

# The sources of South African equity fund performance

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## ABSTRACT

This paper aims to quantify some of the sources of South African equity fund performance. In particular, it aims to provide insights into the relative importance of sector allocation and stock selection as factors to consider in constructing actively managed portfolios. This analysis is done considering the constraint of a concentrated South African market environment. To partially account for this constraint, an assumption of three equity “super sectors”—financial, industrial and resources—is made.

To quantify the sources of equity fund returns, a geometric attribution analysis was conducted on the returns of seven South African equity unit trust funds. An attribution decomposition of the seven funds' tracking error and volatility was also performed to enable a risk adjustment to be made.

The results of these attribution analyses indicated that it is possible to source excess returns through both selection and allocation efforts. Furthermore, the attribution analysis also revealed different levels of success at earning excess returns per sector. South African equity fund managers also demonstrated skill in reducing risk over the sample period, as the majority of the managers were able to reduce portfolio risk relative to the benchmark portfolio, but still source excess returns. It is, however, important to note that these results are influenced by market structure and manager practices.

## KEYWORDS

Active investment, stock selection, sector allocation, attribution analysis, South African equity fund performance, tracking error, volatility

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## 1. INTRODUCTION

### 1.1 Introduction

Certain active fund managers seek to generate an excess return (net of fees) over that of the benchmark agreed upon with the client. This objective characterises and defines the role of the assumed skilled active manager within the market, noting that it is very difficult to identify skilled managers over those that are lucky, especially over shorter measurement periods.

The ability of the skilled manager to generate the desired excess returns is a consequence of their ability to manipulate the three investment performance determinants as outlined by Brinson, Hood and Beebower in their seminal work, “Determinants of Portfolio Performance” (1986). In this defining work, the investment management process is decomposed into three contributing processes, namely that of: asset allocation, sector selection and security selection.

The implication of this decomposition is that the active manager can get an understanding of how each of these processes has contributed to return. Consequently, an understanding of the underlying dynamics and relative importance of each of these three distinct choices will enable the assumed skilled active manager to potentially generate the desired excess returns over that of the required benchmark.

In particular, the Brinson, Hood and Beebower (1986) study established the platform for further research towards understanding these underlying dynamics and the relative importance of each of these three processes. The controversial conclusion of this study was that investment policy (i.e. asset allocation) accounted for more than 90% of the volatility of the total return, making it the most significant of the three decisions in the investment process.

However, as pointed out by Ibbotson and Kaplan (2000: 26), the methodology and results of the Brinson, Hood and Beebower (1986) study relates specifically to the variability of return achieved by a single fund over time and not to the absolute level of return earned.

In an attempt to quantify the extent to which differing asset allocation policies influence the differences in the returns achieved amongst funds, Ibbotson and Kaplan (2000) applied cross-sectional regression techniques. The conclusion of this cross-sectional regression was that asset allocation policy contributed only 40% to the returns.

The implication of this result for active fund managers is that excess returns (relative to benchmark) can be achieved through both sector allocation and stock selection. Asset allocation and specific asset class mandates are increasingly being separated in the asset management process to capitalise on specific manager skills.

## 1.2 Research Objectives

The objective of this research is to identify the relative importance of sector allocation and stock picking decisions as sources of South African equity unit trust fund performance. This research will seek to answer the questions:

- How have timeous over- and under-weightings of each sector within the equity portfolio influenced the equity fund performance relative to the benchmark?
- To what extent does specific stock selection within each sector influence the potential for equity fund returns i.e. can returns from each sector be significantly enhanced through the selection of the correct individual stocks?

These questions are addressed within a framework bound by three significant constraints, namely, the structure of the South African equity market, the differing investment philosophies amongst managers and the level of risk that managers are prepared to take on in order to deliver active performance. By implication, it may be challenging to determine a generalised solution to maximise potential active returns.

## 1.3 Importance / Benefits of the Study

To date, limited research has been undertaken to answer the two questions outlined in the research objectives. The most relevant study is that of Fox and Krige (2013), which used unit trust data. In this study, the researchers only had access to portfolio returns (and not details of portfolio composition) and so had to estimate the sector allocation of the managers over time. The method applied by Fox and Krige (2013) to estimate the applicable sector allocations was based upon Sharpe's (1992) study of the asset allocation of US mutual funds.

Sharpe's (1992) study utilised multiple regressions to determine the likely sector allocations. This regression analysis was adjusted within the Fox and Krige (2013) study to compensate for their definition of five equity sectors, as opposed to the 12 equity asset classes defined by Sharpe (1992).

The analysis presented in this study has the benefit that data used includes both the manager's active monthly sector allocation and the monthly performance for that sector. This means that the effect of sector and share selection can be analysed directly.

The study also aims to cover new ground in South African literature by performing an attribution analysis on a risk-adjusted basis in assessing the extent to which managers outperform their benchmarks from both sector allocation and share selection decisions by considering benchmark risks undertaken by the managers. Through this type of study investors and active managers can better understand the sources of excess returns.

In particular, this understanding of skill is of importance for active investment management styles due to the higher (relative) costs associated with such an investment strategy. These costs are borne by the investors and are typically up to 1% p.a. for institutional investors (this includes manager fees and trading costs) and can be in excess of 2% p.a. for retail investors.

## 1.4 Research Design and Methodology

Within this study, research was conducted in an attempt to attribute specifically the sources of the relative performance of South African equity funds, similarly to that of Fox and Krige's 2013 study. However, this study differs in that portfolio composition details were available (not just portfolio returns) and does not prescribe specific focus towards comparing the relative allocation and selection successes between different fund mandates. Whereas the Fox and Krige (2013) study compared the sources of equity fund performance for general, growth and value equity funds, this study will instead focus only on general equity funds. A further difference is that actual sector allocation data was available for this study, in addition to return data.

### 1.4.1 DATA LIMITATIONS AND ASSUMPTIONS

The usefulness of the data is limited for reasons discussed below. Assumptions made to overcome these limitations are also discussed.

The first limitation is that of the concentrated nature of the South African equity market environment. This is discussed further in the Literature Review section, and is based upon the findings of Raubenheimer (2010), Kruger and Van Rensburg (2008) and Fox and Krige (2013). The implication of this concentrated nature is that sufficiently broad equity sectors will need to be defined in order to minimise spurious inferences about whether sector allocation or stock selection has been the driving source of equity fund performance.

To illustrate this, consider highly concentrated sectors (such as the beverage sector), where one dominant stock comprises most of the sector market capitalisation. In this situation, picking the particular sector essentially becomes picking the dominant individual stock, and the active investment decision leading to equity fund performance cannot be determined with certainty. In order to address this limitation, the assumption of three "super sectors"<sup>1</sup>—financials, industrials and resources—was made.

Secondly, this market concentration leads to a lack of suitable performance benchmarks. The implications of the lack of suitable performance benchmarks are addressed within the studies of Rousseau and Zwonnikoff (2002) and Cabot-Alletzhauser (2008), and are also further analysed within the Literature Review section.

In terms of this study, the implication of this limitation is that the use of ALSI returns as a proxy for benchmark returns may not provide a completely representative picture of the actual market performance. Other indices such as the SWIX and CAPI have been developed in an attempt to provide a more accurate representation of market performance. The specific definitions and limitations of each of these indices are presented in Section 3.

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1 Within this paper, the equity listings on the JSE are classified as belonging to one of three broadly defined super sectors, namely, those of industrials, financials and resources. The relevant returns and weightings for an equity fund portfolio and the benchmark are considered with respect to these three sectors.

Due to its use as benchmark reference by some of the managers in the sample, the ALSI will be used within this study to determine and analyse the sources of excess equity portfolio performance. The SWIX could also have been used; however a number of managers are currently reviewing the continuing use of this index as their benchmark due to concentration concerns.

#### **1.4.1.1 Data utilised**

The data used constitutes the “super sector” weightings and the achieved monthly “super sector” returns of seven South African equity unit trust investment managers. These seven equity funds have been referred to as Fund A to G to preserve manager confidentiality. A summarised version of the applicable fund objectives is given in Table A.1, Appendix A. The period over which this data was made available varies from three years (for one fund in the sample, a new fund) to seven years. While the authors could not establish an ideal period over which to assess fund managers, it would seem reasonable that it should extend over a full market cycle. It is unlikely that three years would be sufficient; however periods exceeding seven years are also likely to be problematic if there are changes to the investment team, processes or size of assets under management.

The authors were limited to the data available, and while data over a longer period would have been useful, it can still be used to illustrate the application and potential use of the methodology followed. In addition to the limited period, the period for which data was available was not identical for all funds, which limits direct comparison between the funds.

#### **1.4.2 DATA ANALYSIS METHODOLOGIES**

Three research methodologies were applied to the available dataset. These methodologies are namely those of an economic analysis of sector movements, an absolute attribution analysis and a risk-adjusted performance attribution analysis.

##### **1.4.2.1 Economic analysis of sector movements**

This entailed an analysis of the history of the relative performance of the “super sectors”. This allowed for the variation in the returns across sectors to be assessed to determine whether opportunities existed for sector allocation excess returns to be generated.

##### **1.4.2.2 Absolute attribution analysis**

The sources of equity fund performance were analysed and quantified through a geometric performance attribution analysis. The Advanced Portfolio Analytics (Andreas Steiner Consulting GmbH, 2013) Excel add-in “attribution” function were used to do this on an individual equity fund level. The results of the attribution analysis will then be analysed on an overall fund and sector-wise level to determine the sources of equity fund performance for the sample funds. This also allowed inferences on the relative importance of stock selection and sector allocation as a source of equity fund performance to be made.

### 1.4.2.3 *Risk-adjusted performance attribution analysis*

An attribution analysis which does not consider risk implications may not present a true representation of the relative success of the manager's active investment decisions. Therefore, an adjustment for risk is required. This adjustment was to be done through a decomposition of tracking error and volatility. This decomposition disentangled the relevant risk introduced through allocation and selection decisions on both a sector and portfolio level. When combined with the findings of the absolute attribution analysis, further insights into the drivers of fund performance were gained.

## 2. LITERATURE REVIEW

### 2.1 Introduction

Originally, much of the research into sources of excess returns focused on the relative importance of the asset allocation decision. More recently, research has widened to consider the relative importance of sector and stock selection.

### 2.2 Market Efficiency

It is not the intention of this study to contribute to, or to take a position on, the body of research relating to market efficiency. The topic of market efficiency is however important in the context of analysing active manager investment performance, and so a brief literature review is appropriate.

The question of whether, and the extent to which, markets are efficient has been, and continues to be, well researched and debated. Numerous empirical studies have yielded anomalies that dispute the Efficient Market Hypothesis (EMH). Treynor and Mazuy (1966) found that there is no evidence that fund managers were able to outperform the market based on a study of fifty-seven funds. Fama & French (1993) identified common risk factors in the returns of shares and bonds, the three factors for shares being an overall market factor, and factors relating to firm size and book-to-market value. The existence of these factors appears to violate EMH. Basu (2012) found that price-to-earnings ratios have some predictive power in determining future investment performance. A study by Elze (2012) found that publicly available information can be utilised to create portfolios that consistently outperform the market.

Studies that support EMH include Schwert (2003) who found that anomalies such as the effects of size, value, the weekend and dividend yield, were not consistent over time, and were largely eliminated by arbitrage once they were recognised. Malkiel (2003) studied anomalies such as short-term momentum, long-term return reversals, seasonal patterns, dividend yields and price-earnings effects, and found explanations for all these effects within the EMH framework. His conclusion was that although price irregularities can exist in the short term, markets are efficient in the long term, and that no anomalies can be exploited consistently. In South Africa, Mabhunu (unpublished) and Mlambo and Biekpe (2007) found evidence in support of weak form efficiency on the JSE (Johannesburg Stock Exchange). Numerous studies show that the majority

of active equity fund managers have not demonstrated an ability to outperform their benchmarks on a consistent and risk-adjusted basis, which would support the EMH.

### 2.3 The Significance of Asset Allocation

Brinson, Hood and Beebower (1986: 40) define asset allocation as the long-term weighting of each of the asset classes within a particular portfolio. These weightings are based upon prerequisites and mandates imposed upon the fund, as well as the fund objectives. Because of these stipulations, the asset allocation process is effectively reduced to a “passive factor” within the investment process, leaving sector allocation and security selection as the two “active management” variables.

Brinson, Hood and Beebower’s 1986 pioneer and frequently cited work, *Determinants of Portfolio Performance*, establishes the quantitative evidence for the importance of this “passive factor” towards the achieved variation in portfolio return. Using published data from 91 large US pension plans over the period 1974–1983, the authors determined that 93.6% of the variation in total plan return was a consequence of the asset allocation of the pension fund.

Although the study reflected that skilled active investment strategy in terms of strategic under-/overweighting of an asset class relative to its benchmark weight and security selection were contributing factors towards generating fund returns, the relative importance of these activities was dominated by the influence of long-term market asset movements.

### 2.4 A Refocus towards the Merits of Active Management

However, Ibbotson and Kaplan (2000) challenged this dominance of asset allocation within the investment decision-making process, and its implication on the observed fund returns. Their study analysed the influence that differing asset allocation policies had in explaining the differences in the returns achieved amongst funds. This study entailed a cross-sectional analysis of both mutual and pension fund data.

The study ascribed 40% of the variation between funds to be attributable to asset allocation, implying that 60% of the variation was due to timing and security selection decisions by fund managers. One consequence of this study was a subsequently greater attention to the merits of the other two decision-making processes of sector allocation and stock selection. This refocusing allowed for an increase in the body of literature analysing the relative importance of these two processes.

### 2.5 Active Equity Fund Management

In the particular context of the equity portfolio decision, “sector allocation” could be viewed as the timeous over- or underweighting of a particular sector relative to the benchmark and “stock selection” as the picking of the individual equities to fill the sector allocation decided upon.

There is a diverse range of investment methodologies and opinions as to the relative significance placed upon sector rotation and stock selection to achieve excess

returns. A substantial body of literature exists in which the relative merits of sector-based strategies and stock-picking methodologies are explored. This allows for the existence of evidence to promote a range of investment methodologies and to justify a diverse range of arguments.

### 2.5.1 SECTOR ALLOCATION INVESTMENT METHODOLOGIES

Investment methodologies that focus on sector allocation include that of sector momentum and sector contrarian approaches, and according to Legomsky (2001: 9), sector rotation strategies are still widely used on Wall Street.

#### 2.5.1.1 *Advantages of sector rotational strategies*

According to Hulbert (2002: 18), the allure of such a sector-only rotational strategy lies in the premise that such an investment methodology is a practical middle path between a pure buy-and-hold strategy and a high trading strategy. It is argued that such an investment approach should limit the potential excess losses usually associated with a pure buy-and-hold strategy during bear market periods, assuming that the manager can make the sector call correctly. This is because a sector rotation approach creates the environment to exploit such upside potential because certain defensive sectors usually continue to perform well, even within a bear market environment (Hulbert, 2002: 18).

In addition, the potential merits of such a sector rotation strategy were validated by the findings of Vardharaj and Fabozzi (2007), who argued that the empirical evidence suggested that the sector allocation policy of an equity fund had the most significant influence on the equity fund performance. They used the technology bubble performance of the late 1990s as an illustrative example of the importance of an appropriate and timely sector allocation, i.e. avoiding this sector in the early 2000s would have added significant value to an equity portfolio.

Their argument hinged on the premise that a greater level of market efficiency was prevalent at a micro-level than at the macro-level. This assumed that a greater level of market inefficiency within the macro environment implied and justified an increased importance of sector weighting within a portfolio.

In addition, as highlighted by Hulbert (2002: 18), a further advantage and justification for such an increased significance and focus towards appropriate tactical sector weighting deviations was the opportunity that such an action presented to exploit the advantages of momentum effects. Hulbert (2002: 18) noted that academic studies have confirmed the existence of short-term momentum movements for individual stocks, and argued that sector rotation is a more reliable mechanism by which to capitalise on such effects. This is because sector-momentum investment methodologies may benefit from the homogeneity presented by a particular industry that is benefitting from a particular tailwind. Equivalently, if a stock within a particular industry is benefitting from an economic and market environment conducive to business growth; it is likely that other stocks within the industry will be yielding the



same benefits. Therefore, a sector-momentum approach presents the opportunity to exploit the cumulative advantages presented by such an environment.

Sector-momentum based strategies are not the only sector-based strategies available; sector strategies could also be contrarian. In this case, the investor holds the view that over the long-term, each sector return should converge to their long-term average return. On this basis, a sector that is significantly out of favour and cheap is assumed to offer the prospect of eventual higher returns as the sector reverts to its long-term mean.

### *2.5.1.2 Limitations of sector rotational strategies*

However, Legomsky (2001: 9) argues that the applicability of these potential advantages due to differences in the relative performance of different sectors is no longer as relevant in the current market environment as it was historically. Legomsky (2001) presents the justification for this statement based upon the observed convergence in Wall Street sector returns over the period January to June 2001 and the trend towards a narrowing of the period of relative sector outperformance from several months to a few weeks.

Such considerations prompt a focus on the use of specific stock selection instead in an attempt to generate excess returns.

### *2.5.2 STOCK PICKING INVESTMENT METHODOLOGIES*

Stock-picking methodologies concentrate upon identifying individual securities whose expected returns lie off the security market line (L'Habitant, 2001: 156), and is a methodology based upon a bottom-up approach to portfolio formation. Proponents of such an approach have presented an extensive body of literature and arguments in an attempt to justify the merits of stock picking efforts.

#### *2.5.2.1 Advantages of stock picking strategies*

Kritzman and Page (2002) contributed to the body of this literature through streamlining the analysis of the merits of stock picking. They argued that the specific stock selection within the equity component had a more substantial influence on the actual return achieved than the asset weighting policy of the fund.

The argument for this is based upon the more volatile nature of individual stock returns when compared to the broader sector and asset classes in which the security is defined. Shiller's frequently cited 1981 test for excessive volatility provides evidence for the observed greater variation in share prices than anticipated when compared to a perfect foresight price model. Theoretically, such inefficiencies within a micro-level environment should create the opportunity for the active manager to select specific stocks to generate excess returns.

Kritzman and Page (2002) sought to quantify this intuitive argument through the application of both a bootstrap simulation and a variation of the Black-Scholes option-pricing model. The bootstrap results offered compelling evidence in favour of stock selection. The results of the modified Black-Scholes option-pricing model

indicated that security selection skill was more highly valued than asset allocation skill, which confirmed the bootstrap analysis results.

The results of Hall and McVicar (2013) also implied that security selection skill was of the greater relative significance in forming portfolios that outperform the benchmark. This was motivated through the results of a time series regression that implied that 61% of the variation between different funds' performance could be attributed to varying levels of security selection skill between fund managers.

This varying level of security selection skill is of critical importance in attempting to explain the factors contributing to the generation of alpha within a portfolio. In particular, Chen, Jegadeesh and Wermers (2000) sought to examine evidence to ascertain whether or not specialised equity sector funds possess enhanced stock picking abilities in comparison to general equity funds.

Based upon the analysis of specialised mutual fund data over the periods 1975, 1985 and 1995, the authors concluded that sufficient evidence was present to suggest that specialised funds did possess superior stock selection skills, however the informational advantages presented due to such specialisation was relatively short-lived. In particular, Chen, Jegadeesh and Wermers (2000: 345) concluded that in general, growth-orientated funds exhibited better stock selection skill than income-orientated funds.

#### 2.5.2.2 *Stock picking methodologies and the "Fundamental Law of Active Management"*

In addition, Chen, Jegadeesh and Wermers (2000) noted that the empirical evidence suggested that mutual funds with a more active, higher turnover strategy exhibited more consistent and improved stock selection capabilities. These findings are consistent with the ideas of the "Fundamental Law of Active Management" as proposed by Grinold and Khan (2000).

The Fundamental Law of Active Management is a simple and general mathematical formula that seeks to quantify the additional value added to a portfolio due to an active investment management approach.

In Grinold and Khan's 2000 defining and pivotal work, *Active Portfolio Management*, the authors propose and define the underlying mathematical rigour for relative measure known as the "information ratio".<sup>2</sup> The information ratio is proposed as a function of the investment opportunities available to the manager.

Grinold and Khan (2000: 148) further the notion of the information ratio as a measure of value added through an active investment approach, through assuming that if the manager were to exploit the available opportunity set in a manner consistent with mean/variance-efficiency concepts, the value added by the manager would be

2 The information ratio is the ratio of annual excess portfolio returns to annual excess portfolio risk. This excess is taken with respect to the fund benchmark. According to Grinold and Khan (2000:114), a top quartile investment manager will have an information ratio of around 0.5.

proportional to the information ratio squared. Consequently, managers and investors would seek to optimise and maximise the information ratio in an attempt to add maximum potential value from active management investment decisions.

Grinold and Khan (2000: 148) deepen the concepts underlying this information ratio through decomposing the ratio into a bivariate function of the investment strategy's "breadth" and the individual manager's "information coefficient". "Breadth" is essentially a measure of the number of independent investment decisions made by a manager over a single year period, and the "information coefficient" is a simple numerical measure of manager skill. The precise form of this relationship between the information ratio, breadth and information coefficient is given by the mathematical formula:

$$\text{Information Ratio} = \text{Information coefficient} \times \sqrt{\text{Breadth}}$$

This result is known as the Fundamental Law of Active Management.

The implication of this proposed fundamental relationship is that Grinold and Khan (2000:148) essentially argue that the value added to a portfolio through an active management approach can be enhanced either through an increase in the breadth of investment activities or through an improvement in the level of manager skill. Equivalently, in order to maximise value added through active management, it is ideal that the manager engage in a wide breadth and number of investment activities, particularly within the investment activities in which the manager has the highest level of expertise.

Intuitively, a substantially greater challenge is presented to the active manager attempting to improve significantly their level of investment skill, due to limitations imposed by imperfect information. Hence, if the adverse impact of increased expenses and costs is ignored, the simplest way for the manager to improve active value added is through an increase in the breadth of investment activities.

A simplistic explanation of the underlying concept driving this law is that the more decisions a manager makes, the greater the number of opportunities the manager has to make the "correct" investment decision. Essentially, the manager increases the sample set from which to draw "successful" investment decisions through increasing the breadth of investment activities, even if the manager skill level remains unchanged.

If this intuitive concept is applied to the problem of sector allocation versus stock selection as a source of equity fund performance, the implication is that the investment methodology that allows for the greatest potential expanse in breadth should also provide the greatest potential to enhance active value added.

This concept would suggest that the benefits of stock selection are particularly enhanced in market environments in which the potential to diversify through uncorrelated sector calls are limited. The implication of this could be an enhanced relative importance of security selection efforts in such market environments.

### 2.5.3 AN EQUAL IMPORTANCE OF ACTIVE MANAGEMENT ACTIVITIES

However, adding a new dimension to the debate, studies by Assoé, L'Her and Plante (2006) and Xiong et al. (2010) indicated that the investment manager should view both sector allocation and stock picking activities as a source of equity fund returns with equal relative importance.

In particular, Assoé, L'Her and Plante (2006) based this inference upon illustrating that the relative importance of these two investment management decisions is time-dependent. They argued that in the presence of crises and an ever-changing market climate, it is not possible to describe one activity as being consistently a more significant source of value than the other activity.

As an implication of this time-dependent nature, it becomes important that the individual active fund manager is able to attribute and understand the precise drivers behind their observed equity portfolio returns. Such enhanced understanding is potentially made possible through attribution analysis methods.

## 2.6 The South African Equity Fund Environment

Fox and Krige (2013) streamlined the analysis of the investment management decision and debate to focus specifically within the context of the constraints imposed by the South African equity market environment. This was done in an attempt to investigate the sources of performance within South African general equity unit trusts.

The concentrated nature of the South African equity market environment is potentially the most significant constraint imposed on the South African general equity fund manager. The severity of this highly concentrated environment is reiterated by the findings of Raubenheimer (2010), whose study on long-term equity funds concluded that at certain times within the dataset, two resource companies comprised more the 20% of the JSE All Share Index (ALSI). This 20% value was determined based upon applicable market capitalisations.

Furthermore, if the market capitalisations of the top five shares of the approximate 165 shares comprising the ALSI are considered, then the weighting within the index of those five shares is as substantial as 40% (Fox and Krige, 2013: 46). Furthermore, Kruger and Van Rensburg (2008) note that these consequent concentration risks are aggravated by the volatile nature of the resources sector.

For the active South African equity portfolio manager, the resulting implications and the limitations imposed by this concentrated equity market environment are two-fold. Firstly, this concentrated equity market structure creates a problematic environment for the active manager in which effectively to determine efficient benchmarks by which to measure fund performance (Fox and Krige, 2013: 47). This problem is reiterated by the findings of Cabot-Alletzhauer (2008), who concluded that the above-mentioned concentration considerations have led to traditional benchmarks and yardsticks being poor indicators of relative performance measures.

In particular, Rousseau and Zwonnikoff (2002), highlight deficiencies pertaining to the use of the Shareholder-Weighted Index (SWIX) as benchmark index. Despite

this, the SWIX remains a prominently used benchmark by equity fund managers through which to ascertain relative fund performance (Fox and Krige, 2013: 47).

The second limitation imposed on the portfolio manager of a South African equity fund due to the concentrated market structure pertains to the difficulties in effectively disentangling the effects of sector allocation and stock selection activities.

The particular problems pertaining to the lack of available stock diversity within certain South African equity market sectors are further addressed and scrutinised within the research methodology section.

Within the framework of these imposed problems and limitations, Fox and Krige (2013) investigated the sources of performance for South African equity unit trusts. This was done through a study with the objective of determining what proportion of their sample of equity funds' return could be attributed to that of active sector allocation and stock selection activities. In particular, they focused on the different sources of active value added between general, growth and value equity fund mandates.

In order to compensate and avoid spurious inferences that could potentially arise due to the concentrated nature of the South African equity market structure, Fox and Krige (2013) decomposed the JSE universe into five sub-sector categories: large resource companies, large financial companies, large industrial companies, medium-sized companies and small-sized companies.

Their study concluded that their sample of growth funds had realised a slightly higher proportion of returns attributable to stock selection activities than the sample of general equity funds (Fox and Krige, 2013: 50). Their analysis also indicated that their sample of value funds had generally realised higher returns than both their growth and general equity sample. Comparatively, value funds were able to source the highest return through stock selection activities of the three fund mandates considered (Fox and Krige, 2013: 51).

This result is expected if the objective of a value fund is compared to that of the objectives of growth and general equity funds. The objective of a value fund is to source and acquire stocks below fair value (Fox and Krige, 2013: 52) and therefore it is anticipated that most of their active fund value should be sourced through stock selection activities.

Conversely, a growth fund aims to invest in stocks with good fundamentals and growth prospects (Fox and Krige, 2013: 52), thus making such a mandate naturally more akin to the merits of sector allocation activities. The findings of Fox and Krige (2013) confirm this logic, as the majority of outperformance between their sample of general equity and growth funds was sourced through sector allocation decisions.

However, perhaps the most significant conclusion of the Fox and Krige (2013) study is the observation that the average active fund manager was not able to outperform the market over the sample period, but that top-performing fund managers were indeed able to do so through both good sector and stock allocation over time. These findings highlight the difficulties and complexities underlying an active investment management approach, and the significance of individual manager skill.

## 2.7 Summary

The literature presents arguments for justifying both sector allocation and stock selection activities as being potential sources of excess equity fund performance. The literature further highlights the shortcomings of studies of manager performance as a result of our market structure.

## 3. RESEARCH METHODOLOGY

### 3.1 Introduction

The research methodology draws on the ideas outlined within the literature review to develop a set of three cohesive tests by which to determine the sources of equity fund performance. These tests and techniques are that of an economic analysis of sector movements, an absolute attribution analysis and a risk-adjusted performance attribution analysis.

### 3.2 Data Limitations and Assumptions

The key limitations and constraints faced by this study are that of market concentration and the existence of appropriate benchmarks.

#### 3.2.1 SOUTH AFRICAN MARKET CONCENTRATION

The particular opportunity set of equity investments available to the South African equity fund investor is relatively small. Currently there are 400 companies listed on the JSE<sup>3</sup> compared to over 5000 on NYSE.<sup>4</sup>

This concentrated nature of the index means that care needs to be exercised in interpreting the results of any SA equity attribution analyses. For example, British American Tobacco, Naspers, SA Breweries and Richemont make up 33% of the index, but are all classified under the “Industrials” sector. Thus, if the manager is overweight in these shares, the manager will consequently also be overweight within the industrials sector. As a result, disentangling sector allocation and share selection activities within this particular framework presents challenges.

In particular, this limiting factor will present spurious inferences if the sector definitions are too restrictive. For example, if sectors are to be defined in such a way such that one particular firm within any sector has an overly substantial market capitalisation within that sector (e.g. South African Breweries in the beverage sector), choosing that particular sector effectively becomes selecting that particular stock. Therefore, for constructive inferences to be made in light of this equity market structure, it will be necessary to define sufficiently broad sectors. The three broad “super sectors” proposed are resources, financials and industrial shares as the most data are available for these sectors. Whilst this approach deals in part with the concentration problem, it is however not a complete solution, as illustrated above, for the industrial sector.

3 [www.stockmarkets.com/exchanges/africa/johannesburg-stock-exchange/](http://www.stockmarkets.com/exchanges/africa/johannesburg-stock-exchange/)

4 NYSE: Why NYSE. [www.nyse.com/why-nyse](http://www.nyse.com/why-nyse). retrieved 16 September 2014

### 3.2.2 APPROPRIATE BENCHMARKS

In addition to the above limitation, this concentrated market environment also creates equity market benchmark indices that are highly concentrated. The concentrations of these benchmarks means that the performance of these indices does not necessarily accurately reflect the performance of the market as a whole.

The three most commonly used general equity benchmark indices are that of the FTSE/JSE All Share Index (ALSI), the FTSE/JSE Capped Index (CAPI) and FTSE/JSE Shareholder Weighted Index (SWIX). The last two indices were developed in an attempt to provide a more balanced and less concentrated view of equity market performance than the ALSI. However both of these indices have shortfalls, resulting in some asset managers calling for new indices.<sup>5</sup> CAPI gives undue weight to small, illiquid (and un-investable) stocks, while SWIX does not avoid the problem of individual shares becoming a disproportionately large component of the index. The ALSI was used as a proxy for the South African equity market performance for this paper.

### 3.3 Data utilised

The specific data used is that of the monthly returns and portfolio weightings of seven South African equity unit trust funds. The monthly returns and portfolio weightings of these funds have been decomposed into the respective returns and weightings achieved and attributable to each of the three defined “super sectors”. These funds have been referred to as Fund A–G to preserve manager confidentiality.

The period for which data was available was not identical for all funds, however it is largely overlapping. For the equity Funds A, B, C and D the data analysed pertains to the period July 2007 to June 2014. As this attribution analysis is conducted over the same period for these funds, direct comparison of these funds is possible. The data for Funds E and F is for the period January 2008 to June 2014 and the Fund G attribution considers the three-year period July 2011 to June 2014. While the use of different time horizons is not ideal, it should not invalidate the attribution results, as the time horizons for all funds (except Fund G) overlap substantially. If it can be assumed that an active manager’s skill at sector- and stock-selection is consistent over time, the use of non-overlapping periods should be of less concern.

### 3.4 Data Analysis Methods

#### 3.4.1 ECONOMIC ANALYSIS OF SECTOR MOVEMENTS

Intuitively, only in an environment in which there are substantial and prolonged periods of significant variation in returns across sectors, would exploitable opportunities exist in which to yield the benefits associated with timeous sector allocation.

An economic analysis entailed an analysis of the historic relative performance of each of the “super sectors”. This analysis sought to ascertain whether opportunities

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5 See for example Coronation Asset Management “Corospondent” April 2015: “Constructing the right benchmark”.

have existed in which managers could have potentially generated excess returns through successful allocation efforts.

The performance of each sector was standardised against the performance of the market as a whole. To achieve this standardisation, the total returns of each “super sector” were compared to the return on the ALSI over each month, beginning January 1993. For each “super sector” the ratio of the monthly return to ALSI return was plotted. An upward sloping trend would hence indicate a period of outperformance of the “super sector” relative to the ALSI.

The applicable indices were those of the Resources 20 Index (RESI 20) for the resources sector, the Financial 15 (FINI 15) for the financial sector and for the industrial sector, the Industrial 25 Index (INDI 25).

As this methodology only enabled an assessment of whether opportunities for sourcing returns through positive sector allocation existed, a second methodology was required in which to attempt to quantify the sources of active value (or excess returns).

### 3.4.2 ABSOLUTE ATTRIBUTION ANALYSIS

The second methodology used to quantify the sources of excess returns was that of an absolute performance attribution analysis. According to Menchero (2004: 76), fund managers extensively use performance attribution analysis with the intention of explaining the drivers of active portfolio performance relative to a specified benchmark. To enhance the understanding of this methodology, an introduction to attribution analysis is presented below.

#### 3.4.2.1 Arithmetic and geometric measurement metrics

Through absolute attribution analysis, the sources of active value added and the relative significance of each source can be identified and quantified. This can be done using either an arithmetic or geometric relative performance metric (Menchero, 2004: 77).

Arithmetic performance measures compare relative performance based upon a difference, whereas geometric performance measures compare based upon performance ratios. According to Menchero (2002: 77), there is no industry consensus as to which measurement metric is superior, however the arithmetic measure is more popular due to its more intuitive and simplistic nature. The most popular form of the arithmetic performance measure is that of the Brinson–Fachler method (Frongello, 2005: 1).

Once a decision pertaining as to whether an arithmetic or geometric performance metric is to be applied had been made, a further decision arose as to which method of performance attribution analysis to implement. Three basic methods of performance attribution analysis exist, each with its own unique merits and distinct practical disadvantages. The three basic methods are namely that of multi-factor analysis, style analysis and a return decomposition analysis.



### 3.4.2.2 *Return decomposition attribution analysis*

Attribution analysis using a return decomposition methodology attempts to disentangle the value added through active management, known as the active management effect, into three components, namely, the allocation effect, selection effect and interaction effect.

The allocation effect measures the active value added by the manager stemming from the active allocation of assets to the various sectors.<sup>6</sup> It is a measure that seeks to quantify whether or not timeous over- or underweighting of particular sectors relative to the benchmark achieved the desired result of enhancing returns. Under the arithmetic Brinson–Fachler method, the following simple calculation is performed to calculate a portfolio's allocation effect over a given single period (Frongello, 2005: 1):

$$\begin{aligned} \text{Allocation Effect} = & \\ & = [(Portfolio\ sector\ beginning\ weight - (Benchmark\ sector\ beginning\ weight))] \\ & \times [(Benchmark\ sector\ return) - (Benchmark\ total\ return)] \end{aligned}$$

Within the return decomposition framework, further active returns generated in excess of those attributable to the allocation effect, can in part be explained through the workings of the selection effect.

The selection effect is a measure of the influence of security selection efforts within the particular sectors in yielding excess returns above that of the sector benchmark. A measure of the selection effect under the Brinson–Fachler approach is calculated as follows (Frongello, 2005: 4):

$$\begin{aligned} \text{Selection Effect} = & \\ & [(Portfolio\ sector\ beginning\ weight - [(Portfolio\ sector\ return) \\ & - (Benchmark\ sector\ return)]) \end{aligned}$$

Finally, within the return decomposition framework, the residual active management excess returns not attributable to either allocation or selection effects are prescribed to have stemmed from a phenomenon known as the interaction effect. Again, under the Brinson–Fachler method of performance attribution, the interaction effect term is given by:

$$\begin{aligned} \text{Interaction Effect} = & \\ & = [(Portfolio\ sector\ weight - (Benchmark\ sector\ weight))] \\ & \times [(Portfolio\ sector\ return) - [(Benchmark\ sector\ return) \end{aligned}$$

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6 Performance Attribution White Paper. [www.interactivebrokers.com/images/common/Statements/performance\\_attribution\\_white\\_paper.pdf](http://www.interactivebrokers.com/images/common/Statements/performance_attribution_white_paper.pdf). Retrieved 28 July 2014.

If these three attribution effects are now summed within an arithmetic return decomposition framework, the resulting value is the total attribution (or active management effect) over a single given period.

#### 3.4.2.3 *Arithmetic linking algorithms*

It should be noted that the above formulas prescribe specifically to attribution effects over a single period. In order for the manager to best ascertain the sources of active value added, a multi-period performance attribution analysis is necessary.

However, linking arithmetic single period attribution effects over a multiple number of periods presents a complication. This is because if the allocation, selection and interaction effects are merely summed over the desired number of periods, the resulting attribution effect will not be equal to that of the observed difference between the portfolio return and the benchmark return over the period (Frongello, 2005: 14).

As arithmetic single period attribution methodologies are the industry standard (Frongello, 2005: 14), methodologies have been developed that aim to quantify the value added over multiple time-periods. There are four distinct categories of these algorithms. These are namely that of linking coefficient approaches, compounded notional portfolio methods, recursive models and ad hoc smoothing algorithms.

#### 3.4.2.4 *Applying absolute attribution analysis*

Using the Advanced Portfolio Analytics Excel add-in (Andreas Steiner Consulting GmbH, 2013), the attribution analysis function is used to decompose each individual manager's return into the allocation and selection effects for each sector. This attribution analysis function makes use of the classic Brinson decomposition, and applies a geometric linking algorithm to link single period attribution effects.

Therefore the absolute return decomposition attribution will show, for each individual fund analysed, the total allocation and selection effects over the multiple-period time horizon considered. These allocation and selection effects are given with respect to the portfolio as a whole and for each of the sectors individually. From this attribution, the relative sources of equity fund performance can be determined. The relative value added through sector allocation and stock selection activities can also be ascertained.

### 3.4.3 *RISK-ADJUSTED PERFORMANCE ATTRIBUTION ANALYSIS*

It is evident that summary statistics based on the absolute attribution analysis results of a number of similar individual manager's performance records presents a good basis on which to determine the sources of relative equity fund performance. However, if a risk-adjusted approach is implemented, a deeper understanding will be available in determining the true sources of performance. Despite this opportunity, Kophamel (2003: 51) notes that limited attempts have been made to fuse the concepts of performance attribution analysis and risk-adjusted performance measures.

One potential approach which could be applied to determine the extent to which

the manager has succeeded in adding “genuine” value through active management decisions, is through an analysis using portfolio volatility and tracking error as risk measures.

Both portfolio volatility and tracking error are frequently cited risk measures. Portfolio volatility analysis presents the merit of being applicable within the mean/variance portfolio framework and tracking error presents a useful measure of the variability of excess returns.

Steiner (2012: 2–6) presents the mathematical derivation for a linear decomposition of both portfolio volatility and tracking error. An implication of this derivation is that traditional absolute attribution can additionally be used to decompose the tracking error and volatility of the portfolio into the appropriate allocation and selection effects. This can be done on both an overall fund- and sector-wise level.

This decomposition presents the merit of enabling fund managers to determine in which sectors and particular investment activity (sector allocation or stock selection) the most value per unit of risk has been added.

#### 3.4.3.1 *Applying risk-adjusted performance attribution analysis*

Consequently, such an analysis was performed to understand further the relative sources of equity fund performance within a risk-adjusted space. In addition, the value added through stock selection and sector allocation was also be evaluated within this risk-adjusted space.

To achieve this objective, the Advanced Portfolio Analytics<sup>7</sup> Excel add-in was again used to conduct a linear decomposition of both volatility and tracking error for each fund.

This function decomposes *ex-post* volatility and tracking error through the application of the linear-homogeneous property of volatilities (Steiner, 2012: 3). In order to account for the variability of the portfolio’s constituent weights within *ex-post* calculations, contributions are considered within this decomposition. The return contribution of a sector is defined as the product of the portfolio sector weight and the portfolio sector return at each *ex-post* discrete time point (Steiner, 2012: 3).

When *ex-post* contributions and the linear-homogeneous property of volatilities are considered and applied in conjunction, the following mathematical decomposition of *ex-post* volatility is possible (Steiner, 2012: 3):

$$\sigma_P^{Ex\ post} = \sum_{i=1}^n \rho(c)_{i,P} \times \sigma(c)_i$$

where

$\rho(c)_{i,P}$  is the correlation of the contributions of each portfolio constituent with the overall portfolio and

$\sigma(c)_i$  is the volatility of the portfolio constituent’s contributions.

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7 Andreas Steiner Consulting GmbH, 2013

Finally, if this volatility decomposition is instead considered with respect to active portfolio contributions instead of overall portfolio contributions, tracking error can similarly be decomposed. The tracking error can also be further disentangled to ascertain the tracking error specifically stemming from allocation and selection decisions. This is done as follows (Steiner, 2012: 3):

$$\sigma_A^{Ex\ post} = \rho_{a,A} \cdot \sigma_a + \rho_{s,A} \cdot \sigma_s + \rho_{i,A} \cdot \sigma_i$$

where

- $\rho_{a,A}$  is the correlation between the active contributions and allocation contributions,
- $\rho_{s,A}$  the correlation between active and selection contributions and
- $\rho_{i,A}$  the correlation between active contributions and interaction contributions.
- $\sigma_a$ ,  $\sigma_s$  and  $\sigma_i$  are the allocation, selection and interaction contribution volatilities respectively.

The above-mentioned tracking error and volatility decompositions were applied in this study to transform the absolute attribution analysis to a risk-adjusted space.

#### 4. FINDINGS

##### 4.1 Analysis of Sector Movements

The analysis found that, over the sample period considered, noticeable variations between the relative performances of each of the “super sectors” to the ALSI existed. Such variation should create opportunity for sector-selection excess returns. A graphical representation of these relative sector returns is presented in Figure 1.

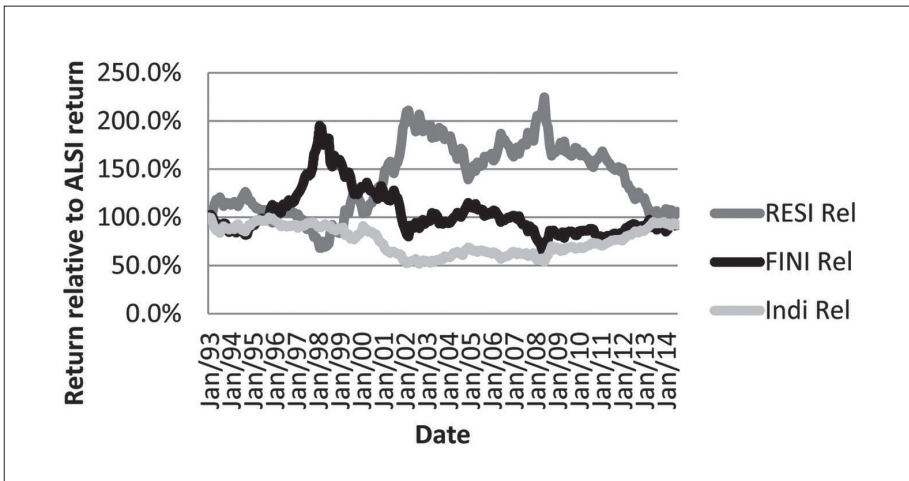


FIGURE 1 Super sector returns relative to the ALSI return

## 4.2 Absolute Attribution Analysis

### 4.2.1 ATTRIBUTION ANALYSIS ON A FUND LEVEL

The result of the equity fund attribution shows that for all funds (except Fund G) substantial excess returns have been generated through both allocation and selection efforts. As an illustration of this potential, consider Fund A that managed to enhance returns by 37.8% through selection efforts over a seven-year period and Fund B that added active value of 43.1% through allocation also over a seven-year period. The implication of this is that both allocation and selection activities may be able to contribute to fund outperformance.

An analysis of the attribution results shows that none of the sample managers (except for possibly Fund A) sourced substantial excess returns through both allocation and selection efforts simultaneously over their considered sample period. Instead, the results suggest that managers’ processes and skills tended to yield excess returns in one of the two active investment activities. There was no clear relationship between these results and the investment objectives outlined by the fund managers. These fund objectives are summarised in Table A, Appendix A.

The results of this attribution analysis seem to suggest that it is possible for fund managers’ decisions to lead to active value added in sector allocation and stock selection. Essentially, the analysis suggests that it is the specific investment processes used to arrive at investment decision that ultimately drives the nature of these sources of equity fund performance (see Figure 2).

### 4.2.2 DECOMPOSING THE ALLOCATION EFFECT

All but one of the sample funds (i.e. Fund B) observed a negative allocation effect from the industrial sector over their considered sample period. However, Fund B was very

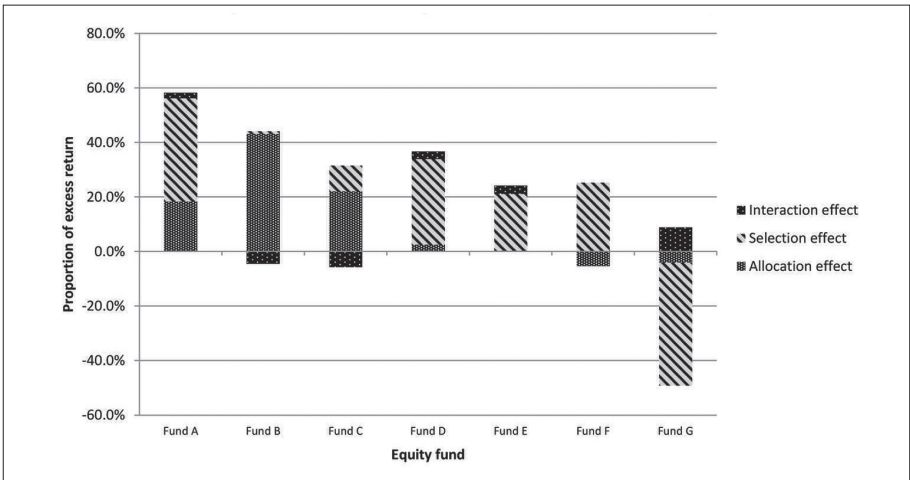


FIGURE 2 Proportional decomposition of excess returns

successful in this regard. This fund can attribute 80.55% of their positive allocation effect to their successes within this sector.

This fund achieved a positive allocation effect by taking on an overweight position in the industrial sector over the period July 2011 to August 2012. This positive allocation was observed as the industrial sector outperformed the benchmark portfolio over this period. Consequently, the other funds that under-allocated to this sector over this period missed this opportunity.

Despite having differing processes in determining their choice of investments, all the funds were able to exhibit positive sector allocation effects towards the resources sector. This was achieved through underweighting the resources sector in the portfolio relative to the resources weighting in the benchmark portfolio. The positive allocation effect resulted from the combined underweighting and underperformance of this sector relative to the benchmark.

Furthermore, six of the seven funds also exhibited a positive allocation effect towards the financial sector. This positive allocation effect was achieved through underweighting the sector in 2008, when the performance of the sector become volatile relative to the benchmark, and then rebalancing the portfolio to overweight the sector from January 2011. This overweighting led to a positive allocation effect from January 2011 onwards as the financial sector outperformed the overall benchmark return over this period.

This decomposition indicated that most of the sample funds had successes in making the correct sector calls towards the resources and financial sectors, but managers were less successful with respect to the industrial sector. This may be a result of the structural composition of the ALSI, as discussed in the section 4.2.5 (see Figure 3).

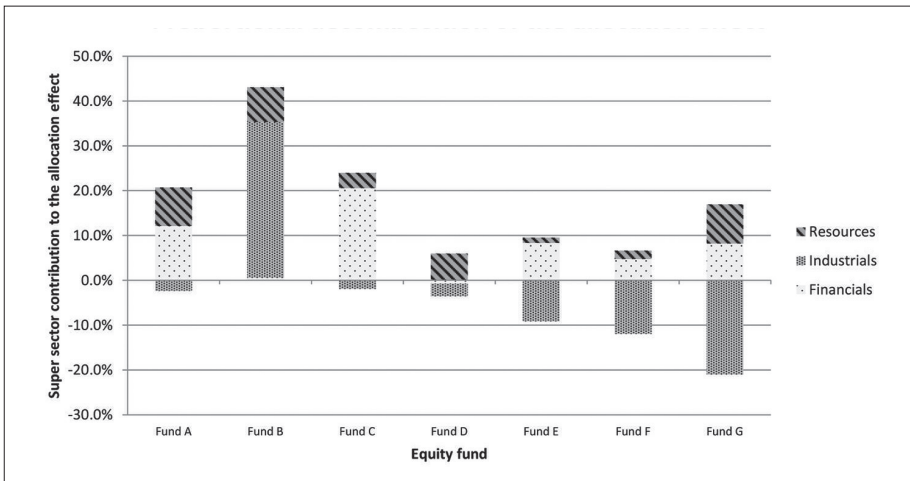


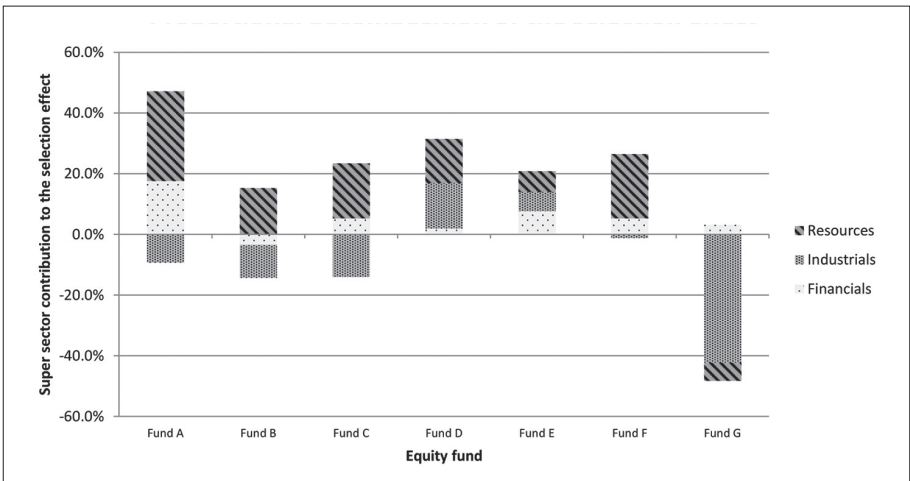
FIGURE 3 Proportional decomposition of the allocation effect

**4.2.3 DECOMPOSING THE SELECTION EFFECT**

Most of the sample funds detracted value from their portfolio because of stock picking efforts within the industrial sector. The only fund that managed to achieve a positive sector allocation effect towards the industrial sector did not manage to also achieve a positive selection effect within the sector. However, some funds that had a negative allocation effect towards this sector were still moderately rewarded for their industrial selection efforts. In particular, the funds that experienced positive selection in the industrial sector over the period July 2013 to June 2014 did this through holding a large weighting of Naspers shares within their portfolios. The outperformance of this stock over the period relative to the industrial benchmark return allowed for this positive selection effect to be observed.

Within the resources and financial sectors six of the seven funds were rewarded for their stock selection activities within these sectors. However, the average of the observed selection effects within the resources sector is 14.2%, which substantially exceeds the 5.4% average of value added through selection efforts from the financial sector. If this result is considered in conjunction with the strong positive allocation effects observed towards this resources sector, it could be argued that this is a sector in which managers can potentially be substantially rewarded for deviating from the benchmark portfolio.

This decomposition of the selection effect suggests that there is potential for stock selection to enhance excess returns. While stock selection activities within the financial, industrial and resources sectors can potentially add value to a portfolio, South African equity fund managers had difficulty in sourcing excess returns from the industrial sector. This may be a result of the structural composition of the industrial sector, as discussed in the section 4.2.5 (see Figure 4).



**FIGURE 4** Proportional decomposition of the selection effect

In order further to understand the relative importance of these activities, a decomposition of the relative value added by the allocation and selection activities on an individual sector-level is conducted.

**4.2.3.1 The financial sector**

An analysis of the excess returns sourced through active investment activities within the financial sector indicate that merits for both sector allocation and selection efforts exists. The justification for this statement is based on the fact that the financial sector observed both high values for value added through sector allocation and stock selection. As evidence of this, consider Fund A and Fund C, that achieved allocation effects of 12.1% and 20.6% respectively. The merits for stock picking efforts within this sector are confirmed by the selection successes of Fund A. Fund A sourced an excess return of 17.5% over seven years through the correct picking of individual stocks within this sector. Notably, this sector also exhibited the highest average of value added through allocation efforts of the three considered sectors (see Figure 5).

**4.2.3.2 The industrial sector**

A comparison of the sample funds industrial sector attribution results revealed a vast dispersion in the value added through allocation and selection decisions within this sector, with this sector exhibiting the greatest variance of achieved allocation and selection effects (see Figure 6).

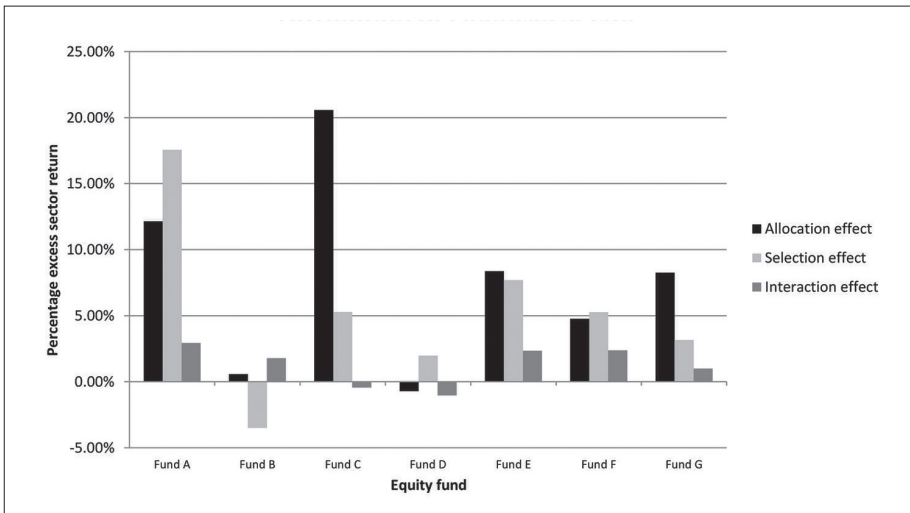


FIGURE 5 Attribution of financial sector



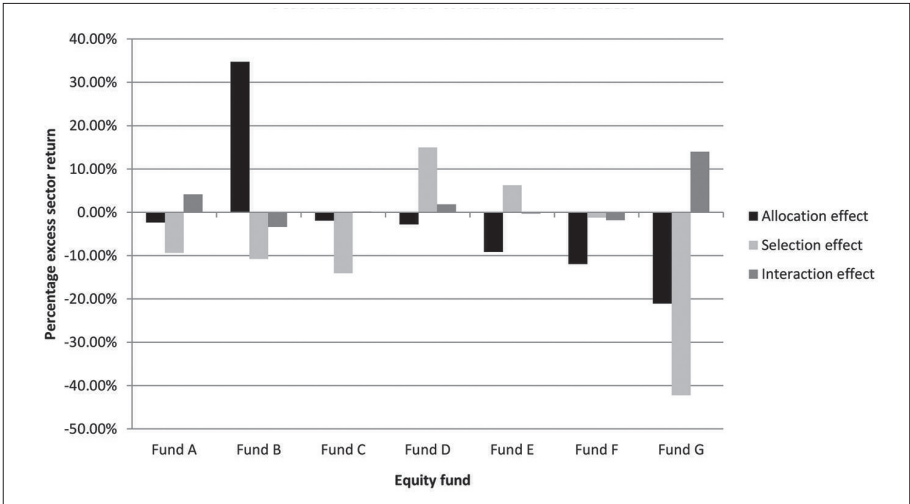


FIGURE 6 Attribution of industrial sector

4.2.3.3 *The resources sector*

Within this sector, the value added by stock selection activities exceeded the value added from the timeous allocation to this sector. This sector also had the highest average of value added through selection activities of all the sectors. Fund A was particularly successful in this regard, and they can attribute roughly half of their fund outperformance to their skill within this activity (see Figure 7).

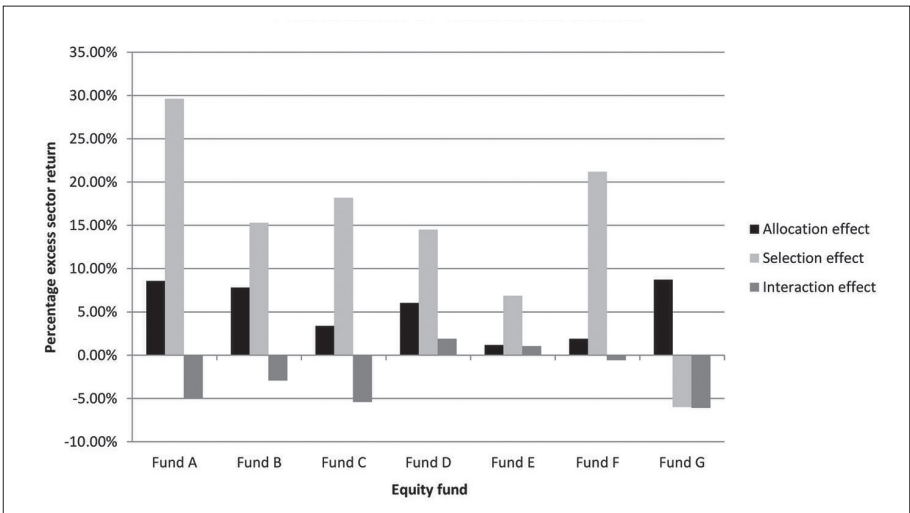


FIGURE 7 Attribution of resources sector

An important consideration when analysing the sources of portfolio returns within this sector is the volatility of the resources sector performance in comparison to the overall benchmark performance volatility. Over the period July 2007 to June 2014, the standard deviation of monthly benchmark portfolio returns was 4.86%, whereas the sector alone had a standard deviation of monthly returns of 7.24%.

The implication of this volatility seems to be a greater difficulty in achieving positive allocation effects within this sector in comparison with the allocation potential prevalent within the other, less volatile, sectors. In order to achieve positive allocation returns, regular changes need to be made to the weight of this sector in the portfolio. The costs involved in such frequent portfolio rebalances could offset the gains that such a strategy may provide, thus rendering such a strategy unviable. This may explain why managers observed the greatest value added from this sector from selection efforts.

#### **4.2.4 CONCLUSIONS**

The results seem to suggest that the relative contribution of allocation and selection efforts to overall excess fund returns is dependent on the investment processes followed by the individual fund managers.

The short time period over which manager performance was assessed does raise the question of whether a manager's success within a particular sector is attributable to luck. As an example of this question and the difficulties involved in identifying skill or luck as the driver of performance, consider Fund B's outlier success in achieving positive industrial sector allocation. It is unclear whether this success can be attributed to the active decision to overweight this sector, or whether this success is simply due to the constituents of the fund portfolio luckily being so that the fund would benefit from relative successes within this sector anyway.

It was noted above that most funds did not add value in the industrial sector. A relevant issue is the extent to which structural issues affect such performance. In particular, if there is one share, or a small number of shares, that dominate the industrial sector, proper diversification of a portfolio might preclude a manager from being overweight in that share (or group of shares). The resulting underweight position will lead to underperformance should this share (or group of shares) outperform the overall index, and outperformance otherwise. Such structural issues make it more difficult to evaluate manager skill.

### **4.3 Risk-adjusted Attribution Analysis**

This risk-adjustment is made with respect to the two risk measures of volatility and tracking error.

#### **4.3.1 VOLATILITY AS RISK-ADJUSTMENT MEASURE**

The findings of this analysis indicated that all of the sample funds were able to construct their portfolios in such a way that the volatility of their portfolio's monthly returns was less than the volatility of the benchmark portfolio's monthly returns (see Figure 8).

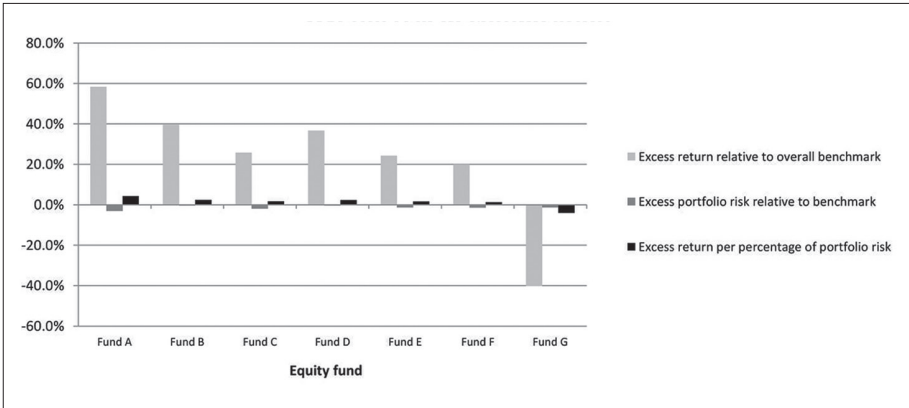


FIGURE 8 Overall risk decomposition

Of interest is that six of the seven managers outperformed the benchmark portfolio, despite reducing the level of risk within their portfolios relative to the benchmark. While the excess return per unit of risk is not large for any of the funds, the consistently positive result (except for Fund G) might suggest a contradiction with standard mean/variance portfolio theory, which suggests that higher expected returns are sourced through taking on increased levels of risk. This observation could be indicative of high levels of manager skill in creating well-diversified portfolios.

In particular, Fund A performed well in this regard. It observed portfolio volatility of 3% less than the benchmark portfolio, but despite this volatility reduction, added 19.4% in excess returns per percentage of volatility reduced.

On a sector level, the resources sector presented the best opportunity potentially to generate excess risk-adjusted returns, as the sector simultaneously allowed for the greatest average of risk reduction and the highest average of excess sector returns generated. The driving force for this observation could potentially be linked to the sample funds avoiding particularly volatile stocks within this sector. These volatile stocks may be shareholdings in gold companies, as their share price would be linked to the temperamental commodity price of gold (see Figure 9).

In contrast to the resources sector, in order to generate excess returns within the financial sector, additional risk had to be taken on relative to the benchmark financial portfolio. However, this additional risk contributed the smallest percentage to the overall portfolio volatility for all seven funds considered (refer to Appendix C).

In exchange for this small increase in overall portfolio volatility, funds were rewarded through an increase in excess returns. If it were additionally considered that the financial sector achieved the highest average sector excess returns per percentage of volatility in sector returns, it would suggest that good opportunities exist to generate excess-risk adjusted returns within the this sector (see Figure 10).

The industrial sector also required additional risk to be added to the portfolio

in order to generate excess returns. However, funds were not that successful in generating excess returns through taking on this additional risk, with only two equity funds having success in this regard. The majority of the sample experienced their

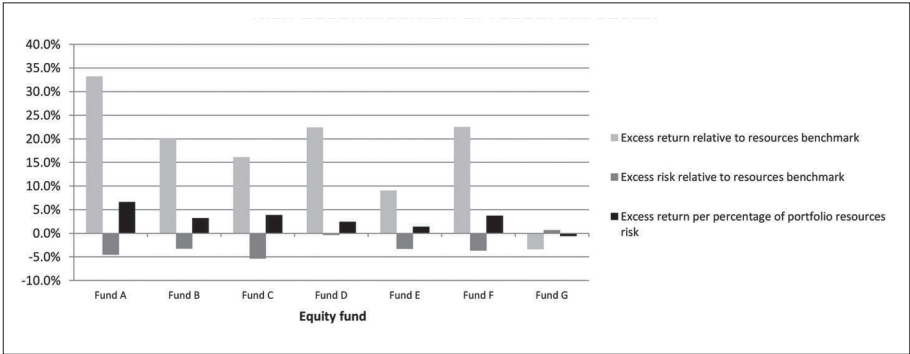


FIGURE 9 Risk decomposition of the resources sector

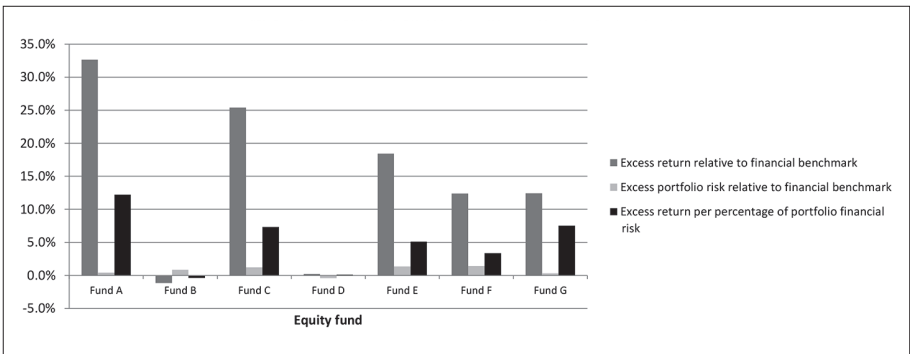


FIGURE 10 Risk decomposition of the financial sector

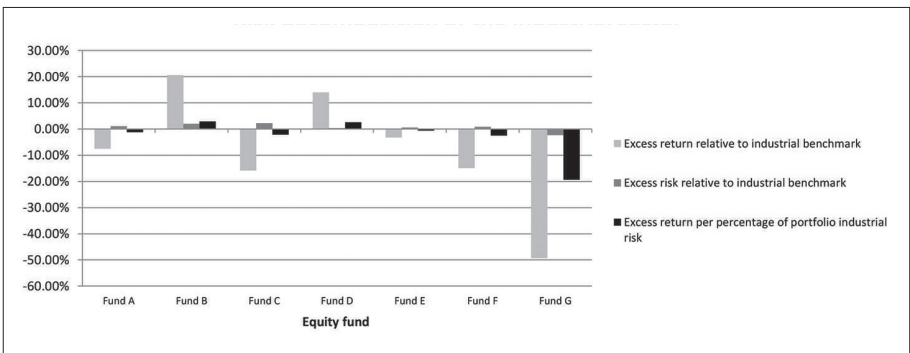


FIGURE 11 Risk decomposition of the industrial sector

worst performance in this sector, achieving a negative excess return relative to the benchmark, despite taking on additional risk relative to the benchmark portfolio in this sector (see Figure 11). For three of the funds, this sector also provided the greatest contribution to portfolio volatility (refer to Appendix C).

The analysis of portfolio volatility has provided insights into the sources of risk-adjusted equity fund performance. However, additional benefits in order to deepen the understanding of the sources of active investment performance can still be gained through a decomposition of tracking error.

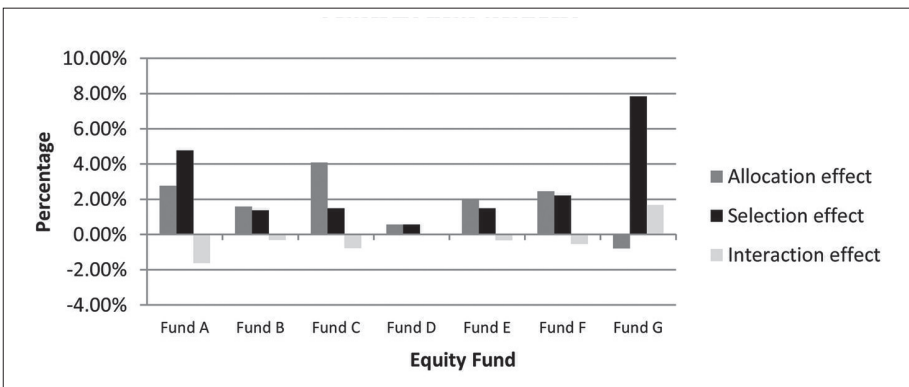
**4.3.2 TRACKING ERROR AS RISK-ADJUSTMENT MEASURE**

The tracking error gives a measure of the volatility of the excess returns achieved by a fund, giving an indication of the consistency of fund performance (Vanguard, 2009:1).

Within this study, the tracking errors of the sample funds varied considerably, with a lowest value of 3.28% observed for Fund D and a highest value of 16.54% experienced by Fund G.

Most important in understanding how active value was added by deviating from the benchmark portfolio was that six of the seven funds sourced the largest percentage of their tracking error from the resources sector. To view a schematic breakdown of the contribution of each sector to manager tracking error, refer to Appendix C, Figures C2.1–C2.7.

This large percentage contribution of the resource sector to overall tracking error is indicative of the equity funds’ experiencing the largest volatility in the excess returns generated within this sector. The resources sector was also the only one of the three “super sectors” in which a large contribution to tracking error was sourced through both allocation and selection efforts. This may potentially stem from equity fund managers’ attempts to avoid the more volatile commodity companies, meaning that they hold resources portfolios that differ substantially from that of the benchmark portfolio. Advantageously, all but one of the funds benefited from taking on this excess



**FIGURE 12** Tracking error decomposition of the resources sector

tracking error risk through an increase in the excess returns achieved in this sector (see Figure 12).

In contrast, all the sample equity funds observed the smallest contribution to tracking error from the financial sector and this contribution to tracking error mostly stemmed from selection efforts within this sector (see Figure 13).

In particular, Fund A sourced high excess returns from their active efforts in the financial sector, and observed a small tracking error in doing so. This observation is indicative of consistent successes in generating these excess returns. This financial tracking error stemmed from both allocation and selection efforts, although Fund A was rewarded more substantially per unit of tracking error for their selection efforts.

Fund C also managed to benefit from timeous allocation to the financial sector over the period July 2007 to June 2014. They managed to source a large proportion of their excess returns from positive allocation to this sector over this period, and did so through introducing only a small percentage of 0.2% of tracking error into the portfolio.

The industrial sector also presents for an interesting analysis of tracking error decomposition and, as with the financial sector, the observed tracking error within this sector can mostly be attributed to selection efforts (See Figure 14). Despite this, few of the managers were rewarded for their active stock selections within this sector, with Fund D and Fund E being the only two funds to have had success in this regard. Selection within the industrial sector contributed 45.3% to Fund D's tracking error; however, they were rewarded with 14.9% in excess returns for these efforts over the period July 2007 to June 2014.

In general, the tracking error introduced through selection efforts tended to contribute positively to sourcing excess selection returns. The sample funds were, on average, less successful in achieving excess allocation returns through the tracking error sourced from allocation efforts. However, Fund B had particular success in this regard, as they managed to source 88.6% of their excess returns through allocation

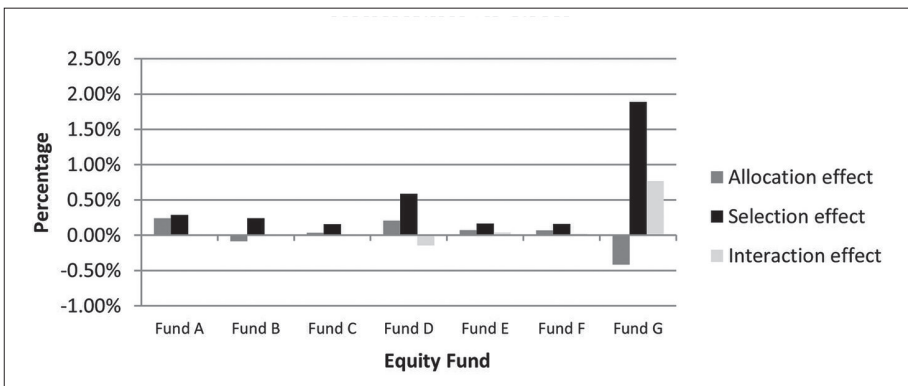


FIGURE 13 Tracking error decomposition of the financial sector

efforts, but allocation efforts only contributed 34.0% towards their total tracking error (see Figure 15).

4.3.3 CONCLUSION

Total tracking errors of the sample of equity funds were sourced through both selection and sector allocation activities. For the majority of funds, a greater percentage contribution to their respective tracking errors can be ascribed to their selection efforts. However, managers on average did benefit from these deviations from the benchmark portfolio, as it allowed excess selection returns to be sourced. The degree of efficiency to which this increase in tracking error contributed to excess returns, however, varied substantially across the managers. This is indicative of differing information ratios and differing levels of manager skill observed in this regard.

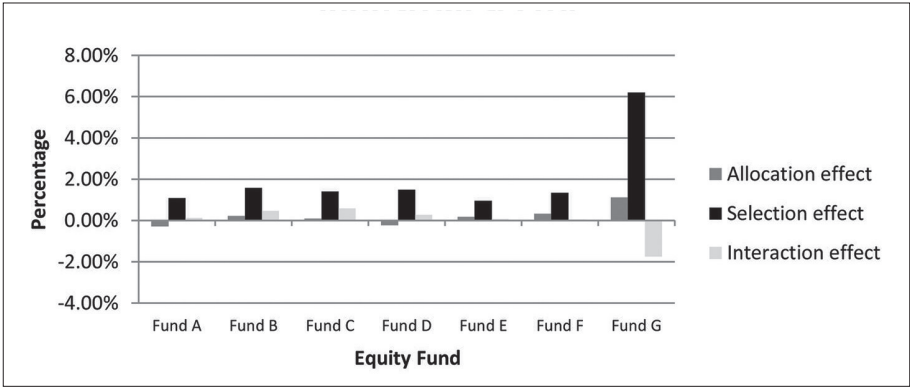


FIGURE 14 Tracking error decomposition of the industrial sector

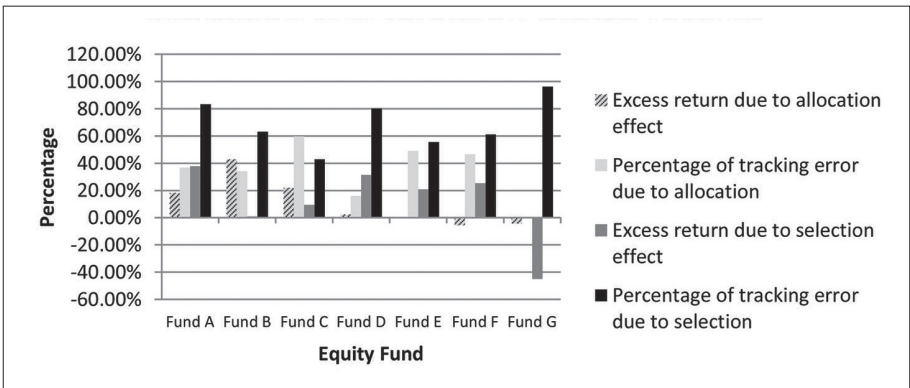


FIGURE 15 Allocation and selection tracking error vs allocation and selection excess returns

On average, managers added less risk-adjusted value from their allocation efforts than from their selection efforts. Six of the seven managers contributed positively to tracking error from allocation, however only three of the funds observed substantial excess returns as a result of this deviation from the benchmark portfolio. One of the managers was even adversely penalised for their increase in tracking error through allocation. This may be indicative that this manager's energies may have been better spent within other active investment activities. This is particularly relevant when it is considered that the manager was able to source excess returns through selection efforts.

When the sources of tracking error are evaluated on a sector level, it becomes evident that most funds experienced the largest contribution to tracking error from the resources sector, and this was sourced through both allocation and selection activities within this sector. However, most managers benefited from substantial excess returns from this deviation from the benchmark portfolio.

On average, the financial and industrial sectors contributed smaller respective percentages to total tracking error, and most of this tracking error was sourced through selection efforts within these sectors. However, the value added by this increase in tracking error to the excess sector returns generated varied substantially across the managers.

## 5. SUMMARY AND CONCLUSION

### 5.1 Introduction

This research sought to identify and explain some of the sources of South African equity fund performance, whilst considering the constraints of the South African active investment environment and data limitations. Active investment management is a broad topic that has generated great interest within both the academic and financial world. This interest has led to the development of a vast body of literature and portfolio analysis techniques that seek to better understand the drivers of active performance.

### 5.2 Summary of the Main Findings

This study attempted to quantify some of the sources of South African equity unit trust fund performance through the implementation of three methodologies. These methodologies included an analysis of opportunities for excess returns from sector allocation in the South African market environment and two attribution analyses: one that was conducted on an absolute level and the other that also considered risk-adjusted returns. These methodologies were adapted to consider the constraints imposed by the South African equity market environment.

The first methodology considered the performances of each of the "super sectors" relative to the ALSI. The variability of returns for each of the sectors relative to each other and to the ALSI provided managers with the potential to generate excess returns through sector allocation decisions.

In addition to sector allocation decisions, managers attempt to generate excess returns by selection of individual stocks. A performance attribution analysis was



carried to out to investigate the relative importance of sector and stock selection decisions.

This attribution analysis showed that sector allocation and stock selection activities have both been a source of excess returns over the periods investigated. However none of the managers (except for perhaps managers of Fund A) sourced substantial excess returns in both these two investment activities simultaneously. Instead, it appears that managers generally yielded excess returns from only one of these investment activities (either sector allocation or stock selection). The relationship between these results and fund manager objectives was not clear.

The attribution analysis also provided insight into the relative merits of sector allocation and stock selection at a sector level. Overall, most managers generated excess returns from sector allocation decisions relating to each of the sectors. The exception to this was in the industrial sector, in which the observed allocation effect was generally negative. The financial sector contributed on average the greatest value to positive allocation, but sound allocation merits were also presented by the resources sector.

The poor experience relating to the industrial sector could be as a result of structural issues, namely the dominance of a small group of shares which makes it difficult for managers to be overweight without exposing their portfolios to excessive concentration risk.

In terms of observed stock selection effects, a similar trend to that of the sector allocation effect was experienced. Most funds experienced adverse stock selection effects in the industrial sector, but gained through positive stock selection in the resources and financial sectors. However, in terms of value added through selection activities, the most active value was added through the resources sector.

The risk-adjusted attribution analysis demonstrated that the managers were able to source excess returns without increasing their portfolio risk relative to the benchmark. In fact, on average, the sample of equity funds generated excess returns despite decreasing their portfolio risk relative to the benchmark. This result may be indicative of the presence of manager skill. The analysis presents some evidence to justify the statement that the sample of South African equity fund managers preside over a level of skill in the active investment activities in which they engage. However, it must be noted that the universe of managers used within this study is very small and the results are measurement-period dependent.

As a consequence of this, perhaps the greatest value that can be extracted from the findings of this paper is a presentation of a methodology that could be used to analyse portfolio returns. This method can be adjusted to consider any number of sectors, or any potential index as benchmark, over any desired period. The choice of these input parameters would depend on the purpose for performing the analysis. When deciding on these inputs, it is important to consider the structural issues that the South African market environment presents if the output is to have value.

Such decomposition of performance could be used by managers to better understand the results of their decisions by attributing their performance to sector allocation

and stock selection decisions, and understanding how their decisions changed their fund's risk relative to the benchmark. This may help them to verify that their decision-making process is indeed leading to added value in the manner which it is intended to do. Investment consultants can also use such results to evaluate if managers are indeed adding value in the manner in which they claim to be doing. Furthermore, with enough data, trends can be evaluated over time, and an investment consultant would be able to compare how the sources of a fund's performance have changed over time, under different market conditions.

### 5.3 Further Research

The greatest limitation of this study arises from the small size of the sample set. The value of this study would be greatly enhanced through additional data from more funds, and over longer periods.

The risk-adjusted analysis introduced in this study could be extended through an implementation of a "performance cubes" style analysis.

### ACKNOWLEDGEMENTS

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## APPENDIX A

TABLE A.1 Sample funds and their respective fund objectives and benchmarks

<b>Fund name</b>	<b>Fund objective</b>	<b>Benchmark</b>
<b>Fund A</b>	The fund aims to outperform the South African equity market over the long term, without taking on greater risk.	FTSE/JSE ALSI
<b>Fund B</b>	This fund uses fundamental research in an attempt to generate long-term risk-adjusted returns. It is style agnostic, a combination of value and growth styles, and is benchmark conscious with a tracking error of 3–6%.	FTSE/JSE SWIX Index
<b>Fund C</b>	This fund aims to deliver positive real returns that exceed the local equity market returns in the long-term. Fund C is an active value fund that places more emphasis on track record and fact than forecast and speculation.	FTSE/JSE SWIX Index
<b>Fund D</b>	Fund D seeks to achieve broad-based exposure to shares that offer value and medium- to long-term growth, whilst still limiting volatility relative to the FTSE/JSE All Share Index.	ASISA South African – Equity – General Category Mean
<b>Fund E</b>	The aim of this fund is to maximise performance within a reasonably tight tracking error constraint. The fund aims to be fully invested in South African equities on a consistent basis, and uses a bottom-up research process to select their investments.	FTSE/JSE SWIX Index
<b>Fund F</b>	This fund seeks to significantly outperform its benchmark over time. This fund also uses a bottom-up research process to determine their investment decisions.	FTSE/JSE SWIX Index
<b>Fund G</b>	Fund G is geared towards the more aggressive investor as it seeks to achieve long-term capital growth with a level of risk acceptable only to an aggressive investor.	FTSE/JSE ALSI

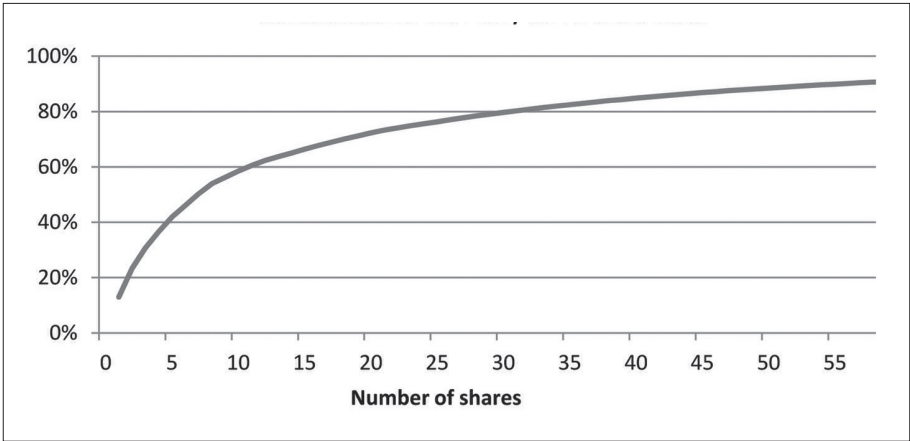


FIGURE A.1 Concentration of the FTSE/JSE All Share Index

Sector weight relative to benchmark weight	Benchmark return	
	Benchmark sector return > Benchmark total return	
Portfolio sector weight > Benchmark sector weight	Positive allocation effect The investment manager over-allocated assets to a sector that outperformed the total benchmark	Negative allocation effect The investment manager under-allocated assets to a sector that outperformed the total benchmark
Portfolio sector weight < Benchmark sector weight	Negative allocation effect The investment manager over-allocated assets to a sector that underperformed the total benchmark	Positive allocation effect The investment manager under-allocated assets to a sector that underperformed the total benchmark

FIGURE A.2 The four allocation effect scenarios

APPENDIX B

ABSOLUTE ATTRIBUTION ANALYSIS- FINDINGS

B.1 Fund A Equity Fund Attribution Results

TABLE B.1 Fund A Equity Fund absolute attribution results

Attribution results				
Geometric return attribution – BHB	AA	S	I	Total
Financial	12.1%	17.6%	2.9%	32.6%
Industrial	-2.3%	-9.3%	4.1%	-7.5%
Resources	8.6%	29.6%	-5.0%	33.2%
<b>Total</b>	<b>18.4%</b>	<b>37.8%</b>	<b>2.1%</b>	<b>58.3%</b>

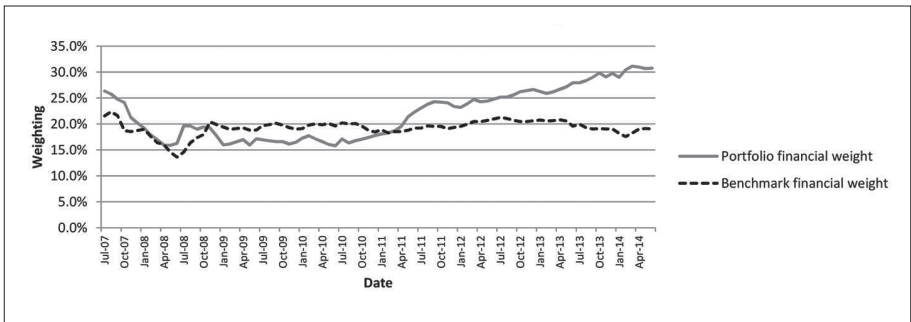


FIGURE B1.1 Fund A financial sector weights

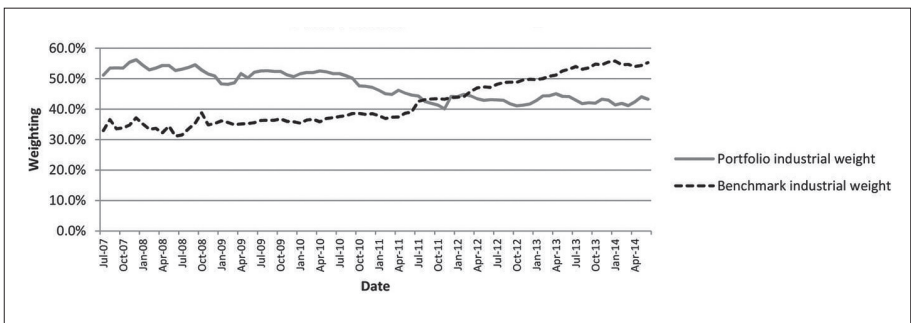


FIGURE B1.2 Fund A industrial sector weights

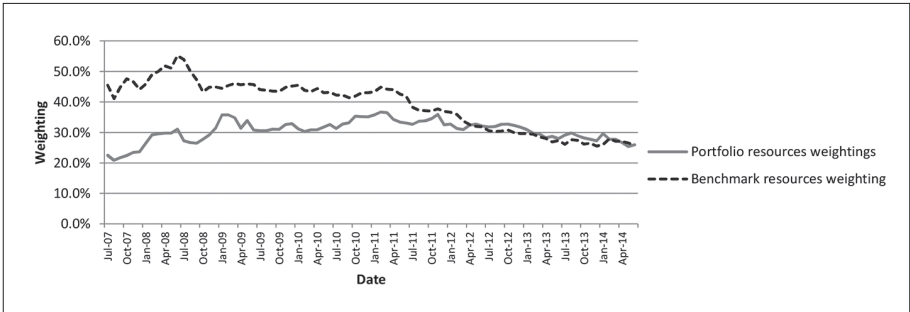


FIGURE B1.3 Fund A resources sector weights

B.2 Fund B Equity Fund attribution results

TABLE B.2 Fund B Equity Fund absolute attribution results

Attribution results				
Geometric return attribution – BHB	AA	S	I	Total
Financial	0.6%	-3.5%	1.8%	-1.1%
Industrial	34.7%	-10.8%	-3.3%	20.6%
Resources	7.8%	15.3%	-2.9%	20.2%
<b>Total</b>	<b>43.1%</b>	<b>1.0%</b>	<b>-4.5%</b>	<b>39.6%</b>

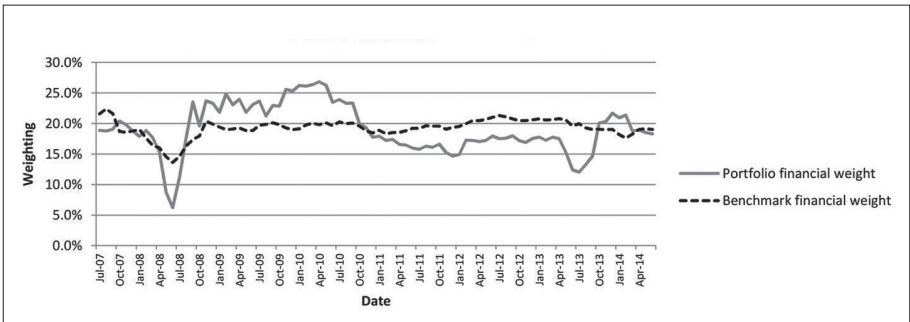


FIGURE B2.1 Fund B financial sector weights



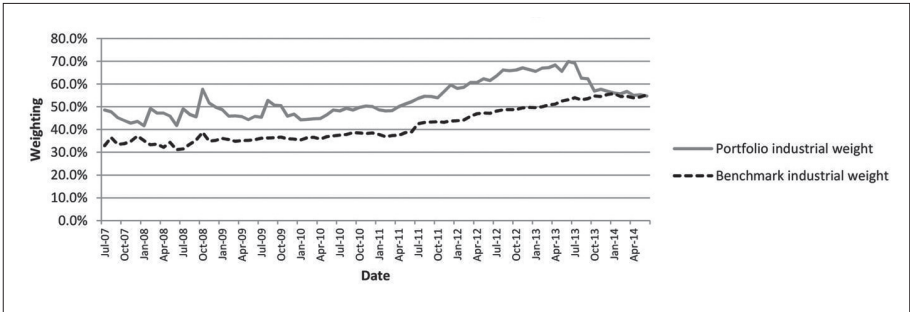


FIGURE B2.2 Fund B industrial sector weights



FIGURE B2.3 Fund B resources sector weights

**B.3 Fund C Equity Fund attribution results**

TABLE B.3 Fund C Equity Fund absolute attribution results

Attribution results				
Geometric return attribution – BHB	AA	S	I	Total
Financial	20.6%	5.3%	-0.4%	25.4%
Industrial	-1.9%	-14.0%	0.1%	-15.8%
Resources	3.4%	18.2%	-5.4%	16.1%
<b>Total</b>	<b>22.1%</b>	<b>9.4%</b>	<b>-5.7%</b>	<b>25.8%</b>

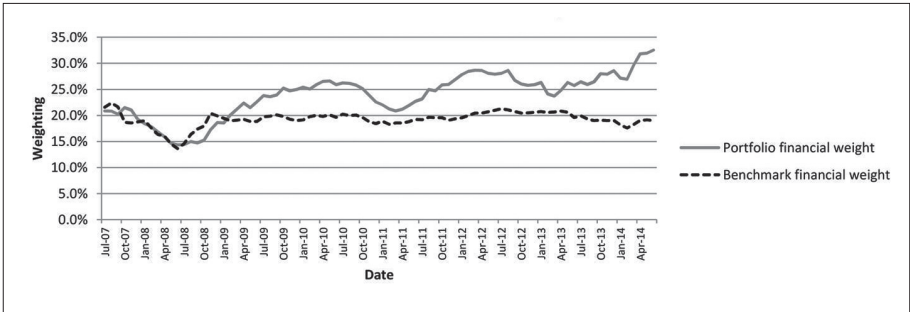


FIGURE B3.1 Fund C financial sector weights

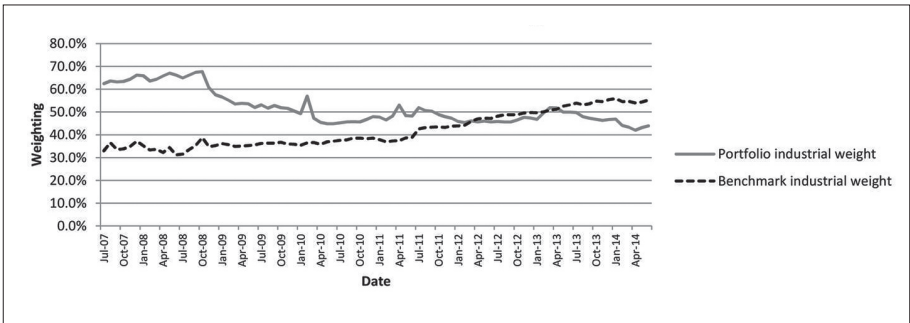


FIGURE B3.2 Fund C industrial sector weights

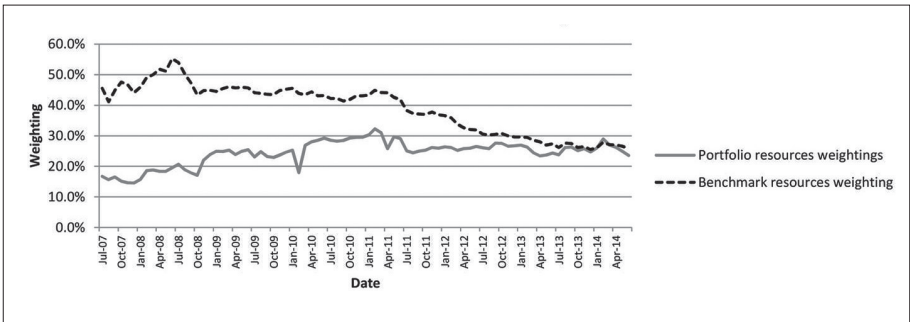


FIGURE B3.3 Fund C resources sector weights

### B.4 Fund D Equity Fund attribution results

TABLE B.4 Fund D Equity Fund absolute attribution results

Attribution results				
Geometric return attribution – BHB	AA	S	I	Total
Financial	-0.7%	2.0%	-1.0%	0.2%
Industrial	-2.8%	14.9%	1.8%	14.0%
Resources	6.0%	14.5%	1.9%	22.4%
<b>Total</b>	<b>2.5%</b>	<b>31.4%</b>	<b>2.7%</b>	<b>36.6%</b>

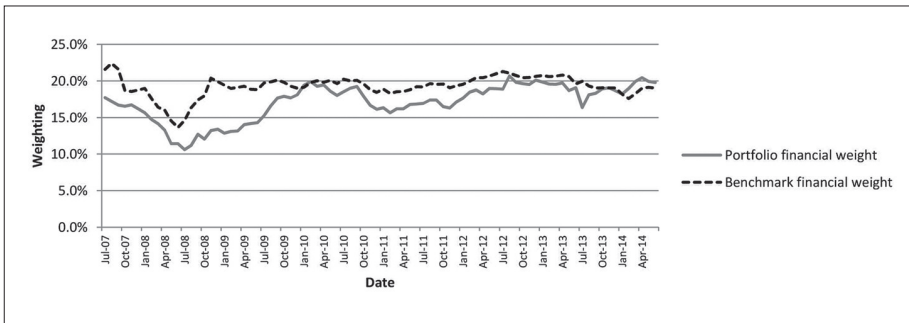


FIGURE B4.1 Fund D financial sector weights

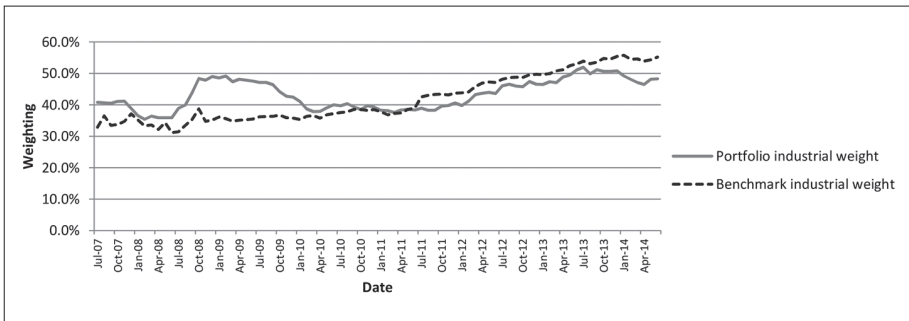


FIGURE B4.2 Fund D industrial sector weights

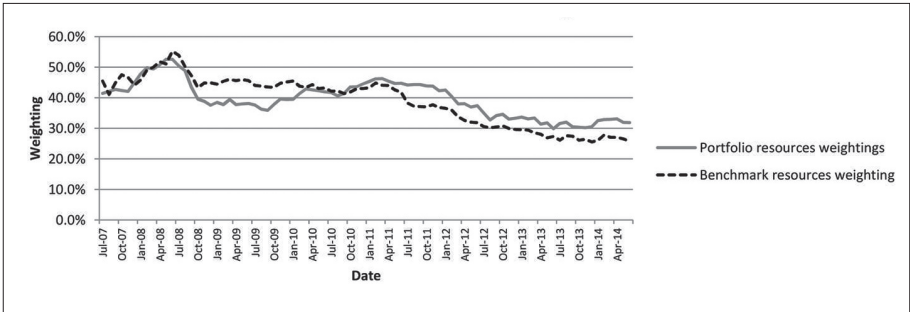


FIGURE B4.3 Fund D resources sector weights

B.5 Fund E Equity Fund attribution results

TABLE B.5 Fund E Equity Fund absolute attribution results

Attribution results				
Geometric return attribution – BHB	AA	S	I	Total
Financial	8.4%	7.7%	2.3%	18.4%
Industrial	-9.2%	6.2%	-0.3%	-3.2%
Resources	1.2%	6.9%	1.0%	9.0%
<b>Total</b>	<b>0.4%</b>	<b>20.8%</b>	<b>3.1%</b>	<b>24.2%</b>

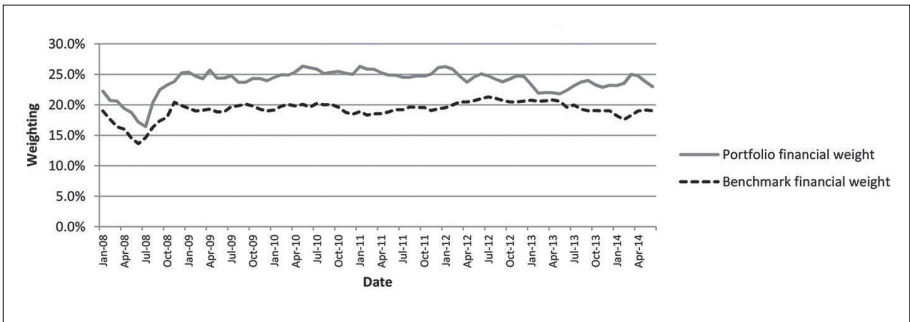


FIGURE B5.1 Fund E financial sector weights

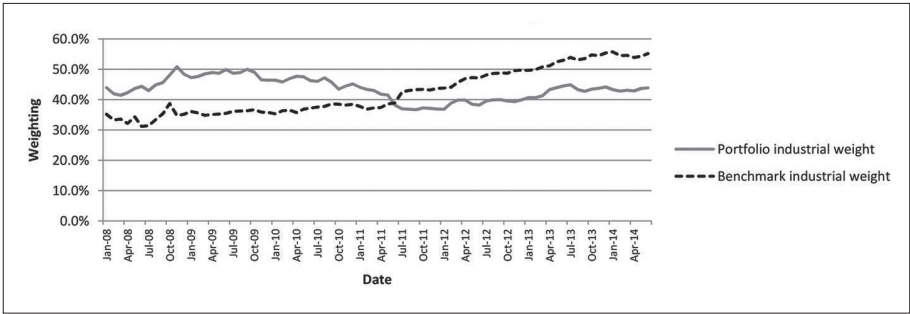


FIGURE B5.2 Fund E industrial sector weights

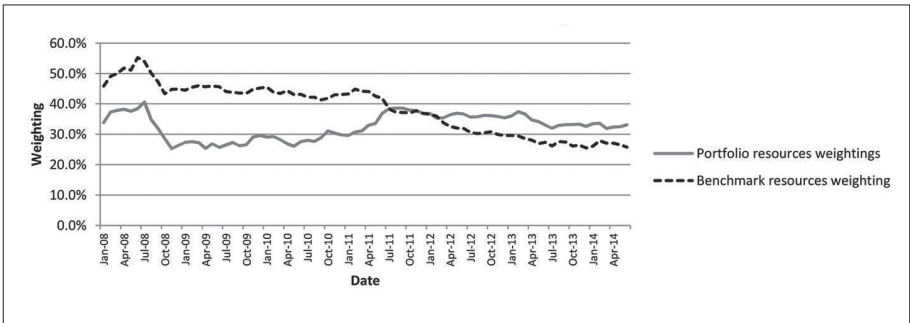


FIGURE B5.3 Fund E resources sector weights

**B.6 Fund F Equity Fund attribution results**

TABLE B.6 Fund F Equity Fund absolute attribution results

Attribution results				
Geometric return attribution – BHB	AA	S	I	Total
Financial	4.8%	5.3%	2.4%	12.4%
Industrial	-11.9%	-1.2%	-1.8%	-14.9%
Resources	1.9%	21.2%	-0.6%	22.5%
<b>Total</b>	<b>-5.3%</b>	<b>25.3%</b>	<b>0.0%</b>	<b>20.0%</b>

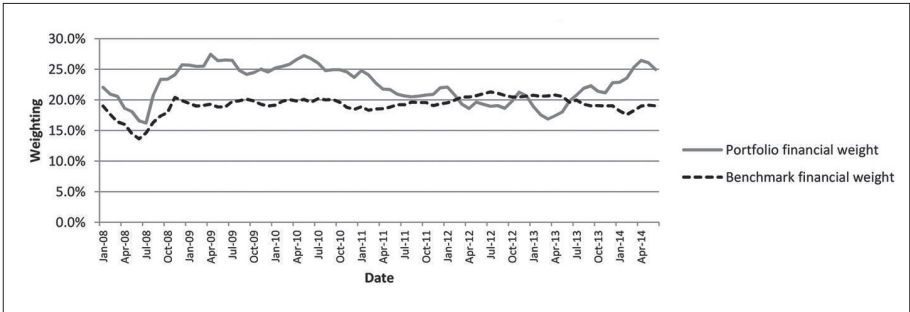


FIGURE B6.1 Fund F financial sector weights

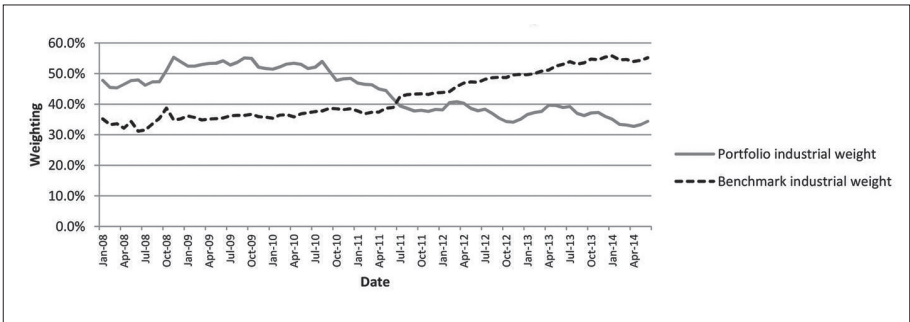


FIGURE B6.2 Fund F industrial sector weights

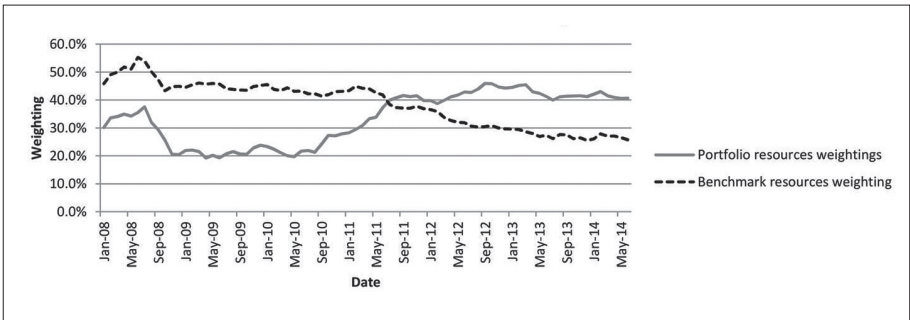


FIGURE B6.3 Fund F resources sector weights

### B.7 Fund G Equity Fund attribution results

TABLE B.7 Fund G Equity Fund absolute attribution results

Attribution results				
Geometric return attribution – BHB	AA	S	I	Total
Financial	8.3%	3.2%	1.0%	12.4%
Industrial	-21.0%	-42.2%	14.0%	-49.3%
Resources	8.7%	-6.0%	-6.1%	-3.4%
<b>Total</b>	<b>-4.0%</b>	<b>-45.1%</b>	<b>8.9%</b>	<b>-40.3%</b>

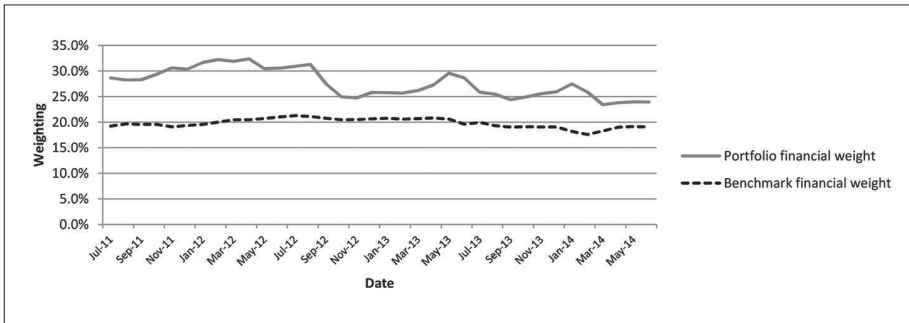


FIGURE B7.1 Fund G financial sector weights

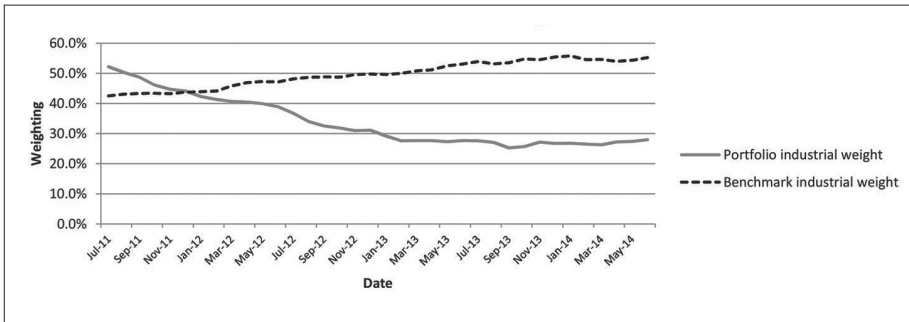


FIGURE B7.2 Fund G industrial sector weights

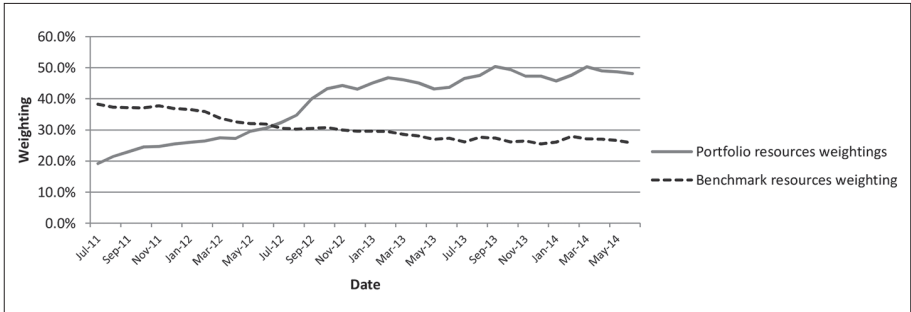


FIGURE B7.3 Fund G resources sector weights



## APPENDIX C

### RISK-ADJUSTED ATTRIBUTION ANALYSIS – FINDINGS

#### C.1 Volatility as Risk-adjustment Measure

##### C1.1 FUND A EQUITY FUND VOLATILITY DECOMPOSITION RESULTS

TABLE C1.1 Fund A volatility decomposition

Risk decomposition	Financial	Industrial	Resources	Total
Portfolio	2.7%	6.1%	5.0%	13.8%
Benchmark	2.2%	5.0%	9.5%	16.8%

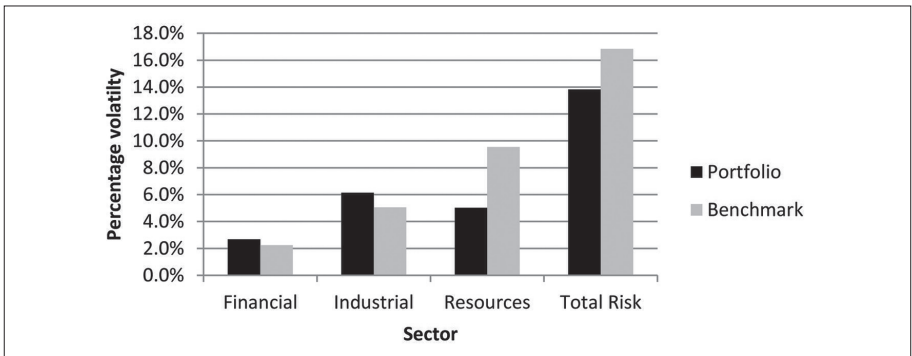
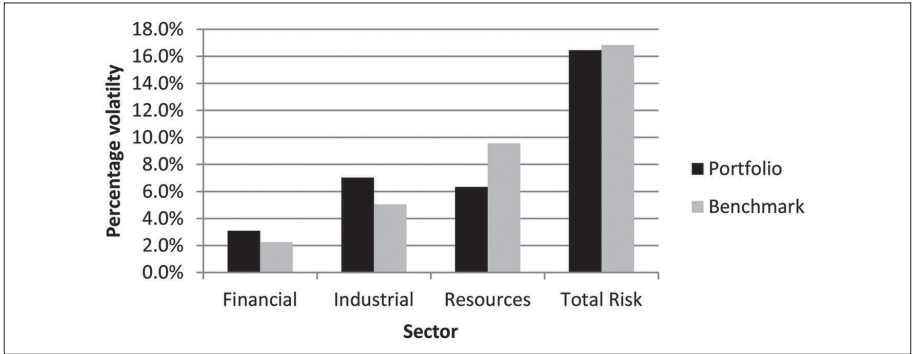


FIGURE C1.1 Fund A volatility decomposition

**C1.2 FUND B EQUITY FUND VOLATILITY DECOMPOSITION RESULTS**

**TABLE C1.2** Fund B volatility decomposition

Risk decomposition	Financial	Industrial	Resources	Total
Portfolio	3.1%	7.0%	6.3%	16.5%
Benchmark	2.2%	5.0%	9.5%	16.8%

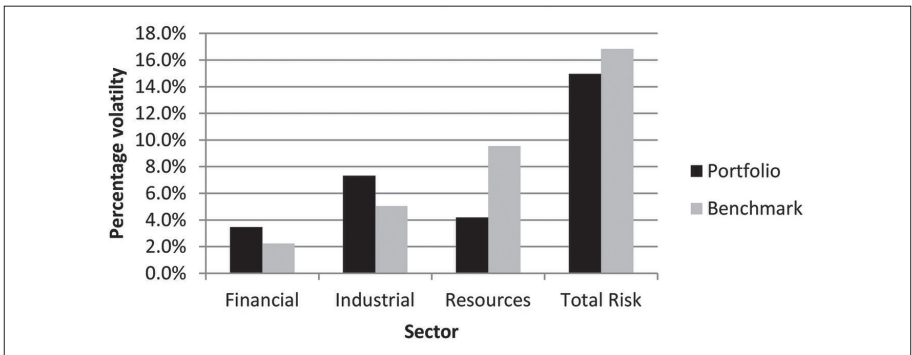


**FIGURE C1.2** Fund B volatility decomposition

**C1.3 FUND C EQUITY FUND VOLATILITY DECOMPOSITION RESULTS**

**TABLE C1.3** Fund C volatility decomposition

Risk decomposition	Financial	Industrial	Resources	Total
Portfolio	3.5%	7.3%	4.2%	15.0%
Benchmark	2.2%	5.0%	9.5%	16.8%

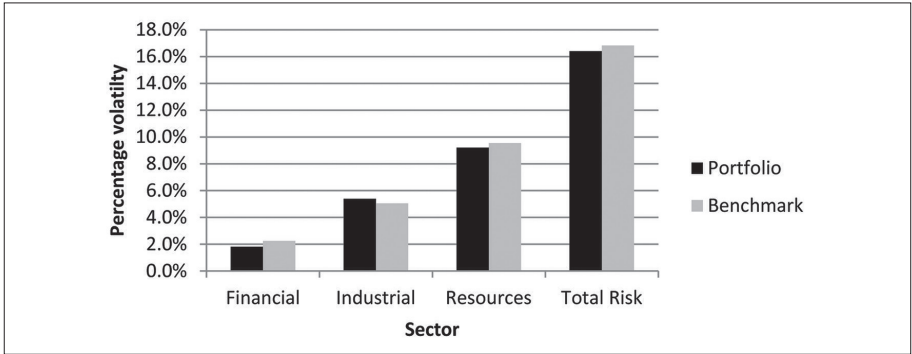


**FIGURE C1.3** Fund C volatility decomposition

**C1.4 FUND D EQUITY FUND VOLATILITY DECOMPOSITION RESULTS**

**TABLE C1.4** Fund D volatility decomposition

Risk decomposition	Financial	Industrial	Resources	Total
Portfolio	1.8%	5.4%	9.2%	16.4%
Benchmark	2.2%	5.0%	9.5%	16.8%

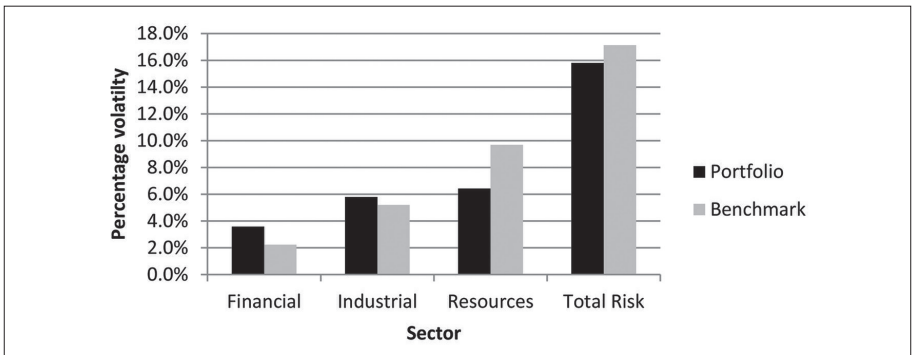


**FIGURE C1.4** Fund D volatility decomposition

**C1.5 FUND E EQUITY FUND VOLATILITY DECOMPOSITION RESULTS**

**TABLE C1.5** Fund E volatility decomposition

Risk decomposition	Financial	Industrial	Resources	Total
Portfolio	3.6%	5.8%	6.4%	15.8%
Benchmark	2.2%	5.2%	9.7%	17.1%

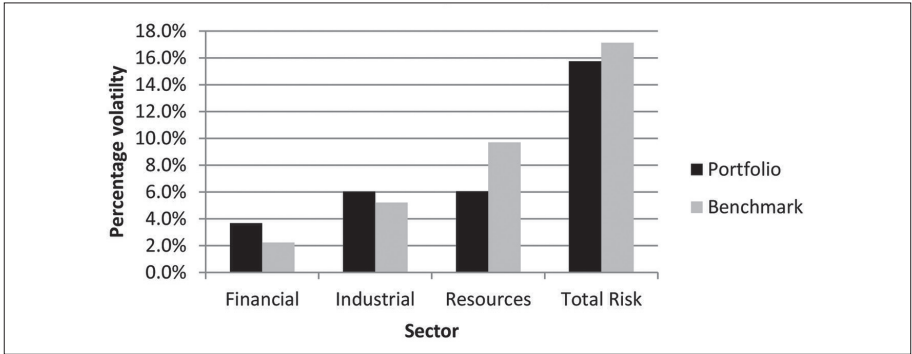


**FIGURE C1.5** Fund E volatility decomposition

**C1.6 FUND F VOLATILITY DECOMPOSITION RESULTS**

**TABLE C1.6** Fund F volatility decomposition

Risk decomposition	Financial	Industrial	Resources	Total
Portfolio	3.7%	6.0%	6.1%	15.8%
Benchmark	2.2%	5.2%	9.7%	17.1%

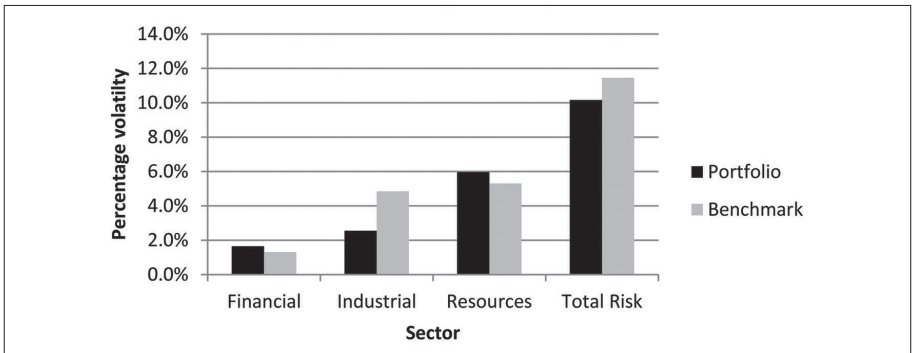


**FIGURE C1.6** Fund F volatility decomposition

**C1.7 FUND G EQUITY FUND VOLATILITY DECOMPOSITION RESULTS**

**TABLE C1.7** Fund G volatility decomposition

Risk decomposition	Financial	Industrial	Resources	Total
Portfolio	1.6%	2.5%	6.0%	10.2%
Benchmark	1.3%	4.8%	5.3%	11.4%



**FIGURE C1.7** Fund G volatility decomposition

**C.2 Tracking Error as Risk-adjustment Measure**

**C2.1 FUND A EQUITY FUND TRACKING ERROR DECOMPOSITION RESULTS**

TABLE C2.1 Fund A tracking error decomposition

TE decomposition – BHB	AA	S	I	Total
Financial	0.2%	0.3%	0.0%	0.5%
Industrial	-0.3%	1.1%	0.1%	0.9%
Resources	2.8%	4.8%	-1.6%	5.9%
<b>Total</b>	<b>2.7%</b>	<b>6.1%</b>	<b>-1.5%</b>	<b>7.4%</b>

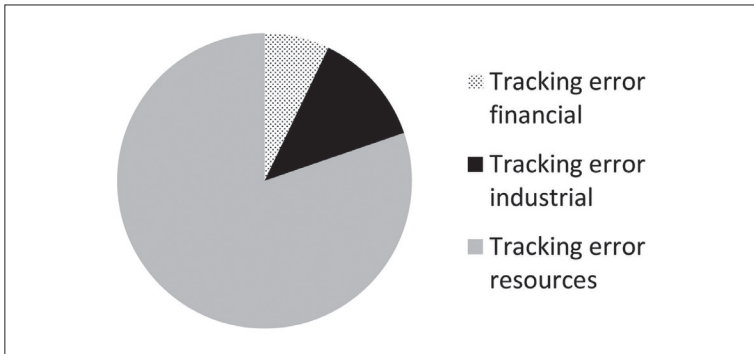


FIGURE C2.1 Fund A tracking error decomposition

**C2.2 FUND B EQUITY FUND TRACKING ERROR DECOMPOSITION RESULTS**

TABLE C2.2 Fund B tracking error decomposition

TE decomposition – BHB	AA	S	I	Total
Financial	-0.1%	0.2%	0.0%	0.2%
Industrial	0.2%	1.6%	0.5%	2.3%
Resources	1.6%	1.4%	-0.3%	2.6%
<b>Total</b>	<b>1.7%</b>	<b>3.2%</b>	<b>0.1%</b>	<b>5.0%</b>

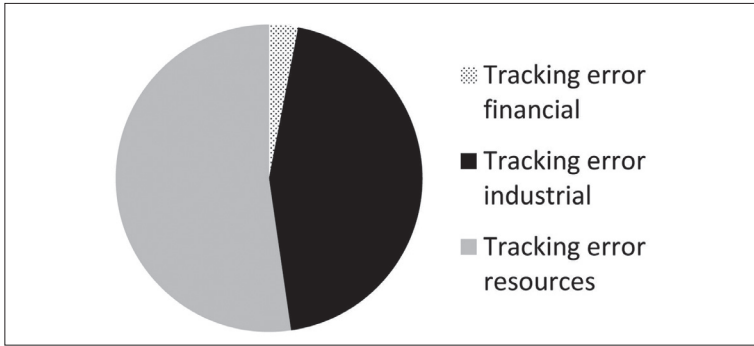


FIGURE C2.2 Fund B tracking error decomposition

**C2.3 FUND C EQUITY FUND TRACKING ERROR DECOMPOSITION RESULTS**

TABLE C2.3 Fund C tracking error decomposition

TE decomposition – BHB	AA	S	I	Total
Financial	0.0%	0.2%	0.0%	0.2%
Industrial	0.1%	1.4%	0.6%	2.1%
Resources	4.1%	1.5%	-0.8%	4.8%
<b>Total</b>	<b>4.2%</b>	<b>3.0%</b>	<b>-0.2%</b>	<b>7.1%</b>

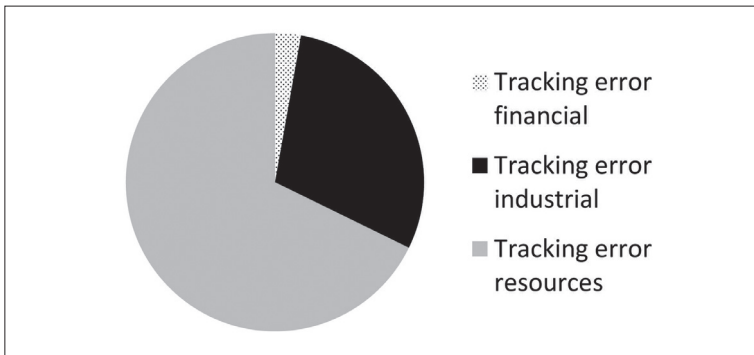
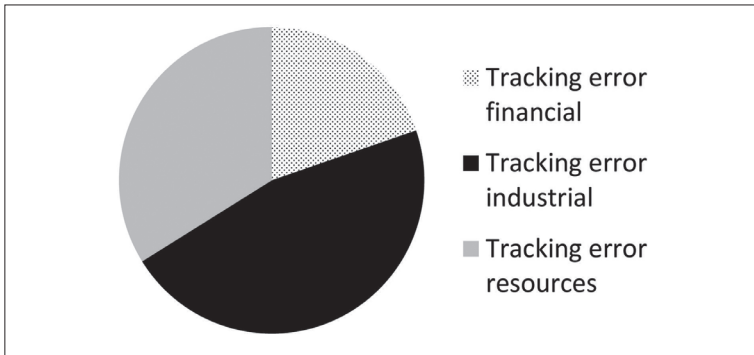


FIGURE C2.3 Fund C tracking error decomposition

**C2.4 FUND D EQUITY FUND TRACKING ERROR DECOMPOSITION RESULTS**

**TABLE C2.4** Fund D tracking error decomposition

<b>TE decomposition – BHB</b>	<b>AA</b>	<b>S</b>	<b>I</b>	<b>Total</b>
Financial	0.2%	0.6%	-0.1%	0.6%
Industrial	-0.2%	1.5%	0.3%	1.5%
Resources	0.6%	0.6%	0.0%	1.1%
<b>Total</b>	<b>0.5%</b>	<b>2.6%</b>	<b>0.1%</b>	<b>3.3%</b>



**FIGURE C2.4** Fund D tracking error decomposition

**C2.5 FUND E EQUITY FUND TRACKING ERROR DECOMPOSITION RESULTS**

**TABLE C2.5** Fund E tracking error decomposition

<b>TE decomposition – BHB</b>	<b>AA</b>	<b>S</b>	<b>I</b>	<b>Total</b>
Financial	0.1%	0.2%	0.0%	0.3%
Industrial	0.2%	1.0%	0.1%	1.2%
Resources	2.0%	1.5%	-0.3%	3.2%
<b>Total</b>	<b>2.3%</b>	<b>2.6%</b>	<b>-0.2%</b>	<b>4.7%</b>

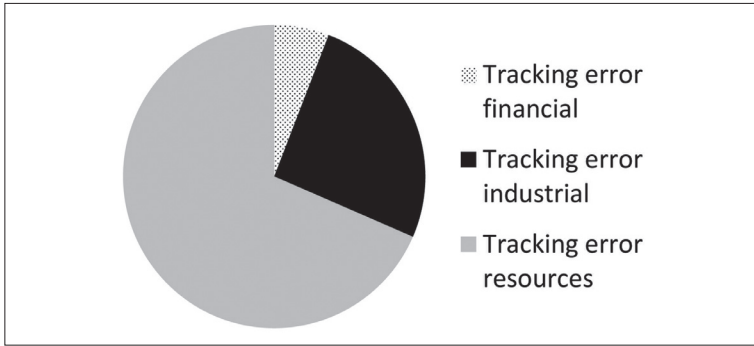


FIGURE C2.5 Fund E tracking error decomposition

**C2.6 FUND F EQUITY FUND TRACKING ERROR DECOMPOSITION RESULTS**

TABLE C2.6 Fund F tracking error decomposition

TE decomposition – BHB	AA	S	I	Total
Financial	0.1%	0.2%	0.0%	0.2%
Industrial	0.3%	1.3%	0.0%	1.7%
Resources	2.5%	2.2%	-0.5%	4.1%
<b>Total</b>	<b>2.8%</b>	<b>3.7%</b>	<b>-0.5%</b>	<b>6.1%</b>

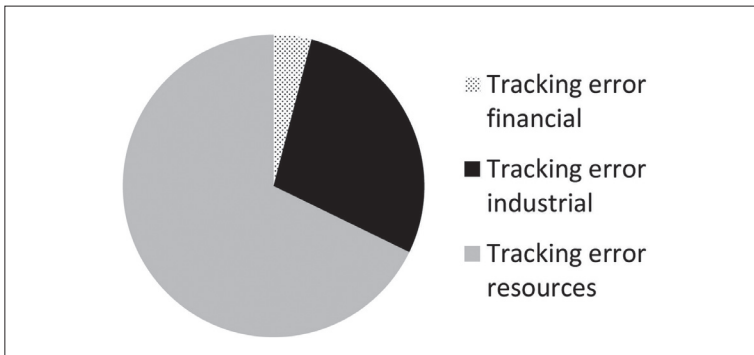


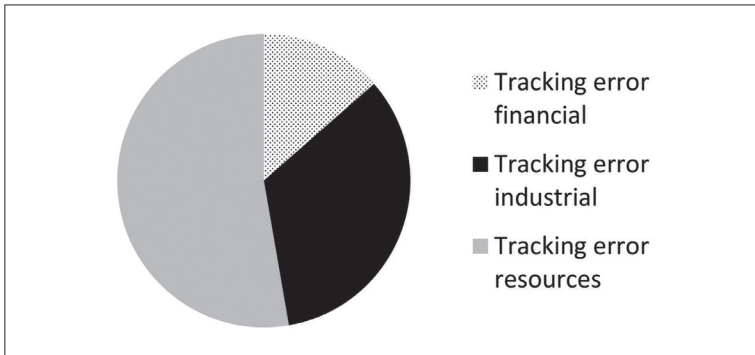
FIGURE C2.6 Fund F tracking error decomposition



**C2.7 FUND G EQUITY FUND TRACKING ERROR DECOMPOSITION RESULTS**

**TABLE C2.7** Fund G tracking error decomposition

<b>TE decomposition – BHB</b>	<b>AA</b>	<b>S</b>	<b>I</b>	<b>Total</b>
Financial	-0.4%	1.9%	0.8%	2.2%
Industrial	1.1%	6.2%	-1.7%	5.6%
Resources	-0.8%	7.8%	1.7%	8.7%
<b>Total</b>	<b>-0.1%</b>	<b>15.9%</b>	<b>0.7%</b>	<b>16.5%</b>



**FIGURE C2.7** Fund G tracking error decomposition