market Cap (80%, 20%)**  
**Value, Growth = Book to Price per Share (50%, 50%)**

*Note : The user can choose to partition the benchmark rather than the market. It is also possible to define cells based on explicit factor values input by the user.*

### 3. Further Risk Attribution

Portfolio risk can be decomposed into contributions from Stock Selection (“Equity Risk”), Style Tilts, Sector Allocation and, for multi-currency portfolios Market Allocation and Currency Allocation. The *Risk Report* sheet in the analysis output decomposes the Tracking Variance (the square of Tracking Error) into these components and expresses them as percentages of the overall Tracking Variance. This is also shown graphically as a bar chart on the top right of the Risk Report output sheet.



The example above is taken from the analysis of an international equity portfolio. While there are some active Market (i.e. Country) allocations which are contributing to the active risk of the portfolio the active variance is dominated by Sector and Stock Specific risk. The Style X'Terms bar indicates that there is some concentration of risk due to the correlation between Style (within Sector) and Sector exposures (and possibly between Styles and Markets or Currencies). For example if the portfolio has a Value orientation (within Sectors) and the portfolio is also overweight a “Value” Sector such as Financials this can result in a reinforcement of active risk.

The *Risk Decomposition* sheet provides further analysis of the tracking variance by Style, by Sector and by Country and using the same categories as the bar chart above. This can be used to identify further the components of risk within each of the Style, Sector and Market risks. For example, in the chart above we could establish *which* Sectors were contributing the most to the Sector Risk by looking at the *Contribution to Tracking Variance by Sector* table and examining the Sector Risk column. Each of these contributions could also be expressed as a percentage of the Tracking Variance. So for example we might conclude that “Sector Risk explains 36% of the portfolio Tracking Variance with the three main sector contributors being Consumer Staples (10%), Telecomm Services (8%) and Industrials (7%)”. Similar interpretations could be made such as “Style Risk explains 8% of the portfolio Tracking Variance with 5% coming from Small Growth”. The Risk Decomposition sheet can also be used to answer questions such as “Is the (pure) Equity Risk coming from any particular Country or Sector?”. The answer to this question could easily be found by examining the *Contribution to Tracking Variance by Country* section of the Risk Decomposition Sheet under the Equity Risk column.

For multi-country portfolios the Risk Decomposition sheet will also audit trail down to Contributions to Tracking Variance by Country, Sector, and Style. So for example this

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might reveal that a significant part of the Equity Risk in a portfolio arises from stocks in a specific category, say, Large Growth companies within Healthcare within the United States.

As well as the decompositions shown on the Risk Decomposition sheet it is also possible to decompose the Tracking Variance (i.e. active variance) into contributions from *individual stocks*. This is shown in the *Stock Level Risk Data* sheet in the analysis output under the *Contrib. Risk* column. The sum of all of these stock level contributions will be equal to the tracking variance (the square of the Tracking Error). Taking these numbers as percentages of active variance allows us to provide quantitative estimates of the distribution of tracking variance by stocks. So for example we can check to see whether the active risk of a portfolio is concentrated in just a few stocks or has been constructed in a more diversified fashion.

The Stock Level Risk Data sheet also contains a *Marginal Contribution to Risk* column. The highest and lowest Marginal Contributions to Tracking Error from this list are also summarized on the lower table of the Risk Report. Note also that an Individual stock holding's marginal contributions to portfolio Tracking Error risk can also be taken directly from the Portfolio Listing.

Marginal Contribution to Tracking Error risk is also available on the Portfolio Data Listing.

According to standard Mean-Variance portfolio theory, portfolio efficiency requires that securities with high Marginal Contributions to Tracking Error risk must have high implicit forecasts for future returns (otherwise, why would a rational investor take the risk?).

The screenshot shows an Excel spreadsheet titled 'Portfolio Style Analysis'. The table contains columns for 'Stock', 'Sector', 'Weight', 'Marginal Contribution to Risk', and other metrics. The data is organized into rows representing different stocks and their contributions to the portfolio's overall risk. The table is dense with numerical data, and the 'Marginal Contribution to Risk' column is highlighted in the text box to its left.

The Marginal Contribution to Tracking Error for a stock is the change in Tracking Error for a 1% weight increase in the current position of that stock. The key insight is that the marginal contribution to risk from an individual position will not just depend on the active weight of that position; it will also depend on *all other* portfolio positions and take into account the country, currency, sector, style and stock specific risk of all stocks and their covariances.

The Marginal Contribution to Risk for a stock is important as it is directly related to the implied return for that stock based on the current active positions in the portfolio and each position's currency, country, sector, style, and stock specific risk characteristics. This is particularly useful for portfolio construction when assessing potential position shifts against the expected alpha from those positions.

Stocks with the highest and lowest Marginal Contributions to Tracking Error have the most potential to make the biggest impact on the future relative performance of the portfolios for a small change in position i.e. marginal changes in the positions of these stocks can affect portfolio risk the most.

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The implication is that the fund manager must like these stocks the most/least across all stocks in the investable universe. If not, better risk/return trade-offs are available. Stocks with high Marginal Contributions are associated with negative portfolio impact if stock underperforms and so are implied as best performing. Similarly the lowest Marginal Contributions are associated with negative portfolio impact if stock outperforms and so are implied as worst performing.

Note that it is possible for a portfolio to be underweight in a stock and still have a high Marginal Contribution to Tracking Error. This can occur when the stock has characteristics, e.g. Country, Sector, Style, which are highly correlated with overweight positions in respect of these characteristics. So although the underperformance of that stock will make a positive contribution to that underweight position it is likely to be associated with overall negative performance of the *portfolio as a whole*.

Although closely related, note the difference between “Contribution to Risk” and “Marginal Contribution to Risk”. The Stock Level Contribution to Risk explains the sources of active variance, stock by stock, in the current portfolio. The Stock Level *Marginal* Contribution to Risk explains how the current risk profile will change for a marginal change in position and therefore suggests more about implied returns and potential trades.

The Stock Level Risk Data sheet also has a Stock Selection Risk column which provides a decomposition of the Equity Risk. This is useful for identifying individual stock specific risk contributions (net of currency, market, sector or Style).

The Stock Level Risk Data sheet also contains other information such as portfolio, benchmark and active weights for all stocks in the portfolio and the benchmark. The table also provides other classification information such as the Country, Sector and Country and Sector Relative Style (CASA Style) for each company.

### Fund of Funds Risk (Holdings-based)

The fund of funds risk decomposition shows the breakdown of risk, and other statistics, when the portfolio is made up of a number of funds. For fund of funds and multi-managers it provides a summary of how the various funds interact with each other and how they contribute to the overall risk of the portfolio.

Within the main table there is information about the funds themselves: weights in the portfolio, tracking error, absolute volatility and beta (vs. the benchmark). The overall fund of funds tracking error, beta and volatility are also shown. Note that the overall beta is the weighted combination of the funds' betas. This is not the case for overall tracking error and volatility, since these depend on how the funds themselves correlate with each other. These correlations are shown in the correlation matrices, both in absolute and benchmark relative terms. They have been calculated via the stock covariance matrix. As such, they are based on the current structure of the funds (rather than their historic time series), and therefore better reflect the likely correlations going forward.

<b>Fund of Funds Tracking Error Report</b>							
<b>Fund</b>	<b>Wght</b>	<b>TE</b>	<b>Marginal Cont. to TE</b>	<b>Cont. To Tracking Variance</b>	<b>Cont. To TV %</b>	<b>Volatility</b>	<b>Beta</b>
Total Fund	-	1.80	-	3.22	-	19.49	1.00
Fund 1	31.27	9.27	0.00	0.88	27.30	19.91	0.91
Fund 2	19.00	14.38	0.00	0.80	24.95	22.38	0.89
Fund 3	30.10	8.32	0.00	0.90	27.83	20.76	0.98
Fund 4	19.63	14.25	0.00	0.64	19.92	28.07	1.28
<b>Correlation Matrix</b>							
	1	2	3	4	Benchmark		
1. Fund 1	1.00	0.57	0.80	0.68	0.89		
2. Fund 2	0.57	1.00	0.60	0.65	0.77		
3. Fund 3	0.80	0.60	1.00	0.75	0.92		
4. Fund 4	0.68	0.65	0.75	1.00	0.88		
Benchmark	0.89	0.77	0.92	0.88	1.00		
<b>Benchmark Relative Correlation Matrix</b>							
	1	2	3	4	Benchmark		
1. Fund 1	1.00	-0.37	-0.06	-0.50	0.00		
2. Fund 2	-0.37	1.00	-0.41	-0.15	0.00		
3. Fund 3	-0.06	-0.41	1.00	-0.29	0.00		
4. Fund 4	-0.50	-0.15	-0.29	1.00	0.00		
Benchmark	0.00	0.00	0.00	0.00	0.00		
<b>Optimization Constraints</b>							
	Min %	Max %					
Fund 1	0.00	100.00					
Fund 2	0.00	100.00					
Fund 3	0.00	100.00					
Fund 4	0.00	100.00					

When Optimization option has been enabled.

There are a number of ways to use this information. In the main table the marginal contribution to tracking error from each fund is shown. Each marginal contribution shows the change to the overall tracking when an additional 1% is invested in that fund (and divested, pro rata, from the other funds). Managers looking for ways to increase/decrease risk in the overall portfolio can use this information to identify the most risk enhancing/diversifying funds. Note also, that if the overall fund of funds blend is assumed

## Style Research

to be efficient, then these marginal contributions will reflect the risk-adjusted preference for each fund. In other words, the higher the marginal contribution, the better the (fund of funds) manager expects the fund to perform relative to the others.

The contribution to total fund variance is also shown (as a value, and as a percentage of overall variance). This data indicates where the bulk of the variance is coming from. It helps to determine how concentrated are the risks in the fund of funds – whether the risk is spread across many funds, or mainly comes from just a few funds.

Depending on whether the focus is on absolute or benchmark relative management, the correlation matrices permit the closer analysis of which funds may blend best with each other. The lower the correlations between two funds, the better diversified the blend between them. In the benchmark relative case, it is not uncommon to see negative correlations between two funds. This suggests that when one fund outperforms the benchmark, the other is likely to underperform. So a fund of funds manager with a list of candidate funds can use the correlation matrix to identify portfolios that have a strong overlap, and those which have complementary risk characteristics.

Finally, when requested, the report returns that combination of funds which has the lowest tracking error subject to any constraints that may have been specified (this option is available in the *Optimization* tab as “*Optimize then Analyze Fund of Funds*”). All the risk data (and any other Style Analysis) will then correspond to this minimum risk combination. Min/Max percentage weight constraints can be set for individual funds or a group of funds (e.g. funds from the same manager).



## 5. Hedge Fund Analysis

### Introduction

Hedge Funds can be defined as portfolios that include stock or cash positions that have been sold short, in addition to long equity holdings and/or cash. This mix of both positive and negative holdings is easy to examine in the Style Research Portfolio Analyzer. This section describes how to load and analyze such portfolios. Hedge funds can be analyzed in much the same way as long only portfolios. Consequently, the main emphasis here is on any significant differences in their treatment.

### Loading Securities

The normal procedures (see Load Funds/Benchmarks) should be followed for loading a portfolio or benchmark. Weights or values may be assigned to each stock, with negative weights or values for the stocks that have been sold short. Care should be taken, however, to ensure that the loaded portfolio is a true reflection of the total capital committed to the hedge fund. For example, suppose a hedge fund consists of \$100 in stock A and -\$100 (equivalent to selling \$100 worth short) in Stock B. If this were the only information loaded into the analyzer, the net asset value ('NAV') of the portfolio would be zero. This would make it impossible to measure a return on this portfolio, let alone any more complex analyses. Fortunately there is a sensible and simple remedy for this, which is to include the portfolio's cash position. Suppose \$400 was committed to this hedge fund. The cash position would then be  $\$400 - (\$100 \text{ longs} + -\$100 \text{ shorts}) = \$400$ . So the loadings file would have the structure of:

Identifier A	Name A	100
Identifier B	Name B	-100
CashUSD	USD Cash	400

or, if weights were used:

Identifier A	Name A	25%
Identifier B	Name B	-25%
CashUSD	USD Cash	100%

By including the full net asset value of the fund in this way, the portfolio's implicit gearing can be taken into account and all the calculations may proceed as normal.

### Analyzer Settings

The portfolio should be selected in the usual way (see Portfolio Analysis Specifications for full details). However, even if the fund's objectives are absolute return and not benchmark relative it is necessary to select a market region and equity benchmark. This is because the opportunity set, from which the hedge fund manager selects stocks, is needed in order to be able to measure style, risk and so on. Without these being defined, concepts such as 'value will outperform' are meaningless. Styles are a relative measure and only have meaning in the context of a market/benchmark.

Once the appropriate region and market have been selected, the user may then choose to run the analysis against the benchmark, or, in the case of an absolute return manager,

cash. The latter may be set by checking the box “Is Hedge Fund”<sup>1</sup> (or toggling that field if in batch mode). Both analyses may be useful. In addition to measuring risk against cash, the “Is Hedge Fund” option breaks out long, short and net positions into a number of output charts, as described below.

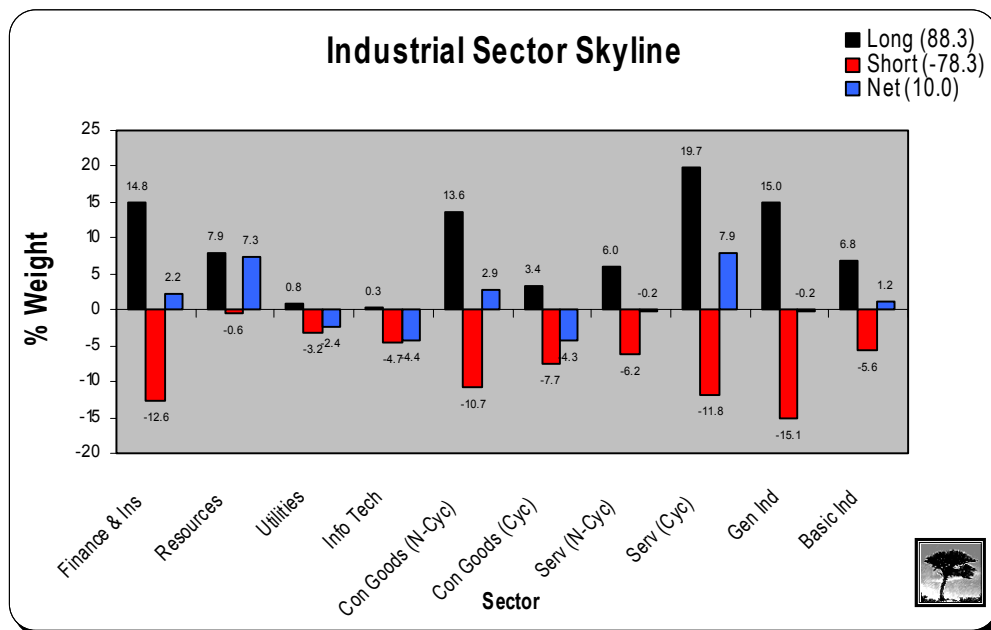
## Interpretation of Output

### Style Skylines

The Style Skyline analysis is unaffected by the “Is Hedge Fund” setting. The tilts are calculated based on the benchmark specified (see the section on Raw Factor Tilts and Short Positions), which takes into account the sign of the holdings. For example, if the benchmark’s average EPS growth is 10%, a short holding in a stock with 5% growth would give a net positive exposure to earnings growth. In this way the Style Skyline charts can be interpreted in much the same way as for long only portfolios.

### Style Skyline within Sectors

The per sector style skylines are also unchanged by the “Is Hedge Fund” setting. However, the Industrial Sector Skyline does depend on this. When this option is selected, the long, short, and net positions (as a percentage of the portfolio’s NAV) are shown for each sector. The chart below illustrates this new chart.



The total long, short and net positions are shown in the top right hand corner of the chart. In this example the portfolio is approximately market neutral, with 88.3% of the NAV in long stocks and -78.3% in shorts. This gives rise to a net equity exposure of 10%. The remaining 90% of the NAV is in cash.

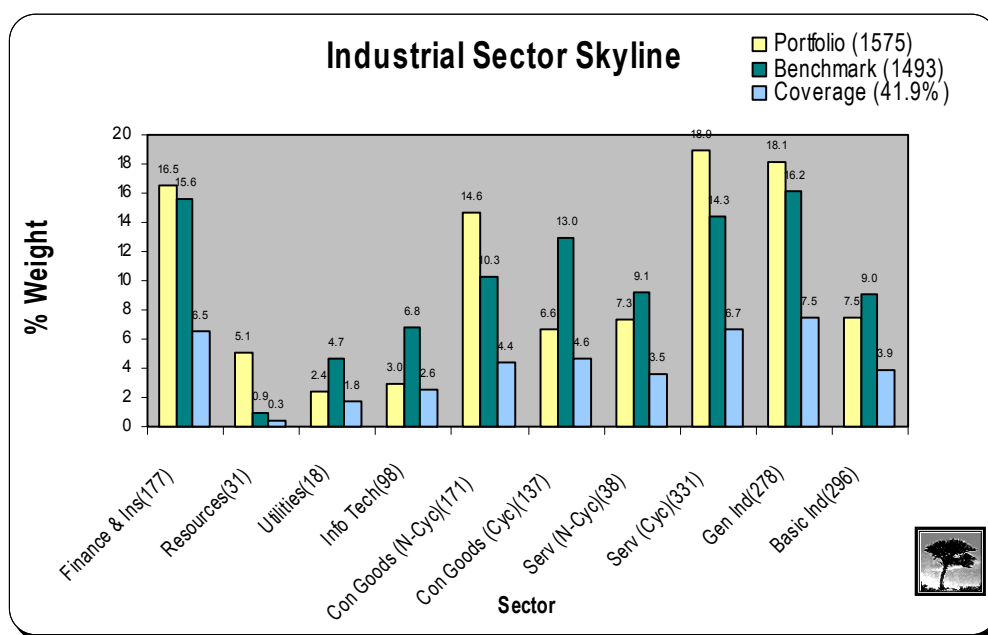
<sup>1</sup> This option used to be termed “Risk against Cash”. Note that a long only manager needing an absolute risk calculation should select this option.

The chart shows that the biggest contribution to the long position comes from the 19.7% in Cyclical Services stocks, whereas the biggest shorts are found in the General Industrials sector<sup>2</sup>. The main contributor to the net position is the Cyclical Services sector. The blue net bars will add up to the total portfolio net position, in this case to 10% of NAV.

This sector compositional analysis is therefore useful for analyzing ‘where the money is’ in a long short portfolio.

When the “Is Hedge Fund” option is deselected the total positions in each sector are shown, along with the weights in the benchmark, and the coverage.

In the case where the portfolio includes short positions, but “Is Hedge Fund” is switched off, the industrial sector skyline shows the ‘activity’ (long plus absolute value of shorts) in each sector as a percentage of the ‘activity’ (long plus absolute value of shorts) across the whole portfolio. So, in the above example, the total aggregate holdings across the portfolio is 88.3% (longs) + 78.3% (shorts) = 166.6%. Within Cyclical Services the aggregate position is 19.7% (long) + 11.8% (short) = 31.5%. Therefore the position shown for Cyclical Services is 31.5/166.6 = 18.9%, as shown in the chart below.

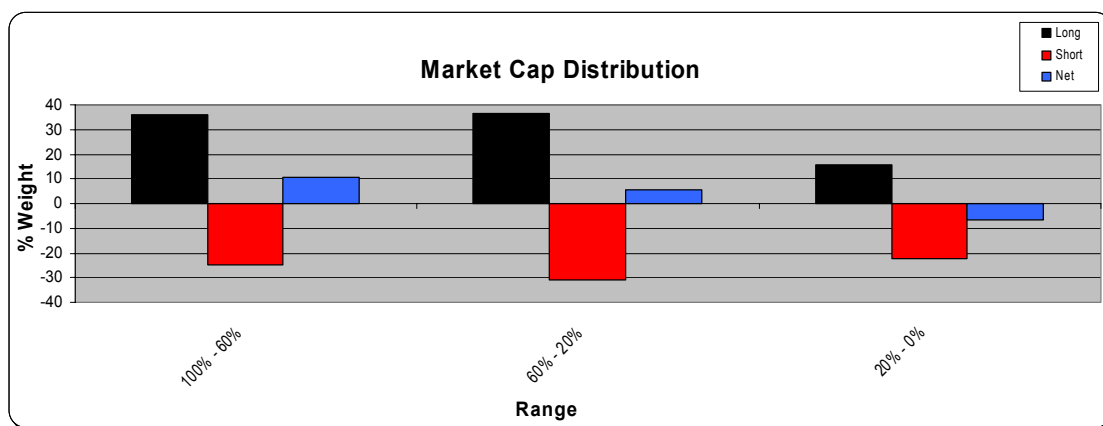


The net positions are not shown in this view. However, when the portfolio is either 100% long, or 100% short, the positions shown are equivalent to net positions.

<sup>2</sup> This example uses FTSE Sector classifications. Note that the Style Research Portfolio Analyzer is also available with MSCI Sector classifications.

**Size/Style Distributions**

This shows the proportion of the portfolio in each distribution band. The chart below illustrates the default case for the size distribution, where the market is split into bands of top 40%( large), next 40% (mid) and bottom 20% (smaller) by size.



The chart permits the user to see the distribution of the longs and shorts within these segments of the market. In this example, there is a net position of around 10% of NAV in the large stock segment, made up of around 35% long and 25% short. The portfolio is net about 6% long in mid-caps, offset by 6% net short in smaller stocks.

If the analysis is run without selecting "Is Hedge Fund", the chart shows the 'activity' (long plus absolute value of shorts) in each band. The calculation is similar to that for the Industrial Skyline, described above.

The Style Distribution is shown in an analogous way. Long, short and net positions are shown when "Is Hedge Fund" is selected, and 'activity' is shown when it is not.

**Active Sector Weights/ Country Weights**

As in the Size/Style Distributions, the charts in Active Sector Weights (and Country weights) depend on whether "Is Hedge Fund" is selected.

When it is switched on, long and short positions are shown per sector in the top chart, and net positions in the bottom chart. The tables show the biggest longs and 'biggest' shorts, and their sector (country) classification. An additional table shows the composition of the cash position (including longs and shorts).

When the option is turned off, 'activity' is shown in each sector (country), along with the benchmark weight and coverage. The second chart shows the difference between the activity and the benchmark weight, and the uncovered (benchmark less coverage) positions per sector (country). As before, when the portfolio is pure long, or short, these reduce to the usual net positions. The table shows the biggest active positions relative to the benchmark.

## **Risk Report/Persistence**

This report is dependent on the “Is Hedge Fund” setting.

The cash rate used is based on the Base Currency chosen for the analysis. Though it is more likely that the main cash position in the fund will be the same currency, this does not have to be the case. Currency hedging is also permitted.

### **a) “Is Hedge Fund” selected**

Tracking error.....Risk vs. Cash  
Components of Tracking Variance ..... Using variance vs. Cash  
Portfolio Beta ..... vs. **benchmark**  
Portfolio Volatility .....Absolute Risk (very close to Risk against Cash)  
Benchmark Volatility .....Absolute Risk of benchmark (**not** cash)  
Correlation .....Portfolio vs. benchmark (**not** cash)

### **b) “Is Hedge Fund” not selected**

Tracking error .....Risk vs. benchmark  
Components of Tracking Variance ..... Using variance vs. benchmark  
Portfolio Beta ..... vs. benchmark  
Portfolio Volatility .....Absolute Risk (very close to Risk against Cash)  
Benchmark Volatility .....Absolute Risk of benchmark  
Correlation .....Portfolio vs. benchmark

The Persistence Report analyses the portfolio against the benchmark unless the “Is Hedge Fund” option is selected. In this case the analysis is versus base currency cash.

## **Stock Level Risk Data/ Risk Decomposition**

If “Is Hedge Fund” is selected, the Benchmark % column shows 100% in base currency cash. In this case all the numbers reported (marginal contributions, contributions to risk etc.) are against cash. If “Is Hedge Fund” is deselected, the benchmark is used for all calculations.

## **Simulated Returns Attribution**

All calculations are relative to base currency cash if “Is Hedge Fund” is selected, and vs. the benchmark otherwise.

## 6. Returns-Based Style Analysis Output

Top-Down Returns-Based Style Analysis represents the Style composition of portfolios from analysis of their returns alone. The technique compares a portfolio's historic returns against the returns of Style-based paradigm portfolios and calculates the combination of these paradigm portfolios that best approximates the returns of the actual portfolio. The derived combination of Style paradigms then gives the portfolio's Style characterization.

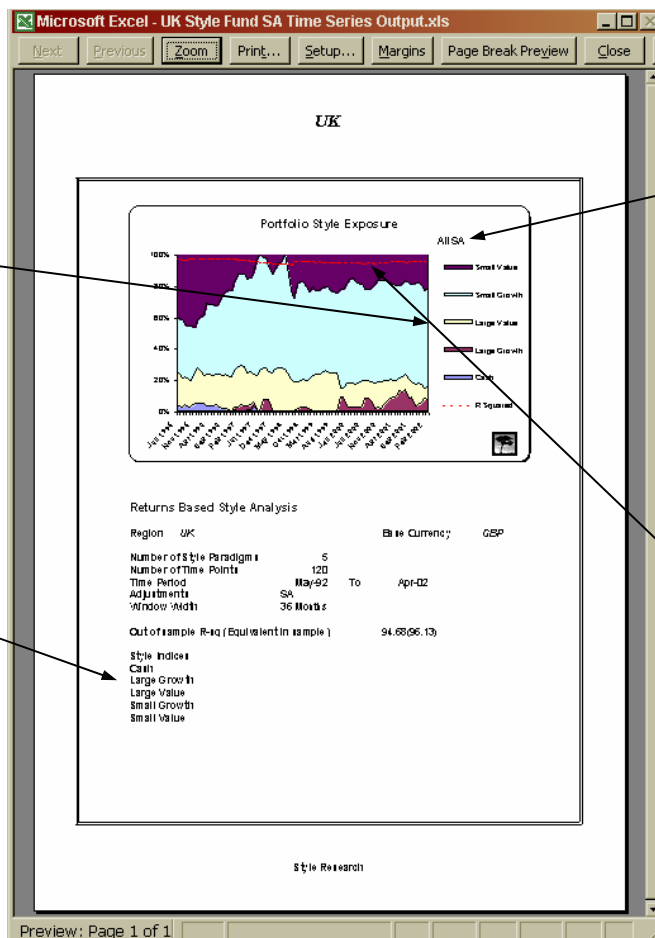
The technique can be used to review and characterize portfolios when only their returns are known ("Top-Down Returns-Based Style Analysis"), or to analyze portfolios according to the performance of the stocks currently held ("Bottom-Up Returns-Based Style Analysis"). In this latter case, constructed returns series, relating to the current holdings of portfolios, are provided in the *Time Series* worksheet of the output file of all Holdings-Based Style Analyses. This data may then be analyzed directly using the Returns-Based module in exactly the same way as genuine portfolio returns histories.

### Style Graph

If "Returns-Based Analysis" has been selected as one of the Time Series outputs, the output will contain a Style Graph sheet similar to the example shown below. This will show the evolution of the Portfolio Style Exposures over time using the rolling window defined in the analysis (the default analysis uses 3 year rolling windows of monthly returns, as in this example). The last time point on the very right of the graph shows the Style exposures from the latest rolling window.

The portfolio return is attributed mainly to Small Growth although Small Value also explains some of the return profile. We can also see that the portfolio has also maintained a fairly consistent pattern of style bets over time.

In this analysis, four sector adjusted indices, plus a Cash index, were selected as the Style paradigms which were then regressed against the monthly portfolio returns over the past 10 years (minimum is 12 months).



CASA, CA or SA indicates that the selected Style Paradigms are based on Style attributes relative to a company's peer group i.e. relative to Sector (SA), Country (CA) or Country and Sector (CASA). These Adjusted Paradigm indices are calculated by Style Research and are available for 53 markets and 9 regions.

The **R-Squared** (broken red line) statistic is a goodness-of-fit statistic and is also shown over all available rolling periods based on the selected window width. In this example we can see an extremely good model fit over the entire history.

The In-sample and Out of sample R-squareds are calculated over the entire period. See Appendix 1 for definition.

## Style Research

The four Style Return Time Series choices in the Style Research Portfolio Analyzer (Large Growth, Small Growth, Large Value and Small Value) are provided in Sector, Country and Country and Sector adjusted forms. It is often useful to repeat an analysis using the adjusted versions of the Style paradigms as well as the Standard Style Paradigms (or vice versa). Standard analyses, although used widely, often conceal the true nature of the investment management process of the fund manager under review. For example, some fund managers look for Value oriented companies within Sectors (or within Global Sectors for international portfolios) or within countries. Running an analysis using Style indices or paradigms which are not adjusted for countries or sectors (or both) may be inappropriate for the correct interpretation of the historic returns delivered by such an investment process. Repeating an analysis using adjusted paradigms (which are included in the Analyzer across 53 countries and 9 major regions) can often reveal a different profile and often with higher statistical significance.

Customized Style paradigms can also be created using the Web tool "Style Research Online" and loaded directly into the Returns Based module for inclusion in analyses. For example, tailored Style indices can be created for Small Cap segments of the market (e.g. the smallest 10% of the US market) which can then also be Sector or Country adjusted. Style indices can also be customized to exclude certain Sectors e.g. Ex Financials, or to create bespoke regions e.g. EAFE ex UK. Of course returns series from any other source can also be used in the analyzer as Style paradigms e.g. monthly returns from an index provider.

### Return Data & Statistics

The Return Data sheet in the Returns-Based Analysis output summarizes all of the returns used in the analysis including those of the selected Style paradigms. All moving model window Style exposures are also explicitly given along with the Style Weight T-Statistics, the R-squared, Prediction errors, Convergence Status and Function Values. (See *Appendix 1* for definitions of these terms.)

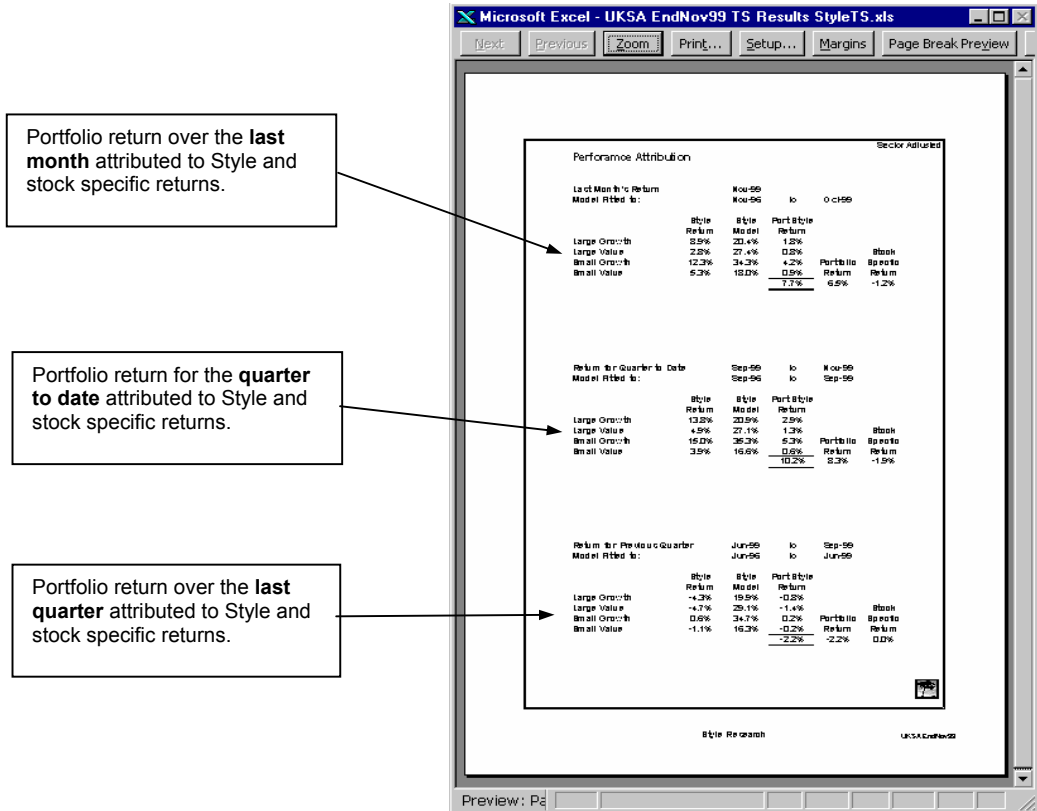
While the *Style Graph* sheet shows Style Weights for each rolling window, the top part of the *Return Data* sheet also shows results fitted to the entire time period using three regression models. While the models shown in the Style Graph have coefficients that are positive and sum to 100%, these constraints are relaxed in two of the three models shown in this table. In the first model, *Unconstrained*, all restrictions are dropped and in the second model, *Constrained*, the positive coefficient constraint is dropped. This is relevant for hedge fund analysis. The third model, *Constrained and Positive*, is the same model used for the Style Graph (if the hedge fund option is not selected), but calculated over the entire period. The T-Statistics for each of the Style Weights in each of the three models are shown to the right and each model's R-squared is shown below the Style Weights.

The weights underlying the Style Graph for each moving window model are also shown explicitly in a table. The rolling window information is also useful to identify systematic or market phase related performance characteristics. The associated Style Weight T-Statistics are shown in the table below and is useful to see which weights are statistically significant and to see how this changes over time.

The *Convergence Status* row in the Return Data sheet shows whether a solution has been found for each rolling window model. The *Function Value*, shown below the Convergence Status in the Return Data sheet, is another practical indicator as to whether a solution should be used or ignored. We can regard a Function Value (which is a variance calculated using predicted versus actual monthly returns) of below 5 as being "good". Between 5 and 10 is acceptable but greater than 10 would generally cause us to disregard the solution for that particular moving window.

## Returns-Based Performance Attribution

The *Performance Attribution* sheet shows the portfolio return attributed to Style and stock specific components for three time periods: the last month, the quarter to date, and the last quarter. For each period the weights from a  $n$  month time series model (where  $n$  can range from 12 to 60 months – 36 months is the default) and the actual Style returns are used to predict the portfolio return over the time period. For example, if a Portfolio's Large Value Style exposure is 20% and this Style returns 10% (for the given period) then we attribute 2% of the portfolio's return to its Large Value exposure. The sum of all such Style returns provides the Portfolio's Style return. The difference between the Style return and the portfolio's actual return is attributed to stock specific return.



## Fund of Funds Reports (Returns-based)

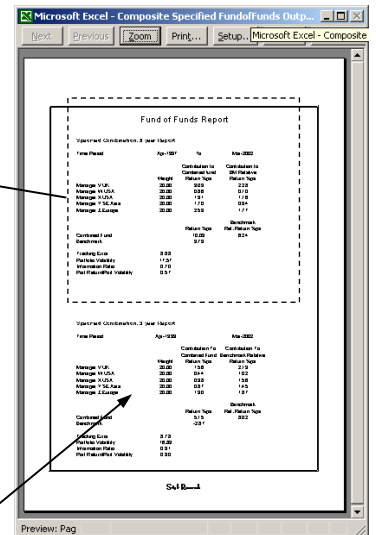
By selecting two or more funds as Time Series Portfolios and then selecting Returns-Based Analysis it is possible to generate many individual fund analyses in a single batch. However it is also possible to view these multiple Time Series Portfolios as a composite or fund of funds which can then be analyzed as a single combined fund. The weights of each fund in the composite can be specified by the user, or the analyzer's Fund of Funds Construction optimizer can be used to determine an optimal set of weights to minimize risk, i.e. Tracking Error, against a specified benchmark. The benchmark itself could be a fund of funds or composite and can also include any return series imported by the user.

### Specified Weights

If *Fund of Funds Specified Weight* was selected in the Analyzer a new fund of funds returns series will be created, using the weights specified by the user applied to each set of monthly returns. The report will show the return characteristics of the fund of funds over the last 5 years and the contribution to performance (absolute and relative to the benchmark) from each of the constituent funds. For the combined fund of funds the report also shows : Tracking Error, Absolute Volatility, Information Ratio (Annualized relative return divided by Annualized Tracking Error), and the Absolute Return divided by Portfolio Volatility (a Return/Risk ratio similar to the Sharpe Ratio). The analysis is repeated for the most recent 3 year period.

This report can be useful to summarize characteristics of a current Fund of Funds or to allow "what-if?" analysis where alternative scenarios can easily be created and compared.

Fund of Funds Report			
Specified Combination, 5 year Report			
Time Period	Apr-1997	To	Mar-2002
		Contribution to Combined fund	Contribution to BM Relative
	Weight	Return %pa	Return %pa
Manager V UK	20.00	3.03	2.28
Manager W USA	20.00	0.86	0.10
Manager X USA	20.00	1.91	1.16
Manager Y SE Asia	20.00	1.70	0.94
Manager Z Europe	20.00	2.53	1.77
			Benchmark
		Return %pa	Rel. Return %pa
Combined Fund		10.03	6.24
Benchmark		3.79	
Tracking Error	8.88		
Portfolio Volatility	17.57		
Information Ratio	0.70		
Port Return/Port Volatility	0.57		



The top half of the report shows results for the last 5 year period (provided the history is adequate). In addition, the lower half of the report repeats the analysis for the most recent 3 year period.

### Optimized Weights

If *Fund of Funds Optimized Weight* was selected in the Analyzer, the Fund of Funds Construction Optimizer will find the set of weights which provides the lowest Tracking Error against the benchmark. A new fund of funds return series will be created using these weights. The Fund of Funds Report will appear identical to the example above but based on the minimum risk combination weights rather than weights specified by the user.

This analysis is useful for suggesting constituent weights in a fund of funds. The optimizer can also suggest whether it is worthwhile including a candidate fund (or funds) into an existing fund of funds. The analysis may reveal that fewer funds are required than previously thought to adequately represent a benchmark or that the inclusion of an additional fund, say a hedge fund or a particular Style oriented fund, could significantly improve the desired benchmark fit. Note that the benchmark could be market or index returns, Style composite portfolios or even competitor fund performance.

## Style Research

Either of the Fund of Funds Reports described above can be created without having to run any Returns-Based Style analysis. However, if one of the “*Returns-Based Analysis Fund of Funds.....*” options is selected, a Returns-Based analysis output will also be created for the fund of funds in exactly the same way as described earlier for a single portfolio time series. The output analysis will be combined into one workbook.

### Funds Data Sheet

The *Funds Data* sheet is included with any Fund of Funds Report. The output will include two correlation matrix tables. The top matrix shows the performance correlation coefficients, based on total monthly returns, between all constituent funds as well as the fund of funds and the benchmark. The bottom matrix is the same but uses benchmark relative returns.

The *Funds Data* sheet also provides a summary of all of the monthly returns used in the analysis including all constituent funds, the benchmark and the fund of funds.

### Volatility Report

A *Volatility Graph* sheet can be created by selecting Volatility Report in the Analyzer. This will be included in the output if a Returns-Based analysis is also selected.

All volatility calculations are based on monthly returns over 3 years. The graph shows the rolling 3 year volatilities.

