

**imas**

INVESTMENT MANAGEMENT  
ASSOCIATION OF SINGAPORE

# Guiding Principles for Investment Risk & Performance Analysis Functions

IMAS BEST PRACTICE GUIDANCE

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# 1. Introduction to the Guidance

## 1.1 Introduction and Purpose

Investment management firms manage and undertake investment risk on behalf of their clients and owners in order to generate investment return. It is therefore critical to the effective management of these organisations that they are able to calculate, analyse and act upon information about the investment risk and return of their products.

Similar to any manufacturing or production process, at the minimum, the process undertaken to create and manage an investment portfolio should be documented. There should be clear definitions around the process and the methodologies employed within, that can assure stakeholders in this process that it is operating as per expectations. Where there are deviations from expectations, these deviations should be proactively understood. The outcome of the process (realized performance or volatility) should also be reviewed periodically in order to provide feedback and refinements to the underlying process.

Unfortunately, largely due to legacy, business structure and internal processes, the lack of consistent client and regulator demands or simply the sheer cost and operational efficiency needed to maintain such a review and feedback process, there are significant inconsistencies amongst investment management firms in the investment risk and performance functions that they undertake.

The Guiding Principles for Investment Risk & Performance Measurement Functions (“Guidance”) seeks to address this issue by providing investment management professionals in Singapore with a set of guiding concepts, principles or best practices to be considered when establishing, developing or reviewing the risk and performance function in an investment management company. **This document is by no means comprehensive, neither does it seek to prescribe or delve into the technical specifications of calculations. Instead, it has been produced by the IMAS Risk and Performance Committee (“RPC”) as a baseline document to help develop the dialogue amongst investment professionals and in particular, risk and performance practitioners inside their organisations and across the industry in Singapore to improve the consistent application of best practices in this area.**

The document acts in concert with well-established standards, such as the Global Investment Performance Standards (“GIPS”), to provide a general roadmap for risk and performance professionals with oversight responsibilities, to strengthen their functional capabilities and build a best-in-class unit.

## 1.2 Scope and Approach

In this initial guidance, the IMAS RPC identified that governance, both of investment companies and the investment process, was as critical to discuss as the areas of investment risk and performance measurement.

Therefore, the Guidance is structured around introducing the key concepts necessary for good investment risk and performance in three (3) broad and generic areas:

- Governance
- Investment risk management
- Performance Analysis

## 2. Governance

An effective investment risk and performance function acts as a control function as well as a service function of the firm. Therefore, governance of both how the function fits into the organisation structure as well as the activities of the function are critical to the success of that function in discharging its duties and supporting the need for both control and reporting in an investment management firm.

The key areas of responsibility for the unit in an investment manager include, but are not limited to:

- Performance measurement, to accurately and consistently measure returns and ex-post risk indicators of *all* portfolios;
- Performance attribution, to explain the impact of investment manager's decisions and strategies on the return (and risk) of the portfolio;
- Investment manager, product and business investment performance appraisal, by providing information and analysis to key internal and external stakeholders;
- Investment risk measurement (including ex-ante risk analysis);
- Technical input into product analysis, Investment policy documents, Investment Manager Agreements, prospectus / offer documents; and
- Operational oversight over providers, including back-office, middle-office and vendor relationships, e.g. pricing, accounting treatment and classifications.

The unit thus plays a critical role in the overall information flow in the investment manager, being one of the only functions that can effectively see the “end-to-end” flow of data from trade to final investment presentation. This breadth of scope and need to be unbiased in discharging its function is why the unit needs to operate in a controlled setting, with clear governance over the unit, thus providing independent governance over various activities of the investment manager.

### 2.1 Governance of the Risk and Performance Unit

The unit should sit independently of the investment function and other related functions (including marketing, client services, and product), so as to be able to effectively discharge its oversight and information support duties. The unit also needs to sit at a senior enough level within the organisation to support the need for independence and lack of bias in its discharge of its duties. In many firms, therefore, the unit can report to a Chief Operating Officer or a Chief Risk Officer, to allow for arms-length dealing with the various businesses in the investment management firm. In the absence of the posts existing at a senior enough management level, the function could report directly to the CEO.

In some firms the investment risk function is separate and distinct from the investment performance function. There is no agreed conclusion as to whether separation is optimal, and this is seen as dependent on the specifics of each investment firm's own structure and resources. However, it is accepted that there is a need for consistencies and scope for synergy between these two functions, particularly in the area of mapping, monitoring and understanding the investment process. It has also been accepted that the production and calculation of metrics needed to support both risk and performance functions require potentially different skills from those needed to effectively interpret and communicate this analysis to other functions.

It is important that the unit establishes operational service level agreements within the investment management firm, to ensure appropriate workflow, management of production activities, as well as change requests mandated by internal and external stakeholders. It may not be feasible in smaller investment management companies to have in place a full framework as mentioned, but this is desired as a best practice for the company to strive to, especially as it grows in size and / or complexity.

## 2.2 Governance within the Risk and Performance Unit

The unit provides an independent (of the investment team or specific investment manager) source of governance for the investment management firm to understand its exposures, concentrations, strategies from an investment risk and performance perspective, which ultimately has far-reaching benefits for the business of the investment manager.

The unit should advocate and promote internally the adherence to best practices in how risk and performance is calculated and presented, including standards promoted by key industry bodies (such as IMAS), codes of conduct, such as those provided by the CFA Institute, and rigor in the provision of the risk and performance analysis.

The unit should provide input into the design and ongoing maintenance of policies across the organisation, including product definitions, investment manager agreements, risk guidelines and operational frameworks to support the various businesses in the investment manager.

The unit therefore should seek to create internal structures that ensure its technical insight is leveraged as a key value added function in the company, ultimately securing the ambition of the investment manager to grow the business through Assets Under Management (AUM) in an appropriately managed, risk-aware and risk-controlled manner.

## 3. Investment Risk Management

Investment risk management plays an integral role in proactive portfolio management and its focus is expected to go beyond traditional ex-post reporting. It involves consideration of economic exposures and relevant portfolio characteristics to identify, measure and monitor the sources of risk.

### 3.1 Investment risk should be independently measured and monitored

Whilst it is best practice for an organisation to embed the notion of risk management broadly at all levels, with specific focus on senior management understanding the business risks in abnormal markets, it is now a fundamental expectation across the industry that investment managers have processes by which investment risk in portfolios is independently measured and monitored. To be clear, in many firms, there is the role of investment strategist or an investment risk professional who operates as part of the investment team. This is deemed by some as best practice and has not been disputed as adding value in organisations that have such a structure. However, it is key to distinguish between this function and its benefits and the need for independent oversight of the portfolio management process as a whole.

### 3.2 Portfolio and Execution Risk Controls

Execution control is a key component of Investment Risk Management. Various limits can be applied or may be specified in an investment management agreement. For example such limits could include counterparty risk limits or stop-loss limits. Limits or Key Risk Indicators can also be set for the risk analytics set out below to monitor the alignment of risk versus appetite, and, or investment style.

### 3.3 A variety of risk analytics should be used

Risk analysis which relies solely on a single or limited number of statistics can prevent a holistic risk profile of a portfolio from being built. Indeed, a key issue highlighted in the aftermath of the Global Financial Crisis was the over-reliance upon a single risk measure, VaR, as a proxy for a total risk management framework.

Examples of risk analytics which could be appropriate are set out below. However, it is important to note that the most relevant set of risk statistics will differ by portfolio, and these should be discussed and agreed by both the investment and the risk management teams.

There is a need to appreciate that both risk analytics relevant to the investment strategy and identified by the portfolio manager, as well as generic risk analytics, are necessary to ensure that the firm does not focus only on the risks they believe are relevant, and therefore avoid “tunnel vision” from a risk perspective.

### **3.3.1 Value at Risk (“VaR”) and Conditional Value at Risk (“CVaR”)**

VaR and CVaR aim to describe the expected potential loss of a portfolio (set of portfolios) over a specified time horizon at a pre-determined probability. CVaR is a complementary measure to VaR, providing an estimation of how much we could lose, on average, if the portfolio losses exceed our VaR estimation.

Given that there are a number of approaches to calculating these numbers, deciding upon the appropriate models for different strategies is key. For example, where portfolios exhibit greater levels of non-linearity, it is a best practice to adopt a Monte Carlo framework. Aligned with model choice is the choice of appropriate timeframe for measurement of VaR and CVaR; the time horizon should correspond with the investment strategy, especially with respect to the inherent expected volatility and turnover characteristics.

### **3.3.2 Percentage and Marginal Contribution to Active / Total Risk**

The contribution to active / total risk in both marginal and percentage terms is effectively an attribution of the overall market risk of a portfolio, typically measured as tracking error or volatility. The decomposition of risk is performed in an ex ante framework, and can be split by multiple categories, depending on the model choice and / or the investment strategy. For example, the decomposition of tracking error for an equity portfolio can be performed according to the Global Industry Classification Standard (GICS) sectors, while the decomposition of volatility of a bond portfolio can be performed by maturity or duration bands.

This risk decomposition also provides a quantification of overall common factor risk and specific risk in the portfolio (and the relevant benchmark), and the contribution from each attribute in the portfolio decomposition. It can be normalised to a percentage form such that direct comparisons can be made (and the numbers added up), or in a marginal manner so that the impact of a change in the position by a certain amount (typically 1%) can be quantified, to assess sensitivity.

### **3.3.3 Portfolio Characteristics**

Portfolio characteristics may differ depending on the type of investments. For equity portfolios, P/E, P/B, dividend yield and other financial ratios could be viewed while fixed income portfolios should be viewed along the likes of duration, spread duration and yield. The portfolio characteristics should be viewed and aggregated by security attributes that facilitates an understanding of the sources of risk along the lines of currency, country and sector. For fixed income portfolios, additional attributes like key rate, maturity bucket and yield bucket are used.



### 3.3.4 Factor Attribution

The use of risk factors is a common approach among practitioners to manage the sources of risk in the portfolios. Types of risk factors include fundamental, statistical and macroeconomic factors, and differ by portfolio type. For example, equity portfolios might consider portfolio exposure by country, sector, and market capitalization, whilst fixed income portfolio exposure is frequently understood through intuitive factors that relate the portfolio's duration and spread duration to interest rate and spread changes. DV01 and spread DV01 are examples of such analytics. In addition, it is important to understand the duration across the key rates for all currencies, as well as spread risk across all currencies, sectors and ratings.

### 3.3.5 Style Analysis

In equity portfolios, besides the usual schema that aggregates the portfolio exposure by country and sector, some practitioners use style analysis to measure and manage the portfolio's major exposure to styles such as growth, value and momentum. The style analysis quantifies the sensitivity of the portfolio to changes in growth, value and momentum factors. Note that the use of market / vendor driven definitions may not be commensurate with the actual investment process, and hence it is key to define the style factors collaboratively with the investment manager(s) to ensure consistency with the investment process.

## 3.4 Risk Concentrations should be Understood and Analyzed

Monitoring the sources of risk can be useful in tracking and managing concentration risk which affects the portfolio in several ways. Concentrations in certain instruments may hurt the portfolio in times of stress and make liquidation costly and difficult. Concentration risk exists not only within the portfolio or strategy, but also across the firm's portfolios using the same strategy. It is best practice to link this back to section 3.2 in terms of the setting of risk limits, taking into account counterparty exposures as well.

Hotspots are identified not only through the portfolio's exposure to risk factors, but also through their risk contribution to the portfolio. The exposure in dollar terms and in relative terms within the portfolio and across the firm's portfolios provides insight into the concentration risk of each investment and risk factor. When evaluating the holdings of a bond across the firm's portfolios, the assessment should consider how much the firm holds as a percentage of issuance outstanding. When examining the holdings of a stock across the firm's portfolios, it is recommended to identify not only how much the firm holds as a percentage of market capitalization, but also as a percentage of free float adjusted market capitalization.

## 3.5 Portfolios should be Subject to Regular Scenario Analysis and Stress Testing

Scenario analysis and stress testing, while different in approach and scope, are highly intertwined. Scenario analysis reprices a portfolio using changes in market factors, such as equity market moves, yield curve changes, and currency fluctuations, experienced in historical scenarios. By contrast, stress testing uses pre-determined

changes to market factors, either in isolation or in conjunction with one another – the key difference being that the tests can consider the correlations between factors or perform them on an uncorrelated basis.

Since the Global Financial Crisis, investors, managers, and regulators the world over have become more focused on the impact on their portfolios of a stressed market environment, and the ensuing impacts to the wider financial system. Normal market assumptions need to be augmented with extreme market scenario analysis. This has also meant that the variables and assumptions used in the risk models have needed to be stressed as well, to ascertain their applicability, appropriateness and stability.

Stress testing should also be conducted not just on market factors but should include other factors, such as liquidity, to provide a more holistic view of risk. Aspects such as trading volumes, bid-ask spreads, volatility, investment structures (for example fund gates) should all be modelled in a range of plausible yet extreme scenarios. The techniques should be performed in a regular continuous cycle, with appropriate feedback into the investment process, starting with the setting of the objectives themselves. Regular model reviews including the list of scenarios to be tested, should be discussed and reviewed for relevance and rigor at the risk committee level.

It is also highly recommended that the CIO and the front office as well as the board of the investment manager set forth key scenarios that will impact the business, and measure these risks including liquidity, in a regular senior forum. This will allow the business to not just react to markets in times of stress, but to be able to proactively manage the business (such as expansion, new markets, product launches and terminations).

### **3.6 Portfolio and position liquidity risk should be measured and monitored**

Liquidity risk is often cited as the “hidden risk” – it is always persistent yet not focused upon until markets are in stress. Liquidity risk can tend to overwhelm the other risks being considered in a portfolio, especially when considering stressed market scenarios, so measuring and monitoring liquidity risk should be a standard and explicit part of the risk measurement and management process.

There are two aspects to liquidity risk for investment management companies, both of which should be measured and monitored:

1. Portfolio liquidity, which concerns the ability of the portfolio to meet certain obligations, chiefly net outflows. The key elements are the extent of the liabilities faced by the portfolio, as well as the proportion of liquid assets that are readily available to cover these liabilities; and
2. Position liquidity, which refers to risk, embedded in a portfolio through its particular positioning of assets. The key attributes being the size of the position, the relative size of the trading volume and markets in which the position can be traded, the underlying volatility of the position, as well as the bid-ask spread of the security underlying the position.

### 3.7 Investment Risk should be reported via the use of Key Risk Indicators

Given the wide range of portfolio characteristics and risk analytics that are available, it is more optimal to present Key Risk Indicators (KRIs) through the mechanism of an investment monitoring dashboard that provides a summary view of the portfolio(s). This reporting could be sorted by KRIs, examples of which could include:

- The top / bottom ten contributors to absolute risk, for the portfolio and for the benchmark, if applicable;
- A similar breakdown of tracking error, if applicable;
- A clear split between common factors and specific risks;
- Guidance in the form of limits (shown through “traffic lights”) to highlight concentration bands;
- Trend analysis, comparing current results with at least 2 discrete prior periods; and
- Comparison of the decomposition to ex post return attribution, to highlight the risk-return trade-off.

The results should be made available to key decision makers, and be regularly reviewed at portfolio construction meetings or similar forums, to ensure that material results (especially changes) are acted upon in an appropriate manner.

### 3.8 Risk Models should be Independently Reviewed and Authorized

Risk models must be appropriate and robust if analysis is to be relevant to the investment strategies, and the investment risk oversight process. Models are also a source of operational risk. As such models should be independently validated. Validation should cover the evaluation of methodology, parameters, data governance, assumptions used as well as the model governance framework. There are numerous best practice and standards in the marketplace such as ISAE3402 and CMMI 3 which provide a measure of comfort to the end users and recipients of risk reports that the models used have been tested and validated.

### 3.9 Risk Models should be Backtested on a Regular Basis

Backtesting is the process of real-world testing of the empirical and model results with actual achieved results, to ascertain either the goodness of fit of the model to the actual results and / or the extent of the variation of the strategy in practice, from the stated objectives. By using techniques such as VaR and Tracking Error envelopes, the investment manager can better understand the behavior of the portfolio through time in both absolute and active risk dimensions.

Backtesting is important as it tests a fund’s actual risk results with the forecasted risk results (which are an execution of the investment parameters of the strategy);

Given the importance of backtesting, and the ability of the technique to add value and assist in the management of risk, a suggested best practice is for the exercise to be carried out by the risk and performance unit as an independent and consistent measurement of the strategy effectiveness. For this to be an effective process, the unit must be in close contact with the front office in terms of understanding both the investment strategy as well as the implementation methods undertaken to execute the strategy.

A common platform of data, calculations and reporting integrated across the business is important in ensuring consistency and accuracy of measurement, which in turn enhances the ability to manage the outcomes more effectively. A best practice is for example to have an integrated solution that links both the ex post achieved results with the ex-ante forecast projections, and for the platform to be able to proactively provide alerts in a dynamic setting. This allows the exercises to be conducted holistically rather than in a reactionary manner.

## 4 Performance Analysis

### 4.1 Fund Performance should be Reviewed Regularly

The review of a fund's performance is a critical function which tests whether investment strategies are appropriate to achieve investment objectives and are implemented in the way they were intended. It can also feed into the refinement of investment process and the evaluation of portfolio managers.

A prerequisite for performance review is a clearly defined performance calculation, performance measurement, performance attribution and performance reporting process. There is no one best practice model for these activities, rather it must be tailored to the firm's, stakeholders' and portfolio manager's objectives and strategy. Once the performance measurement and attribution process is defined, it needs to be industrialized and validated with an impartial, unbiased and consistent process which will be the official performance review.

The performance review process should occur in accordance with clearly defined frequencies, be that weekly, monthly, quarterly and/or annually. Common measures include both pure ex-post performance statistics, as well as some ex-ante risk based calculations. Common practices and recommendations for such indicators include: 1) one, three, and five year performance on an absolute (and active basis, if applicable) which allows for a view of trends over time; 2) peer group percentile ranking for relativity to "like" products, if applicable; 3) risk-adjusted ratio analysis (for example, information ratio, Sharpe ratio, and Sortino ratio); and 4) yearly performance against a pre-set absolute or alpha target.

The performance review process should examine how the performance was achieved, through a comparison to stated investment objectives (perhaps the Investment Management Agreement or Policy Risk Guidelines) and test accountability by challenging the rationale for key portfolio positions versus these objectives. This process of appraisal provides assurance that appropriate investment strategies are being deployed by the portfolio manager and that the performance is not driven by style drift or bets inconsistent with investment strategy. The performance review also ensures that all portfolios are being monitored and reviewed with the same rigor. Reporting templates based on management's and client's objectives should be defined for these performance reviews to facilitate these discussions and highlight exceptions.

### 4.2 Fund outperformance should be considered equally with fund underperformance

It is a natural tendency to focus on the underperforming funds and overlook the outperforming funds during the portfolio review process. However, a positive fund performance could easily turn into underperformance in a short time frame, and rather than examining the investment process and strategies only when the fund underperforms, the performance review provides a consistent, comprehensive and periodic focus on attributing portfolio performance to key factors, examines whether performance was backed by strong conviction and establishes clear line of sight and accountability in the investment process.

### 4.3 Performance attribution should be conducted regularly

In the course of the investment process, it is critically important to understand not only what a portfolio's return was, but also how that return was achieved. Attribution analysis can be used to fully recognize where this out-performance or under-performance comes from (relative to an index). There are a number of ways to section and organize performance results to do attribution. To cut through this noise and be most effective for investment management, the attribution methodology should be consistent with the investment process it is assessing, and where appropriate, utilizes factors relevant to the portfolio's primary drivers of performance. The factors that can be considered will differ by portfolio type, but could include:

#### 4.3.1 Biggest Contributors / Detractors

Biggest contributors / detractors segregate the portfolio's return into factors and components, such as common factors, market timing and stock selection. A basic framework of attribution should include contributors (and detractors alike) to specific return indicators, taking into account each position's (active) weight and the difference between that position's return and the return attributed to the specific factors.

The biggest contributors / detractors clearly identify the factors or components affecting the returns, especially when compared on a time-series basis to spot trends and biases. This consistency analysis also helps support tactical changes to the investment strategy depending on the frequency of analysis and appropriateness to the strategy. The magnitude of impact further provides useful data points for investment managers to actively manage the portfolio. It could also be a basis for the consideration of an investment manager's remuneration, especially the factors relating to stock selection.

The biggest contributors / detractors are widely used for portfolio analysis, but usually used in conjunction with other methods. They are mostly used for post-mortem purposes, especially in commentaries to investors and investment articles. The frequency of formal analysis is usually quarterly if not longer.

#### 4.3.2 Sub-portfolio / Sector Returns versus Benchmarks

This is the monetary return experienced by a holder of a sub-portfolio or sector compared to a specific benchmark. Sub-portfolio returns can be calculated on a daily or long-term basis to serve as a method of assessing a particular investment strategy. This indicator is important to track the performance of sub-portfolios/ sectors against benchmarks for asset allocation purposes. This is particularly important for investment mandates with multiple strategies or sectors handled by different fund managers. It can also serve as the basis for assessing the performance of the individual fund managers.

#### 4.3.3 Strategy Attribution

Using the guiding principle of attributing returns according to relevant decision making, it is recommended to perform strategy attribution where appropriate. In theory this approach can appear complex, but as a basic starting point, utilising familiar attribution models with customised hierarchies can provide valuable insights.

For example, if positions are grouped by the strategies they belong to, utilizing the Brinson-Fachler methodology against these groups as sectors will provide insights into the allocation and selection impacts for these strategies. This requires close collaboration between the risk and performance unit and the front office to define the hierarchy for the attribution, as well as a rigorous maintenance process by which the strategy tags are updated to ensure the attribution remains informative and relevant.

#### **4.4 The process of attribution should be relevant to the mandate**

The approach to performance attribution will differ by asset class, as well as investment style. For equity attribution, it is common to use the Brinson-Fachler methodology, which is seen as an industry standard. It arithmetically (the most typical implementation) decomposes active returns into the value-add from Allocation and Selection decisions made across a given grouping of assets relative to its index. The key benefit of this approach is that it can be adapted to a standard top-down or bottom-up or mixed investment decision making process and highlights the alpha generated accordingly. A best practice for multi-currency portfolios is to perform the analysis in local terms, with currency decisions (passive/active) treated separately.

For Fixed Income, given the nature of a bond versus an equity instrument and the plethora of investment strategies, the basic tenet should be that attribution should be viewed through the lens of yield curve factors that impact a bond's performance, such as effects due to parallel rate shifts (duration and convexity), changes in the shape of the yield curve (twist, butterfly), roll-down, carry return, inflation, and changes in swap and credit spreads. It is best practice to treat currency separately.

By contrast, given that multi-asset portfolios combine both equity and fixed income asset classes into one portfolio, if a detailed factor-based view is required then different methodologies need to be combined. The aspect which is commonly unique in the Multi-Asset space is the impact of asset class level allocation decisions. Accordingly, best practice is that the attribution model used will capture this effect. For a given portfolio, this is achieved through treating each asset class as its own sector with a corresponding asset class level benchmark. Since the portfolio now effectively has two levels of benchmarks (one for the overall portfolio, and one for the sub asset classes), there will be two allocation effects instead of one as typically observed. The first level allocation impact is the effect of value-add due allocation of asset classes relative to the top level benchmark. The second level allocation impact is the effect of value-add due to the allocation within asset classes relative to the asset class specific benchmark. Lastly, there will also be a selection impact which is the effect of security choice excess return within each asset class. As with previous examples, this is an effective means of increasing explanatory power to align with how the investment decisions are made. It is best practice to be able to combine “best-of-breed” approaches in a multi-asset model, with equity attribution models for equity asset classes, and a suitable fixed income attribution model for bond allocations.

#### **4.5 Performance should be calculated and reported in accordance with GIPS**

Defined in the GIPS Handbook, a GIPS composite is an aggregation of one or more portfolios into a single group that represents a particular investment objective or strategy. Composite presentations give potential investors insights into the past performance of an investment manager's strategy. The method of calculation and disclosures presented should be in accordance with GIPS which allows investors to compare the performance of different fund management companies on a fair basis.

Composite presentations will typically display both gross-of-fee and net-of-fee total returns. The use of GIPS composites in the industry is mixed, with an overall trend observed that the bigger the firm the more likely it is to use GIPS composites, compared to the smaller firms.

#### **4.6 Where relevant, peer group analysis should be performed**

Peer group analysis is the practice of comparing a firm's results to those of similar companies or competitors. The emphasis here is on comparing "apples to apples," which means that the constituents of the peer group should be fairly similar to the strategies or funds being compared, particularly in terms of their main styles, benchmarks or other key drivers of performance.

Peer group analysis is widely used by end clients when comparing their pool of asset managers to study opportunity cost as a critical part of their appraisal of the performance process. It is also a valuable tool in promoting fund performance to select clientele, and aids in business development activity. Hence it is important the choice of peer group, the frequency of data management and any survivorship bias are all tested and validated by the risk and performance unit, in conjunction with the product control and investment teams.