

PORTFOLIO RISK MANAGEMENT SYSTEM - (PRISM)

PORTFOLIO HOLDINGS

This module shows the actual and relative holdings in a Portfolio and Benchmark, either in terms of the individual holding values in base currency, or in terms of percentage weights. It also allows the individual Portfolio holdings to be edited or deleted.

The User also has the option of adding other stored information, such as stock betas from a risk model, or user defined stock characteristics, to this report.

PORTFOLIO RISK ANALYSIS

The User begins by selecting a Portfolio, a Benchmark and a Risk Model. This module then offers four options : -

1. The **Summary** analysis shows the risk of both the Portfolio and the Benchmark in absolute terms, as well as the tracking error of the Portfolio relative to the Benchmark.

These risks are expressed in terms of the Variances and their corresponding Standard Deviations, and as percentage contributions from factor risk and stock specific risk.

The **Summary** analysis also shows the absolute and relative risks of the Portfolio in terms of Systematic (Benchmark-related) and Residual (Benchmark-independent) components, and gives the beta of the Portfolio to the Benchmark.

The **Summary** Holdings Analysis shows the number of holdings in the Portfolio and Benchmark, and calculates the Active Share and Deadweight proportions.

The final section of the **Summary** report is the VaR Analysis, which gives various Value at Risk measures for the Portfolio and Benchmark.

2. **Risk Analysis by Holdings** shows the risk structure of the Portfolio in terms of the contributions from the individual stock holdings. It shows the Percentage Holding and Stock Risk of each security in the Portfolio, as well as its Correlation with the Portfolio.

It also shows the Actual, Percentage and Marginal Contributions to Risk from each holding, and finally, the Beta of the Stock to the Portfolio.

While the Percentage Contributions to Variance show how big the bets are from each holding, the Beta shows how extreme the bet is relative to the Portfolio as a whole.

For example, a 5.0% holding contributing 5.0% of the Portfolio risk is a big bet, but no more extreme than the Portfolio as a whole, whereas a 2.5% holding contributing 5.0% of the Portfolio risk is clearly a more extreme bet, since it is contributing twice its 'fair share' of risk to the Portfolio. For efficiency, the more extreme bets should be on the manager's favourite stocks, i.e. those with the highest expected returns.

- 3. Risk Analysis by Risk Model** shows the risk structure of the Portfolio in terms of the contributions from the various factor bets and stock specific bets. It shows the Portfolio Betas on each factor and the Factor Risks, as well as the Correlation of each factor with the overall Portfolio. It also shows the Actual, Percentage and Marginal Contributions to Risk from each of the factor exposures.

As with all reports in PRISM, this analysis can be sorted high-to-low or low-to-high by any of these items, thereby making it very easy to identify which are the largest factor bets in the portfolio, in either absolute or relative terms.

The contribution to overall Portfolio risk from Stock Specific risk is given in the summary rows at the bottom of the report, as are the overall contributions from the combined factor risks in the Portfolio.

- 4. Risk Analysis relative to the Benchmark** shows the risk structure of the Portfolio in terms of contributions from both Systematic and Residual risks relative to the selected Benchmark.

It shows the Percentage Holding of each security in the Portfolio, as well as the stock's Beta to the Benchmark, its Residual Risk and its Total Risk.

It also shows the Actual, Percentage and Marginal Contributions to Systematic, Residual and Total Risk from each holding.

INDEPENDENT BETS

While the Risk Analysis by Risk Model will show how much risk is coming from the exposure to each factor in the risk model, it is often the case that many of these factors are correlated with each other. It is therefore interesting to examine how many Independent Bets there are in a Portfolio, a Benchmark, or a Portfolio relative to a Benchmark.

This is done by performing a Principal Components analysis on the risk structure of the portfolio, and hence deriving combinations of the factors, weighted by the appropriate portfolio betas, that are truly independent of each other. With a K-factor risk model, this analysis will generate K+1 Independent Bets which span the total risk of the portfolio.

One of these bets, obviously, will be the Stock Specific Risk of the portfolio, which is always independent of the factor bets. The most interesting aspect of the result, however, is that the Independent Bets are arranged in descending order of size, and managers are frequently surprised to learn that the majority of their risk, or tracking error, is actually coming from a very small number of Independent Bets.

REVERSE OPTIMISATION

This analysis uses the fact that, in an efficient Portfolio, the contribution to expected return from a holding (or factor) must be proportional to its contribution to Portfolio risk. In an efficient Portfolio, risk is traded off against expected return systematically.

Given a set of Portfolio and Benchmark holdings, and a Risk Model, Reverse Optimisation can therefore be used to derive the Implied Returns required for efficiency. The User can set the Portfolio, Benchmark or Relative expected returns, and the Risk Aversion parameter, to produce any of the (infinite number of) possible solutions.

However, the most valuable aspect of this analysis is the Implied Ranking of securities (or factor exposures) in the Portfolio. A very practical and sensible definition of efficiency for non-quant Portfolio managers is that the Portfolio risk structure should accurately reflect their views on the relative attractiveness of the different stocks held in the Portfolio.

The User begins by selecting a Portfolio, a Benchmark and a Risk Model. In addition, the User has the option of assuming that either the Portfolio is efficient, the Benchmark is efficient, or the Portfolio is efficient relative to the Benchmark (even though, in this last case, neither the Portfolio nor the Benchmark may be efficient in absolute terms).

In the first two cases, the analysis will automatically include all stocks held in either the Portfolio or the Benchmark, and once the Implied Returns have been derived, the report will show the results for both the Portfolio and the Benchmark. Thus, if the User assumes that the Benchmark is efficient, the result will also give the Implied Returns for the stocks in the Portfolio, and for the Portfolio itself (and *vice versa*).

This module offers three main options : -

- 5. Reverse Optimisation by Holdings** derives the Implied Returns for each stock held, either by assuming that the Portfolio is efficient, that the Benchmark is efficient, or that the Portfolio is efficient relative to the Benchmark.

It shows the Percentage Holding of each security, its Risk, its Correlation with the Portfolio and its Beta to the Portfolio. It also shows its Implied Return, and the Return/Risk trade-off for each holding. The Summary rows at the bottom of the report give the corresponding values for both the Portfolio and the Benchmark.

Sorting the holdings high to low by the Implied Returns will generate the Implied Ranking of securities; managers can compare this order to their own assessment of the relative attractiveness of the individual securities to see how efficiently the portfolio composition is reflecting their (possibly non-quantified) own views.

- 6. Reverse Optimisation by Risk Model** derives the Implied Returns for each factor in the Risk Model, as well as the total Implied Alpha, either by assuming that the Portfolio is efficient, that the Benchmark is efficient, or that the Portfolio is efficient relative to the Benchmark.

It first shows the Portfolio Beta on each factor, and the factor risk. It then shows the Contribution to Portfolio variance from each factor exposure, the Implied Return (or Risk Premium) for each factor, its corresponding contribution to the overall Portfolio return and, hence, the Return/Risk trade-off for each factor.

The Summary rows at the bottom of the report give the corresponding values for all the factors combined, as well as showing the contribution from Stock Specific risk and the Implied Alpha for the Portfolio.

- 7. Black-Litterman analysis** : This is a special case of Reverse Optimisation, in which it is assumed that the Benchmark (in principle the Global Market portfolio) is efficient, and that the User wishes to combine the Implied Equilibrium Returns with their own Expected Returns, which have known estimation error properties.

MACRO-ECONOMIC EXPOSURES REPORT

Portfolio managers often ask what the exposure of their portfolio is to Macro-Economic variables such as term spreads, credit spreads, commodity prices, inflation, and so on. We do not normally use such variables as factors in a stock risk model because the strength of the relationship between them and individual stock returns is usually so weak that they fail most statistical significance tests. We therefore determine portfolio exposure to these kinds of variables by a different method.

Any number of Macro-Economic variables can be included in the Universe of securities covered by the CHRM. They will usually not be given priors, but they will be regressed on the risk model factors in the same way as stock returns.

Since the risk model factors are themselves often diversified portfolios of securities (e.g. Country, Industry and Statistical factors), the Macro-Economic variables will get a set of non-zero (i.e. statistically significant) betas to some of the factors, and, of course, they will also have a Specific Risk. PRISM can then determine the exposure of any portfolio to any of these variables, in the same way as we calculate the beta of a portfolio to any benchmark.

In the Macro-Economic Exposures report, the User specifies a portfolio and benchmark, and any number of the Macro-Economic variables covered by the CHR. The report then shows the beta (exposure) of both the portfolio and the benchmark to the variable, and their corresponding R-Squareds, as well as the relative beta.

This report neatly summarises the extent to which the performance of a portfolio relative to its benchmark may be driven by differing sensitivity to changes in some Macro-Economic variable.

PERFORMANCE ATTRIBUTION AND PERFORMANCE ANALYSIS

This analysis combines a portfolio's risk characteristics at the beginning of a period with the factor returns over the period to produce a risk-adjusted analysis of portfolio return.

The analysis is given in terms of contributions from the portfolio's exposure to each of the factors in the risk model, and from the portfolio alpha. By running this analysis over a number of periods, the manager can identify the main drivers of the portfolio's performance, as well as their consistency.

The User supplies the actual returns for the Portfolio (and Benchmark, if required) in the form of NAVs (or Index Values for standard Benchmarks). If there are Cash holdings, it is also possible to store Interest Rate series, in order to calculate the contribution to return from the Cash holdings.

Various reports will show the Date ranges available for this analysis, the Portfolio Betas at the beginning of each period, the Factor Returns over each period, the actual Performance Attribution for each period, including the contributions from each factor, from any Cash holding and from the Portfolio Alpha, and a Performance Analysis which summarises the results over the whole sequence of periods.

Needless to say, there are also a very exciting set of charts which depict the various contributions to return over time.

PRISM TECHNICAL REQUIREMENTS

SOFTWARE

PRISM requires the following (fully patched) software to be installed:

Windows 2003

IIS6

Excel 2007

Microsoft .NET runtime v3.5

MySQL database

R-Squared will provide licenses for all of the above for Option 1 below. Option 2 requires the client to provide these licenses, with the exception of MySQL, which R-Squared will supply as part of the PRISM package.

HARDWARE

The PRISM system is web-based and thus needs to be hosted on a suitable web server. Our recommended hardware and software setup is a dedicated web server running Windows Server 2003 and IIS6 with at least 2GB of RAM and 80Gb of hard drive space, split 20Gb and 60Gb between C and D partitions respectively.

There are 2 main hosting options :

- 1) **On a dedicated R-Squared remote server;**
- 2) **On a client provided server with R-Squared having full *http* and remote desktop access.**

Option 1

Normally R-Squared will provide a remote server to host the system, available over the Internet and securely accessed by HTTP over SSL. FTP is provided to obtain batch reports.

This configuration allows R-Squared to automatically update your Risk Model and stock data on PRISM. (Note - this stock data will include any data used to create the risk model, such as market capitalisation, industry code, active factor data, etc.).

PRISM software updates are also applied automatically, and R-Squared will provide Excel 2007 on the server for the purposes of producing batch reports. If you wish, R-Squared can also take regular backups of the PRISM database and store them offsite.

Option 2

Alternatively, you may wish to host the software on your intranet. If full remote access is provided to R-Squared then this configuration is essentially the same as the first option.

Risk Model data is updated automatically and software updates are applied seamlessly. If you wish to produce reports using PRISM's batch functionality, you will need to install Excel 2007 on the server. You will also need to provide HTTP access to R-Squared's license server.

Hosting Option	Regular Software Updates	Automated Risk Model Updates	Online troubleshooting	Offsite data backups	Excel 2007 provided	License Server access required
R-Squared Server	Yes	Yes	Yes	Yes	Yes	No
Client Server with Remote Access	Yes	Yes	Yes	Yes	No	Yes