

**Portfolio Opportunity Distributions (PODs) for the South African Market:
based on Regulation Requirements**

Hester Maria Nortjé



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Supervisor: JD van Heerden

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Abstract

In this study Portfolio Opportunity Distributions (PODs) is applied as an alternative performance evaluation method. Traditionally, Broad-Market Indices or peer group comparisons are used to perform performance evaluation. These methods however have various biases and other problems related to its use. These biases and problems include composition bias, classification bias, concentration, etc. R.J. Surz (1994) introduced PODs in order to eliminate some of these problems.

Each fund has its own opportunity set based on its style mandate and constraints. The style mandate of the fund is determined by calculating the fund's exposure to the nine Surz Style Indices through the use of Returns-Based Style Analysis (RBSA). The indices are created based on the style proposed by R.J. Surz (1994). Some adjustments were made to incorporate the unique nature of the South African equity market. The combination of the fund's exposures to the indices best explains the return that the fund generated. In this paper the fund's constraints are based on the regulation requirements imposed on the funds in South Africa by the Collective Investment Schemes Control Act No. 45 of 2002 (CISCA).

Thousands of random portfolios are then generated based on the fund's opportunity set. The return and risk of the simulated portfolios represent the possible investment outcomes that the manager could have achieved given its opportunity set. Together the return and risk of the simulated portfolios represent a range of possible outcomes against which the performance of the fund is compared.

It is also possible to determine the skill of the manager since it can be concluded that a manager who consistently outperforms most of the simulated portfolios shows skill in selecting shares to be included in the portfolio and assigning the correct weights to these shares.

The South African Rand depreciated quite a bit during the period under evaluation and therefore funds invested large portions of their assets in foreign investments. These investments mostly yielded very high or very low returns compared to the returns available in the domestic equity market which impacted the application of PODs. Although the PODs methodology shows great potential, it is impossible to conclude with certainty whether the PODs methodology is superior to the traditional methods based on the current data.

Key words:

Portfolio Opportunity Distributions (PODs); Surz Style Indices; opportunity set; benchmarks; peer group comparisons; concentration; portfolio constraints; ALSI; JSE.

Opsomming

In hierdie studie word Portefeulje Geleentheids Verdelings (“PODs”) bekendgestel as ‘n alternatiewe manier om die obrengste van bestuurders te evalueer. Gewoonlik word indekse en die vergelyking van die fonds met soortgelyke fondse gebruik om fondse te evalueer. Die metodes het egter verskeie probleme wat met die gebruik daarvan verband hou. Die probleme sluit onder andere in: die samestelling en klassifikasie van soortgelyke fondse, die konsentrasie in die mark, ens. R.J. Surz (1994) het dus Portefeulje Geleentheids Verdelings (“PODs”) bekendgestel in ‘n poging om sommige van die probleme te elimineer.

Elke fonds het sy eie unieke geleentheids versameling wat gebaseer is op die fonds se styl en enige beperkings wat op die fonds van toepassing is. Die fonds se styl word bepaal deur die fonds se blootstelling aan die nege Surz Styl Indekse te meet met behulp van opbrengs-gebaseerde styl analise (“RBSA”). Die indekse is geskep gebaseer op die metode wat deur R.J. Surz (1994) voorgestel is. Daar is egter aanpassings gemaak om die unieke aard van die Suid-Afrikaanse aandele mark in ag te neem. Die kombinasie van die fonds se blootstelling aan die indekse verduidelik waar die fonds se opbrengs vandaan kom. In die navorsingstuk is die beperkings wat van toepassing is op die fonds afkomstig uit die regulasie vereistes wat deur die “Collective Investment Schemes Control Act No. 45 of 2002 (CISCA)” in Suid-Afrika op fondse van toepassing is.

Duisende ewekansige portefeuljes word dan gegenerer gebaseer op die fonds se unieke groep aandele waarin die fonds kan belê. Die opbrengs en risiko van die gesimuleerde portefeuljes verteenwoordig al die moontlike beleggings uitkomst wat die fonds bestuurder kon gegenerer het gegewe die fonds se unieke groep aandele waarin dit kon belê. Die opbrengs en risiko van al die gesimuleerde portefeuljes skep saam ‘n verdeling van moontlike beleggings uitkomst waarteen die opbrengs en risiko van die fonds vergelyk word.

Hierdie proses maak dit moontlik om die fonds bestuurder se vermoë om beter as meeste van die gesimuleerde portefeuljes te presteer te bepaal. Die aanname kan gemaak word dat ‘n bestuurder wat konsekwent oor tyd beter as meeste van die gesimuleerde portefeuljes presteer oor die vermoë beskik om die regte aandele te kies om in die portefeulje in te sluit en ook die regte gewigte aan die aandele toe te ken.

Die Suid-Afrikaanse Rand het heelwat gedepresieer tydens die evaluasie periode en daarom het fondse groot porsies van hul beleggings oorsee belê. Die beleggings het dus of heelwat groter of heelwat kleiner opbrengste gehad in vergelyking met die opbrengste beskikbaar in die plaaslike aandele mark en dit het die toepassing van PODs beïnvloed. PODs toon baie potential, maar dit is egter onmoontlik om met die huidige data stel vas te stel of dit ‘n beter metode is.

Sleutelwoorde:

Portefeulje Geleentheids Verdelings (“PODs”); Surz Styl Indekse; geleentheids versameling; indekse; portuurgroep vergelyking; konsentrasie, portefeulje beperkings; ALSI; JSE.

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List of Abbreviations

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| ALSI | FTSE/JSE All Share Index |
| ALSI-40 | FTSE/JSE All Share Top 40 Index |
| ASISA | Association for Savings and Investments South Africa |
| CFA | Chartered Financial Analyst |
| CISCA | The Collective Investment Schemes Act |
| EWI | Equal Weighted Index |
| FSB | Financial Services Board |
| HBSA | Holdings-Based Style Analysis |
| IMCA | Investment Management Consultants Association |
| IPS | Investment Policy Statement |
| JSE | Johannesburg Stock Exchange |
| LTD | Limited Company |
| P/B | Price to Book-Value Ratio |
| P/E | Price to Earnings Ratio |
| P/S | Price to Sales Ratio |
| PLC | Public Limited Company |
| PODs | Portfolio Opportunity Distributions |
| RBSA | Returns-Based Style Analysis |
| SA | South Africa |
| SIM | Sanlam Investment Managers |
| SWIX | FTSE/JSE Shareholders Weighted All Share Index |
| US | United States |
| VA | Value Added |

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

“Over the years, the use of benchmarks has expanded far beyond their original role as a general indicator of market sentiment and direction. They have become central to investment management, with an impact on active management, asset allocation, and performance measurement and reward as well as passive indexing” (Siegel, 2003).

Investors have been using benchmarks for more than a century to determine the performance of their portfolios or to determine the performance of funds in which they invested in or wish to invest in. The investment industry evolved over the years as more and more funds were created as time went by. More investors started to manage money and more of them started to invest in funds managed by portfolio managers. Equity benchmarks have been used for centuries and goes back as far as 1884 when the first Dow Jones average was calculated. The average was based on 11 railroad stocks (Siegel, 2003: 1). Back on South African soil, the Johannesburg Securities Exchange (JSE) was established as the stock exchange in 1887. In South Africa, the FTSE/JSE All Share Index (ALSI) was launched on 24 June 2002 as a joint venture between the JSE and the FTSE Group. (History of the JSE, 2013)

Equity unit trusts compare their fund returns against the returns of some benchmark or against the returns of funds with similar mandates in order to evaluate the performance of the fund for the period in question. Investors can compare various funds against a benchmark or against each other to determine whether their money would be better of invested in one of the funds or rather in a passive index tracker-fund¹. There are two traditional performance evaluation methods, namely: comparing the fund's return against a benchmark such as a broad-market index or comparing the fund's return against the returns of similar funds in its peer group. In South Africa the FTSE/JSE All Share Index (ALSI) is used as a benchmark since it represents the South African equity market. The two traditional performance evaluation methods however have various underlying problems and limitations such as biases, Broad-Market Indices have high concentration levels, Broad-Market Indices cannot be replicated due to regulation, peer group comparisons can easily be influenced, etc.

Fund managers will deviate from the index's constituents and weights according to the allowed tracking error² in order to attempt to outperform the fund's benchmark. The South African market,

¹ An exchange-traded fund (also called a tracker-fund) invests in the same companies as the index (which it is tracking) based on a market value weighting system. (Maginn, Tuttle, Pinto & McLeavey, 2007: 422)

² A fund's tracking error is standard deviation of the differences between the fund's return and the return of the benchmark. (Maginn, Tuttle, Pinto & McLeavey, 2007: 886)

much like other developing markets in the world, contains high levels of market concentration. These high concentration levels lead to higher portfolio risk. In an attempt to decrease the risk, managers underweight the large capitalization stocks and overweight the small capitalization stocks relative to the ALSI. The portfolio will then underperform the ALSI if large capitalization stocks outperform small capitalization stocks. Furthermore, the portfolio will outperform the ALSI when the small capitalization stocks outperform the large capitalization stocks.

The important question that now arises is whether the portfolio manager has skill in selecting the shares and assigning the appropriate weights in order to outperform the benchmark. Unfortunately, comparing the portfolio against the benchmark only determines whether the portfolio outperformed the benchmark. It does not determine whether the manager has true skill since it only compares the performance of the fund against the performance of one possible portfolio it could have invested in.

A new performance evaluation method is therefore required which would eliminate the problems and limitations of the traditional methods and which will help investors determine whether the fund managers show true skill. Surz (1994; 1996; 1998; 2003; 2006) introduced a new method called Portfolio Opportunity Distributions (PODs). This method compares the performance of the fund against the performance of all the portfolios it could have invested in given the fund's opportunity set. The opportunity set of the fund is set up based on the fund's unique style mandate and the regulation imposed on the fund by law. The possible portfolios that the fund could have invested in are created by simulating weights for the constituents of the portfolios based on the fund's opportunity set. The resulting portfolios are therefore a much better representation of the possible portfolios the fund could have chosen to invest in. Comparing the fund's performance against the performance of these portfolios therefore provide more accurate results of how the fund actually performed.

The fund's performance is now compared against the performance of thousands of portfolios. It is therefore possible to determine whether the fund manager shows skill in selecting the shares to be included in the portfolio and whether the fund manager consistently outperforms most of the possible portfolios it could have invested in.

PODs offer a new method for performance evaluation that is befitting of the technological revolution of the twenty-first century. It combines traditional statistics with modern day technology to create thousands of random portfolios based on each manager's unique opportunity set by applying Monte Carlo Simulation. Monte Carlo Simulation requires an immense amount of computing power which did not exist until a few years ago. (Surz, 1998)

1.2 PROBLEM STATEMENT

Investors compare the performance of funds against each other or against their benchmarks when deciding in which one they would like to invest in. Thus, there are two methods which are mainly used to compare the performance of the funds under evaluation: namely Broad-Market Indices (as benchmarks) and peer group comparisons (Van Heerden & Botha, 2012). The two traditional methods (Broad-Market Indices and Peer Group Comparison) have various biases and other problems. In South Africa the FTSE/JSE All Share Index (ALSI) is often used as a benchmark. However, the ALSI is highly concentrated and due to the regulation of funds it is impossible for them to replicate the ALSI. Peer group comparison has underlying problems as well. These problems include the fact that different funds have different style mandates and investment philosophies. Therefore it is easy to wrongfully compare funds against each other. Furthermore, with peer group comparison, it is easy to influence the results by selecting different funds to be included in the peer group. Using the abovementioned methods without acknowledging their underlying problems may lead to an inaccurate conclusion regarding the performance of the fund.

Due to the underlying problems in the traditional methods, a new method is required which will eliminate the aforementioned problems. The traditional methods also do not give any indication of the skill of the manager. Surz (1994; 1996; 1998; 2003; 2006) subsequently introduced a new method called Portfolio Opportunity Distributions (PODs). PODs aim to compare the performance of the fund against the performance of all the portfolios it could have invested in given its opportunity set. Furthermore, the ability of the fund manager to consistently outperform (or underperform) these portfolios can be determined. By doing so it is possible to determine the skill of the manager. The aim of this study is to compare the two traditional approaches against the new approach (PODs) for the South African market and to determine which method is superior. The regulation requirements, specific to the South African equity market, are incorporated when creating a funds opportunity set. This is done in order to create a benchmark which is investable and that represent the fund's investable universe.

1.3 CLARRIFICATION OF KEY CONCEPTS

1.3.1 Portfolio Constraints

Portfolio constraints are limitations that are placed on the portfolio if the investor cannot take full advantage of certain investment strategies or if they can only take partial advantage of said strategies. (Maginn, Tuttle, Pinto & McLeavey, 2007: 11-15) The unit trust industry in South Africa is regulated by the Financial Services Board (FSB) based on the Collective Investment Schemes Control Act No. of 2002 (CISCA). Funds are required by law to meet these requirements and therefore constraints are imposed on the fund.

1.3.2 The Investment Policy Statement (IPS)

The Investment Policy Statement (IPS) contains the operational guidelines to be used when managing the corresponding portfolio. The portfolio constraints (mentioned in Section 1.3.1) are included in the IPS. The portfolio manager uses the IPS to create the strategic asset allocation³ for the portfolio based on the long-run capital market expectations⁴. (Maginn, Tuttle, Pinto & McLeavey, 2007: 2-7)

1.3.3 Opportunity Set

A manager's opportunity set is the sample of assets that the manager may invest in (Botha, 2010: 28-30). The opportunity set usually differs from the benchmark index due to certain investment constraints imposed on the portfolio. The opportunity set is set up based on the portfolio constraints (mentioned in Section 1.3.1) and the IPS (mentioned in Section 1.3.2).

1.3.4 Benchmarks: Broad-Market Indices

A benchmark is a reference portfolio against which a portfolio or fund is compared to in order to determine whether the portfolio or fund performed better or worse than the reference portfolio. (Amenc & Le Sourd, 2003: 43) Broad-Market Indices, such as equity indices, are used as benchmarks. These equity indices are basically imaginary portfolios that represent a particular market or a portion of the market.

1.3.5 Concentration

Concentration is an indication of how fairly distributed a certain market is. Both market and sector concentration exists. Market concentration is generally defined as the market's tendency to be dominated by a few large companies (Van Heerden & Saunderson, 2008). Sector concentration is when the cumulative weight of all the shares within a certain sector dominates the market (Botha, 2010: 21-25). Broad-Market Indices tend to be concentrated, especially in developing countries such as South Africa.

1.3.6 Peer Group Comparisons

Peer group comparison is when different fund managers that have the same investment style or invest in the same asset classes are compared against each other (Amenc & Le Sourd, 2003: 49-50) in order to determine how the fund under evaluation compared against similar funds in the market. Similar portfolios are compared against each other according to the division of the portfolios into different styles based on their market capitalization, the amount of growth stocks in

³ The strategic asset allocation of the portfolio consists of the portfolio's investments in the various asset classes to meet the long-run objectives and constraints of the portfolio as set out in the IPS. (Maginn, Tuttle, Pinto & McLeavey, 2007: 1-2)

⁴ The study of the long-run return and risk characteristics of the asset classes included in the portfolio is known as the capital market expectations. (Maginn, Tuttle, Pinto & McLeavey, 2007: 1-2)

the portfolio, the amount of value stocks in the portfolio, etc. (Amenc and Le Sourd, 2003: 49-50; Botha, 2010: 18).

1.4 RESEARCH HYPOTHESES

The main hypothesis to be tested is whether the PODs methodology is superior to the traditional methods. The PODs methodology can potentially provide investors with a method to make better investment decisions regarding investments in South African equity funds. The aim is to test whether this is in fact the case.

Furthermore, a hypothesis regarding the performance of the fund under evaluation is also performed. The hypothesis to be tested is whether the manager had no skill and this is tested against the alternative hypothesis where the manager does indeed have skill. According to Surz (2003b), if the manager falls within the lower decile of the opportunity set which was created using the PODs methodology, then the hypothesis is not rejected at the 90% confidence level. If the manager does not fall within the lower decile of the opportunity set, then the hypothesis is rejected. In this case the investor can choose to stay with the manager since the manager shows skill.

1.5 CONTRIBUTION OF THE STUDY

This study contributes to the equity market literature of South Africa. In this study PODs are used to evaluate the performance of the South African equity funds and to determine whether the fund managers show true skill. The PODs method eliminates some of the problems associated with the traditional performance evaluation methods currently used in the South African equity fund industry and therefore it provides investors with a potentially superior performance evaluation method. By applying the PODs methodology it is possible to unlock hidden information such as whether the manager of a fund shows consistent skill. This information will remain hidden with the traditional methods. Furthermore, it is possible to determine whether the fund manager kept to the fund's style mandate over time.

A similar study was conducted by Botha (2010). This study differs from Botha's (2010) because it incorporates the regulation requirements imposed on funds with regards to their investment in a single constituent. These regulation requirements are incorporated when creating a fund's opportunity set, thus creating a more realistic indication of how the fund performed given the opportunities available to it. It also provides the investor with a more realistic indication of the fund manager's skill in selecting the shares to be included in the portfolio.

The PODs methodology will hopefully provide investors with a superior method they can use to evaluate the performance of the funds they wish to invest in as well as the skill of the fund managers.

1.6 RESEARCH DESIGN AND METHODOLOGY

1.6.1 Data Analysis

The data used for this analysis is obtained from INET and consists of the constituents of the FTSE/JSE All Share Index (ALSI) since June 2010. Data for approximately 97.5% of the constituents listed on the index since June 2010 was obtained. The ALSI represent all the shares listed on the Johannesburg Stock Exchange (JSE) and therefore it is a good proxy of the South African equity market.

The market capitalization, dividend yield and P/E ratio of the constituents are used to set up the Surz Style Indices. The closing prices are used to calculate the returns of the constituents, which in turn is used to calculate the returns of the Surz Style Indices.

1.6.2 Methodology

The index returns are used to calculate the fund's exposure to the Surz Style Indices. These exposures are used to calculate the contribution of each index to the fund's return. These returns are then compared against all the possible returns the fund could have generated for each index given the various possible portfolios it could have invested in.

The possible portfolios that the fund could have invested in are simulated based on the market capitalization of the constituents and the regulation requirements imposed on the funds. The returns of the simulated portfolios create a POD for each period which is compared against the fund's actual return for the same period. PODs graphs are created for those Surz Style Indices to which the fund has an exposure to for each of the evaluation periods as well as for the total returns.

Furthermore, the return and risk of the fund is compared against the return and risk of the simulated portfolios to determine how efficient the fund is compared to the simulated portfolios. The PODs graph is then combined with the return and risk comparison to create a PODs graph which indicates how efficient the fund is when comparing the return and risk of the fund against the return and risk of the simulated portfolios.

The results based on the PODs methodology are compared against the results of the traditional methods in order to determine which method is superior.

1.7 CHAPTER OUTLINE

The research conducted in this paper is set out as indicated in Figure 1.1.

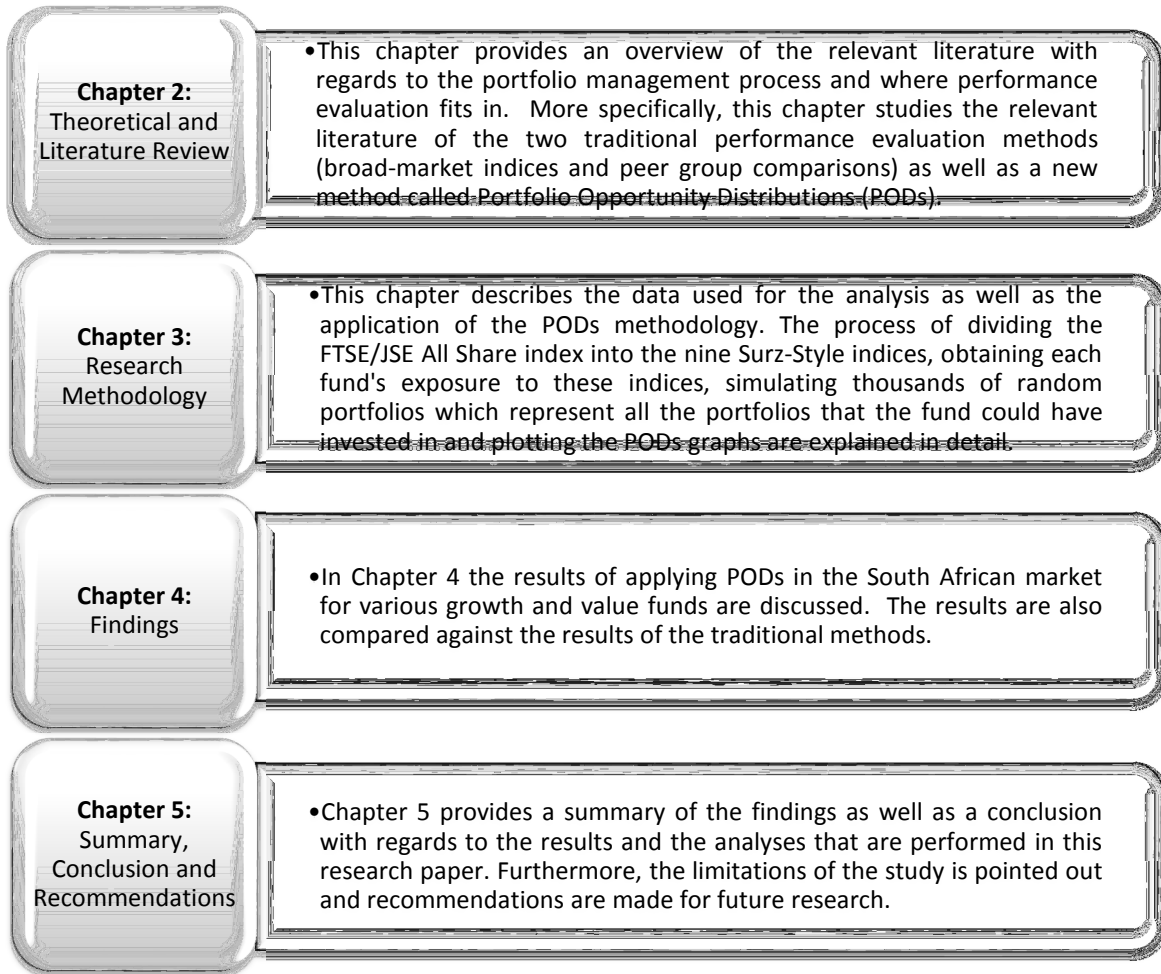


Figure 1.1: Chapter Outline

The MATLAB code that is used to implement the process set out in Chapter 3 and to generate the results in Chapter 4 is provided in Appendix B.

1.8 NATURE AND FORM OF THE RESULTS

The results in this research paper consist of various graphs based on the PODs methodology for 10 different fund managers. Five of the funds classified themselves as growth funds and the other five as value funds. Each fund's performance is evaluated based on the traditional performance evaluation methods and PODs.

Returns-Based Style Analysis (RBSA) was used to determine the exposures of the funds to the Surz Style Indices. The returns of the fund and the shares listed on the JSE were used as obtained via INET. The returns of the funds however consist of all the returns of the fund's assets and not just the returns of the domestic equity investments. During the period under evaluation in this study, the South African Rand depreciated quite a bit. Funds therefore chose to invest quite large portions of their total asset base in foreign investments. Due to the depreciating Rand, these

investments mostly yielded very high or very low returns compared to the returns available in the domestic equity market.

This phenomenon had quite an impact on the construction of the PODs graphs since funds could now generate a return higher or lower than the returns available in the domestic equity market. It is therefore impossible to conclude with certainty whether the PODs methodology is superior to the traditional methods since the performance of the fund's domestic equity investment cannot be evaluated separately without the holdings data of the fund. The PODs methodology did however provide much more insight in the fund and the fund manager's performance and should therefore not be excluded as a potential superior method.

1.9 CONCLUSION

The problems underlying the use of the traditional performance evaluation methods lead to the problem of finding a new performance evaluation method. PODs were developed by R.J. Surz for the United States of America. The South African market is however quite different. It is much smaller and more concentrated. There are also various regulations imposed on South African funds.

Previous studies in South Africa did not include these regulations in the creation of PODs. The research conducted in this study aims to test whether PODs is a superior performance evaluation method when compared against the traditional methods. The unique nature of the South African market and the regulations imposed on the funds are used to adjust the PODs methodology for the South African market. The performance evaluation results of the traditional methods are compared against the results based on the PODs methodology to test the hypothesis.

PODs are created by obtaining the fund's exposure to the Surz Style Indices through the use of Returns-Based Style Analysis (RBSA). The exposures along with the regulations imposed by the Government are then used to simulate thousands of random portfolios. The simulated portfolios represent all the portfolios that the fund could have constructed based on its opportunity set. The fund's performance is then compared against the performance of the simulated portfolios through various graphs.

The methodology used to create PODs for the South African equity market and the corresponding results are provided in depth. This is preceded by a detailed discussion with regards to the portfolio management process, the problems relating to the use of the traditional performance evaluation methods, previous analyses with regards to the use of PODs and the regulation requirements in South Africa.

CHAPTER 2

THEORETICAL AND LITERATURE REVIEW

2.1 INTRODUCTION

The trade of goods or services have been a part of history since the beginning of time. Later on traders began trading financial instruments such as equities and bonds. At some point in time investors started to invest in various assets which lead to the concept of a portfolio of assets. There are various types of possible investment classes such as equities, fixed income (e.g. bonds), cash, alternative investments (e.g. real estate), etc. A portfolio is a collection of investments in one or more of the aforementioned asset classes which is held by an individual investor or by an institution⁵. (Maginn, Tuttle, Pinto & McLeavey, 2007: 1-2) The process of allocating the portfolio's funds to the various asset classes is defined as asset allocation. (Marx, Mpofo, van de Venter & Nortjé, 2006: 246)

It is necessary to manage said portfolio optimally in order to meet the requirements of the investor. These requirements include the return objectives, the risk tolerance, the time horizon as well as certain constraints, which are described in detail in the investment policy statement (IPS). The process to be followed in reaching the objectives is called the portfolio management process which consists of a set of integrated steps to create an appropriate portfolio as well as maintain it, based on the set objectives. (Maginn, Tuttle, Pinto & McLeavey, 2007: 1-2)

Performance evaluation forms a critical part of the portfolio management process. Investors could monitor the progress of their investment through performance evaluation by studying the returns of their portfolios and use it in the asset allocation process to allocate the necessary capital to the various asset classes. (Feibel, 2003: 3-4) Performance evaluation can also be used to select and evaluate portfolio managers in order to identify those who are regarded as highly skilled. (Botha, 2010:11-12)

Performance evaluation is just as important for the manager of a portfolio. For the portfolio manager, performance evaluation is a way of making sure whether he/she met the return requirements. It can also be used as a method to find the sources of the returns, for instance, what sector contributed the most to the overall return? This could be an indication that the portfolio manager shows skill in selecting equities from said sector. The results of the performance evaluation can also be used to attract new investors through marketing if, of course, the results are favourable. (Botha, 2010)

⁵ According to Fabozzi and Markowitz (2002: 4-5), an institutional investor is a pension fund, a depository institution, an insurance company, a mutual fund, an endowment, a foundation, a government agency, etc.

The core focus of this study is performance evaluation; specifically on which benchmarks should be used to determine how the fund compared against a fair representation of the investable universe of said fund. The important question to ask is, “What is a fair representation of the fund’s investable universe?”

In order to explain where performance evaluation fits into the overall portfolio management process and to understand its importance a more detailed discussion of the portfolio management process is in order

2.2 THE PORTFOLIO MANAGEMENT PROCESS

According to Maginn, *et al.* (2007: 15-17), the portfolio management process consists of three phases, namely: the planning phase, the execution phase and the feedback phase. These steps are executed in order to create and maintain a portfolio which contains the appropriate combination of assets so that the clients’ goals are met. Figure 2.1 is a graphical representation of the portfolio management process.

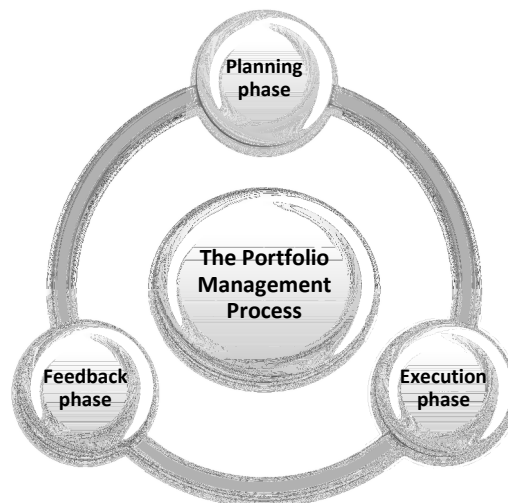


Figure 2.1: The Portfolio Management Process

The first step in the portfolio management process is the planning phase in which the investment strategy, objectives and constraints are formulated. This is followed by the execution phase in which the portfolio composition is set up and implemented. In the last step, the feedback phase, the portfolio is monitored and rebalanced and the performance of the portfolio is evaluated as well. If necessary the first step is revised to improve the portfolio and then the process continues as shown in Figure 2.1. (Maginn, Tuttle, Pinto & McLeavey, 2007: 15-17)

2.2.1 The Planning Phase

The planning phase consists of the formulation of the investment strategy. The investment strategy describes the approach the portfolio manager will follow when performing investment analyses and when the securities to be invested in are selected. The manager can either choose to follow a

passive, active or semi-active investment approach. With a passive investment style, such as indexing, a portfolio is constructed to replicate the returns on a specific index. If the portfolio manager chooses to follow an active investment approach, the portfolio holdings will differ from its benchmark's holdings and the manager will react to changing capital market expectations by adjusting the portfolio accordingly. In such a portfolio the manager thus aims to generate positive alpha⁶. A semi-active investment style also aims to produce positive alpha, but with such a style that the risk relative to the portfolio's benchmark is kept under tight control. The risk of a portfolio is the chance that the actual return will differ from the expected return or the chance of losing some or all of the original investment. (Maginn, Tuttle, Pinto & McLeavey, 2007: 5-8)

2.2.1.1 Investment Objectives

The planning phase starts by identifying and specifying the investor's objectives and constraints. The investor's objectives are the outcomes that the investor desires for the portfolio. (Maginn, Tuttle, Pinto & McLeavey, 2007: 5-8) These objectives consist of the return that the investor requires on the portfolio as well as the amount of risk he/she is willing and able to take. It is important that the required rate of return is consistent with the risk objectives and therefore they should be considered together. Table 2.1 contains a brief description of these objectives.

Table 2.1: Portfolio objectives

| Objective | Description |
|------------------|---|
| Return | It is important to note the difference between the return requirement, which is a primary objective, and the return desired by the investor, which is the secondary objective. The focus should be on the required rate of return which consists of the portfolio's income plus growth. It is important to take into account tax and inflation and therefore investors should distinguish between nominal, real, pre-tax and post-tax returns. ⁷ The risk objective should be kept in mind whenever the return objective of a portfolio is considered. |
| Risk | The risk objective is influenced by both the ability and the willingness to take risk. The ability of any investor to take risk is determined by an investor's financial goals relative to said investor's financial resources. Both the time frame in which these financial goals should be met and the size of the investment shortfall has an influence on the ability to take risk. The willingness of an investor to take on risk is very subjective and will not necessarily remain constant over time. For instance, the willingness of investors to take risk usually decreases as they grow older. |

Source: (Maginn, Tuttle, Pinto & McLeavey, 2007: 11-15)

⁶ Positive alpha is the positive excess, risk-adjusted returns that are generated by the portfolio when compared to its benchmark. (Maginn, Tuttle, Pinto & McLeavey, 2007: 864)

⁷ The nominal rate of return is the return on an investment before the adjustment for inflation. The real rate of return is the return on an investment which is adjusted for inflation. The pre-tax return is the return on the investment before any taxes are paid. The post-tax return is the return on the investment after the taxes on the investment income as well as the realized capital gains, is paid. (CFA Program Curriculum, 2011: 326-328)

2.2.1.2 General Investment Constraints

Constraints are limitations that are placed on the portfolio if the investor cannot take full advantage of certain investment strategies or if they can only take partial advantage of said strategies. (Maginn, Tuttle, Pinto & McLeavey, 2007: 11-15) When considering the constraints it is important that both the internal and external constraints are considered. Table 2.2 contain examples of internal and external constraints.

Table 2.2: Internal and external constraints

| Internal or External | Constraint | Explanation |
|----------------------|-----------------------------|---|
| Internal Constraints | Liquidity | The liquidity requirement of a portfolio is the cash that the portfolio is required to have in excess of any cash inflows or savings. Each portfolio is required to keep a certain portion in cash to meet the portfolio's everyday needs and for any other payments to be made from the portfolio. These payments consist of planned or unplanned expenses. Furthermore, the mandate of a portfolio can restrict said portfolio by not allowing the portfolio to invest in illiquid assets such as property. |
| | Time Horizon | The time horizon of the portfolio can be short, long or multistage ⁸ . The time horizon is influenced by other constraints such as the ability to take risk and the liquidity requirements. For instance, if the portfolio has to make certain payments from the fund, then the time horizon of the portfolio can be split into a multistage time horizon. Another example is investors who are close to retirement. |
| | Unique Circumstances | This includes any constraints (excluding liquidity constraints, the time horizon, tax or legal and regulatory constraints) that are specific to the portfolio. For instance, some portfolios choose to invest only in non-alcoholic companies. All companies selling alcoholic beverages are therefore excluded from the portfolio's investable universe. |
| External Constraints | Tax | The tax constraint is specific to each country in which the investments are made. Taxes are paid on capital gains and investment income. The tax rates applicable for capital gains tax and for investment income usually differ and therefore the tax rates also influences the portfolio manager's asset allocation decisions since the manager would aim to minimise the tax payments. The tax payments can be minimised by investing in tax-free assets. |
| | Legal and Regulatory | There are certain laws imposed by the government or other oversight authorities, which are applicable on portfolios and especially on unit trust funds. In South Africa the Financial Services Board (FSB) ⁹ oversees the management of all mutual funds based on Regulation 28 and the Collective Investment Schemes Act (CISCA). A closer look will be taken on some of these regulations in Section 2.4.3. |

Source: (Maginn, Tuttle, Pinto & McLeavey, 2007: 15-17)

⁸ Time horizons in excess of 10 years are considered to be long time horizons while time horizons shorter than 10 years are considered to be short time horizons. A multistage time horizon is a combination of short and long term time horizons. (Maginn, Tuttle, Pinto & McLeavey, 2007: 15-17)

⁹ The FSB is a quasi-government organization which oversees the South African financial investment environment. (*Financial services board (FSB)*.)

Pouchkarev (2005: 43-48) further distinguished between screening and capital allocation (selection) constraints in his research.

2.2.1.3 Screening Constraints

Screening constraints can be defined as including or excluding constraints. These constraints are defined in Table 2.3.

Table 2.3: Screening Constraint Definitions

| Constraint | Explanation |
|------------------|---|
| Including | Including constraints is when the investment in certain assets is forced upon the manager. For instance, funds are forced to invest a certain portion of their funds in shares that are listed on the JSE. This will be discussed in more depth in Section 2.4.3. |
| Excluding | Excluding constraints restricts the investment in certain asset (or more specifically shares). For instance, most funds are not allowed to invest in any company which are currently involved in a legal dispute. |

Source: (Botha, 2010: 36-37)

Most of the constraints mentioned in Section 2.2.1.2 can be further sub-categorized into either including or excluding constraints. These constraints should also be included when setting up the IPS and when constructing the portfolio. The constraints mentioned in Table 2.3 can be expressed in terms of the weight that is allocated to the asset in question. The weight is the proportion of the portfolio's total capital that is allocated to said asset. The weighting system for the constraints in Table 2.3 is provided in Table 2.4.

Table 2.4: Screening Constraint Weight Allocations

| Constraint | Explanation |
|------------------|--|
| Including | <p>The weight of an asset that satisfies the including constraint will be positive. Let x_i denote the weight of a certain asset. If said asset have to be included in the portfolio then the weight will be positive,</p> $x_i > 0.$ <p>Since all weights have to be smaller or equal to one, the weight will take on a value between zero and one,</p> $0 < x_i \leq 1.$ <p>A weight of one indicates that all the funds are invested in one asset. To conclude, the portion of the fund's capital that is allocated to this asset is positive (greater than zero) which is exactly what the including constraint requires.</p> |
| Excluding | <p>The weight of an asset that satisfies the excluding constraint will be equal to zero. Let x_i once again denote the weight of a certain asset. If said asset have to be excluded from the portfolio then the weight will be equal to zero,</p> $x_i = 0.$ <p>Thus, no portion of the fund's capital is allocated to this asset which is exactly what the excluding constraint requires.</p> |

Source: (Botha, 2010: 36-37)

This section explained that if the asset is included in the portfolio, the manager must assign a weight to said asset. There can be further constraints related to the allocation of the weight to said asset. This is known as capital allocation constraints.

2.2.1.4 Capital Allocation Constraints

Capital allocation constraints are restrictions placed on the portfolio regarding the allocation of weights to the various investments. These constraints include,

- Short sale restrictions.
- Maximum capital exposure restrictions.
- Minimum capital exposure restrictions.
- Risk constraints.

If a manager believes that a share price is going to decrease in the near future, the manager can decide to short sell said share. The manager borrows a certain amount of the share from a broker and then sells the shares at the current price. After the price has dropped, the manager buys the same amount of the share in the market at the lower price and returns the shares to the broker. The manager makes a profit equal to the amount he received for selling the shares initially minus the cost of buying back the shares at the lower price. This is known as short selling. However, this is quite risky because, if contrary to the manager's believe, the share price increases, the manager has to buy back the shares at the higher price and return them to the broker. This could lead to large losses. (Botha, 2010: 37-40)

Because of its risky nature, certain funds (e.g. pension funds) do not allow short selling. A negative weight in a certain share indicates that short selling is taking place for said share. This indicates that the weight in every share in the portfolio has to be positive if short selling is not allowed. Let x_i denote the weight of a certain asset in the portfolio. (Botha, 2010: 37-40) If short selling is not allowed, then each weight must satisfy the following criteria,

$$0 \leq x_i \leq 1.$$

Some funds are allowed to short sell but only up to a certain amount. If short selling is allowed but restrictions are placed upon it, then each negative weight (i.e. short selling) have to be larger than a certain amount say $-\theta$. (Botha, 2010: 37-40) Thus, each weight has to satisfy the following equation,

$$-\theta \leq x_i,$$

where x_i is negative. If the fund is allowed to invest up to θ in short sales for the portfolio as a whole, then the sum of the weights of the portfolio has to be larger than $-\theta$, thus,

$$-\theta \leq \sum_i x_i.$$

Clarke, De Silva and Thorley (2005) found that one of the most binding constraints that managers have to adhere to is short selling.

Maximum capital exposure is when limitations are placed on the maximum proportion (of the portfolio's total asset base) that a manager may invest in a single asset. This ensures that managers do not construct portfolios that are too concentrated and therefore the portfolio will be more diversified. This will be discussed in more detail in Section 2.4.2, specifically looking at the South African fund industry. (Botha, 2010: 37-40)

Minimum capital exposure is when the manager is forced to maintain a certain minimum weight in certain assets, thus forcing the manager to invest in said assets. (Botha, 2010: 37-40) If an asset x_i is required to have a minimum capital exposure α_i , then the constraint can be written as,

$$\alpha_i \leq x_i.$$

As was mentioned in Section 2.2.1.1, the risk of the portfolio is a crucial objective when setting up the IPS and when constructing the portfolio. The amount of risk that the portfolio is allowed to take is also a constraint because the weights allocated to the various assets has an influence on the portfolio's risk. (Pouchkarev, 2005: 41-48) In practice, the most commonly used measures of risk are the variance and standard deviation of the portfolio. The variance and standard deviation are measures of dispersion, thus they measure how much the outcomes differ from the average outcome over a certain period of time. The variance is defined as the average squared deviation, where each deviation is calculated as the outcome in question minus the average of all the outcomes.

The return of each asset has to be calculated first in order to calculate the variance. The return of an asset for a specific period is calculated as a function of the value of the asset at the beginning and at the end of the period. The market value (which is the price of the asset) is usually used for these calculations. Consider an investable universe containing m assets. The return on each asset is calculated using the following equation (assuming no dividends),

$$\begin{aligned} R_{j,t} &= \frac{P_{j,t} - P_{j,t-1}}{P_{j,t-1}} \\ &= \frac{P_{j,t}}{P_{j,t-1}} - 1, \quad j = 1, 2, \dots, m \end{aligned} \quad (2.1)$$

where:

- $R_{j,t}$ = The return of asset j at time t .
- $P_{j,t}$ = The price of asset j at time t .

(Botha, 2010: 14-15; Amenc & Le Sourd, 2003: 20-25)

Some assets also pay dividends or other sources of income, which should be included in the return calculation. The total return for a specific period of an asset is calculated when all the sources of income is incorporated into the calculation. The following calculation is used to calculate the total rate of return,

$$R_{j,t} = \frac{P_{j,t} - P_{j,t-1} + D_{j,t}}{P_{j,t-1}}, \quad j = 1, 2, \dots, m \quad (2.2)$$

where:

- $R_{j,t}$ = The return of asset j at time t .
- $P_{j,t}$ = The price of asset j at time t .
- $D_{j,t}$ = The dividend or other source of income of asset j at time t .

(Botha, 2010: 14-15; Amenc & Le Sourd, 2003: 20-25)

The average return of asset j over n sub-periods (e.g. days, weeks, months, etc) is calculated using the following equation,

$$\bar{R}_j = \frac{1}{n} \sum_{t=1}^n R_{j,t}, \quad j = 1, 2, \dots, m \quad (2.3)$$

where:

- $R_{j,t}$ = The return of asset j at time t .

(Botha, 2010: 14-15; Amenc & Le Sourd, 2003: 20-25)

The return on the portfolio can be calculated in the same way. The return on the portfolio is calculated using the following equation,

$$R_{P,t} = \frac{V_t - V_{t-1} + D_t}{V_{t-1}} \quad (2.4)$$

where:

- $R_{P,t}$ = The return on the portfolio at time t .
- V_t = The value of the portfolio at time t (at the end of the period in question).
- V_{t-1} = The value of the portfolio at time $t - 1$ (at the beginning of the period in question).
- D_t = The cash flows which were generated by the portfolio during the period in question.

(Botha, 2010: 14-15; Amenc & Le Sourd, 2003: 20-25)

The return on the portfolio can also be written as a linear combination of the returns of the underlying asset returns,

$$R_{P,t} = \sum_{j=1}^m x_{j,t} R_{j,t} \quad (2.5)$$

where:

- $R_{P,t}$ = The return on the portfolio at time t .
- $x_{j,t}$ = The weight of asset j at time t .
- $R_{j,t}$ = The return of asset j at time t .

(Botha, 2010: 14-15; Amenc & Le Sourd, 2003: 20-25)

Formulae (2.1) to (2.5) ignore transaction costs, thus it is based on the assumption that no assets were sold or bought during the evaluation period. In this study the same assumption is made regarding the transactions and transaction costs. The incorporation of transaction costs in the above formula will therefore not be studied in this research.

The returns can also be calculated using the natural logarithmic function (\ln). Using this function provides certain advantages, such as the fact that log returns are additive. The return of each asset is calculated using the following equation (assuming no dividends),

$$\begin{aligned} R_{j,t} &= \ln\left(\frac{P_{j,t}}{P_{j,t-1}}\right) \\ &= \ln(P_{j,t}) - \ln(P_{j,t-1}), \quad j = 1, 2, \dots, m \end{aligned} \quad (2.6)$$

where:

- $R_{j,t}$ = The return of asset j at time t .
- $P_{j,t}$ = The price of asset j at time t .
- \ln = The natural logarithmic function.

(Connor, Goldberg & Korajczyk, 2010: 3)

The return on the portfolio can also be written as a linear combination of the returns of the underlying asset returns as in Equation 2.5.

The variance of the j^{th} asset (denoted by σ_j^2) is calculated using the following equation,

$$\sigma_j^2 = \sum_{t=1}^n \left(p_{j,t} (R_{j,t} - \bar{R}_j) \right)^2 \quad (2.7)$$

where:

- $p_{j,t}$ = The probability of the return of asset j at time t .
- $R_{j,t}$ = The return of asset j at time t .
- \bar{R}_j = The average return of asset j .
- n = The number of time periods t .

The variance of the portfolio (denoted by σ_p^2) is calculated using the following equation,

$$\sigma_p^2 = \sum_{j=1}^m \left(x_j (R_j - \bar{R}_p) \right)^2 \quad (2.8)$$

where:

- x_j = The weight of asset j .
- R_j = The return of asset j .
- \bar{R}_p = The average return of the portfolio.

Equation (2.8) can be rewritten as a linear relationship as follows,

$$\begin{aligned}\sigma_p^2 &= \sum_{j=1}^m x_j^2 R_j^2 (x_j(R_j - \bar{R}_j))^2 \\ &= \sum_{j=1}^m x_j^2 \sigma_j^2 + 2 \sum_{i=1}^m \sum_{j=1, i \neq j}^m x_i x_j \sigma_{ij}\end{aligned}\quad (2.9)$$

where:

- x_j = The weight of asset j .
- σ_j^2 = The variance of asset j .
- σ_{ij} = The covariance between asset i and j .

The covariance between asset i and j (denoted by σ_{ij}) is calculated as follows,

$$\sigma_{ij} = \frac{1}{n} \sum_{t=1}^n (R_{i,t} - \bar{R}_i)(R_{j,t} - \bar{R}_j) \quad (2.10)$$

(Elton, Gruber, Brown & Goetzmann, 2007: 45-58)

The standard deviation of the portfolio (denoted by σ_p) is the square root of the portfolio's variance and is thus calculated as,

$$\sigma_p = \sqrt{\sum_{j=1}^m (x_j(R_j - \bar{R}_p))^2} \quad (2.11)$$

The standard deviation is mostly used for comparative purposes since it is in terms of the same units as the returns. The variance on the other hand is calculated in terms of the squared returns. A larger standard deviation (or variance) is associated with a more risky portfolio.

The risk constraint is when the risk of the portfolio has to be under a certain level. The weights allocated to the various asset classes have an influence on the risk of the portfolio and therefore the risk can be kept under a certain level (say Ω) by adjusting the weights. (Botha, 2010: 37-40)

The variance expressed in (2.9) must therefore meet the following criteria,

$$\sum_{j=1}^m x_j^2 \sigma_j^2 + 2 \sum_{i=1}^m \sum_{j=1, i \neq j}^m x_i x_j \sigma_{ij} \leq \Omega.$$

where:

- Ω = The maximum variance level.

The constituents of a portfolio is selected to either maximize the portfolio's expected return for the specified levels of risk, or to minimize the portfolio's risk level given a specified expected return. (Maginn, Tuttle, Pinto & McLeavey, 2007: 2-7) The Investment Policy Statement (IPS) of any

portfolio is set up based on the aforementioned objectives and constraints. (Maginn, Tuttle, Pinto & McLeavey, 2007: 2-7) The next step in the portfolio management process is to execute portfolio decisions set out in the IPS.

2.2.2 The Execution Phase

This phase consists of the selection of the portfolio composition and the implementation of said portfolio composition by combining the investment strategies and capital market expectations in the planning phase. The portfolio composition step consists of assigning weights to the different investments in the various asset classes based on the guidelines set out in the IPS. (Maginn, Tuttle, Pinto & McLeavey, 2007: 8-9)

The portfolio has to be reviewed on a constant basis and if necessary it should be rebalanced to meet the requirements set out in the IPS and by the law. A change in the capital market expectations is one possible reason for the portfolio to be reviewed. As time goes by the IPS might have to be reviewed as well since the circumstances of the investor might change. If the IPS changes then the strategic asset allocation of the portfolio will have to be revised as well. (Maginn, Tuttle, Pinto & McLeavey, 2007: 8-9)

There may, however, be differences in the actual asset allocation of the portfolio and its strategic asset allocation. This could be temporary and it can possibly be on purpose. One possible reason for such differences is tactical asset allocation. With tactical asset allocation the manager reacts to changes in the short-term capital market expectations instead of the changes in the investor's circumstances which were mentioned previously. (Maginn, Tuttle, Pinto & McLeavey, 2007: 8-9)

The portfolio should be optimized at all times. Portfolio optimization is a quantitative tool which is used to combine the various assets in an efficient way so that the return and risk objectives are met. It is also important that the implementation of the portfolio decisions is done effectively to reduce costs and maximize the returns. The next step is to monitor the results and make changes if necessary. This is known as the feedback phase. (Maginn, Tuttle, Pinto & McLeavey, 2007: 8-9)

2.2.3 The Feedback Phase

The third phase of the portfolio management process consists of monitoring and rebalancing the portfolio as well as evaluating the portfolio's performance. The circumstances surrounding both the investor and the economic factors are monitored in this phase so that if there is any change the IPS can be adjusted accordingly and the portfolio can be rebalanced if necessary. (Maginn, Tuttle, Pinto & McLeavey, 2007: 9-10)

2.2.3.1 Performance Evaluation

The third phase also includes a backward looking process which determines whether the portfolio manager has added value to the portfolio and whether the investment objectives were achieved.

This is called performance evaluation. The performance evaluation process is done periodically (e.g. daily, weekly, monthly, quarterly, half-yearly or annually) and consists of three steps, namely: performance measurement, attribution and appraisal. (Maginn, Tuttle, Pinto & McLeavey, 2007: 9-10)

Performance measurement is the calculation of the returns on the portfolio, which can be either positive or negative, for the chosen intervals. (Maginn, Tuttle, Pinto & McLeavey, 2007: 9-10) An investor would of course prefer a positive return. The return is the percentage increase in the value of the portfolio between the inception date and the evaluation date. The size of the return generated on the portfolio is influenced by the skill of the manager to select stocks and whether the correct weight was assigned to the different assets. (Botha, 2010: 19)

As an investor one would like to minimize the risks and maximize the returns. A portfolio that takes on more risk and generates less return than the benchmark will therefore not be acceptable since the investor could obtain a higher return by simply replicating the index and it will also be less risky. According to Markowitz (Markowitz, 1952), it is important to include risk in the performance evaluation process if portfolio managers assume that investors wishes to minimize the risk and maximize the returns. It is therefore necessary to find some way to measure the risk as was discussed in Section 2.2.1.4.

It is important that the portfolio manager or investor also identify the major sources of risk¹⁰ in the portfolio. The reason for this is that even if the total risk of the portfolio is within the risk objectives set out in the IPS, some of the major sources of risk might not be within the constraints of the portfolio. (Botha, 2010: 20)

The next step is performance attribution. This step determines why the portfolio performed in the way that it did as well as what sources contributed to the portfolio's performance. This is followed by the performance appraisal step. In this step the obtained return is compared against a benchmark or a peer group to determine whether the objectives set out in the IPS has been met and to evaluate the portfolio manager's skill. (Maginn, Tuttle, Pinto & McLeavey, 2007: 9-10) When comparing the returns against a benchmark or peer group it is important to also take the risk that the manager took to generate the obtained return into account. (Botha, 2010: 15-20) Thus, the risk and return of the portfolio is compared against the risk and return of the benchmark or peer group.

As was mentioned before, the aim is for the manager to add positive alpha to the portfolio. The value added to the portfolio (denoted by VA) is the return of the portfolio in excess of the benchmark's return. The value added between time $t - 1$ and time t is calculated as,

¹⁰ The identification of the sources of the portfolio's risk is defined as the risk attribution of the portfolio. (Botha, 2010: 20)

$$VA_t = R_{p,t} - R_{b,t} \quad (2.12)$$

where:

- $R_{p,t}$ = The return on the portfolio at time t .
- $R_{b,t}$ = The return on the benchmark at time t .

The average value added (denoted by \overline{VA}) is calculated as,

$$\overline{VA} = \overline{R}_p - \overline{R}_b \quad (2.13)$$

where:

- \overline{R}_p = The average return on the portfolio.
- \overline{R}_b = The average return on the benchmark.

A portfolio manager that constantly outperforms the benchmark has the required level of skill to manage the portfolio since it indicates that the manager mostly adds positive value to the portfolio. The results obtained from the performance evaluation can thus be used to make future investment decisions and to conclude whether the portfolio performed satisfactory or not. Performance analysis is also used to determine why the portfolio performed satisfactory or not. (Botha, 2010: 9-20)

2.2.4 Summary

The portfolio management process can be summarized as shown in Figure 2.2.

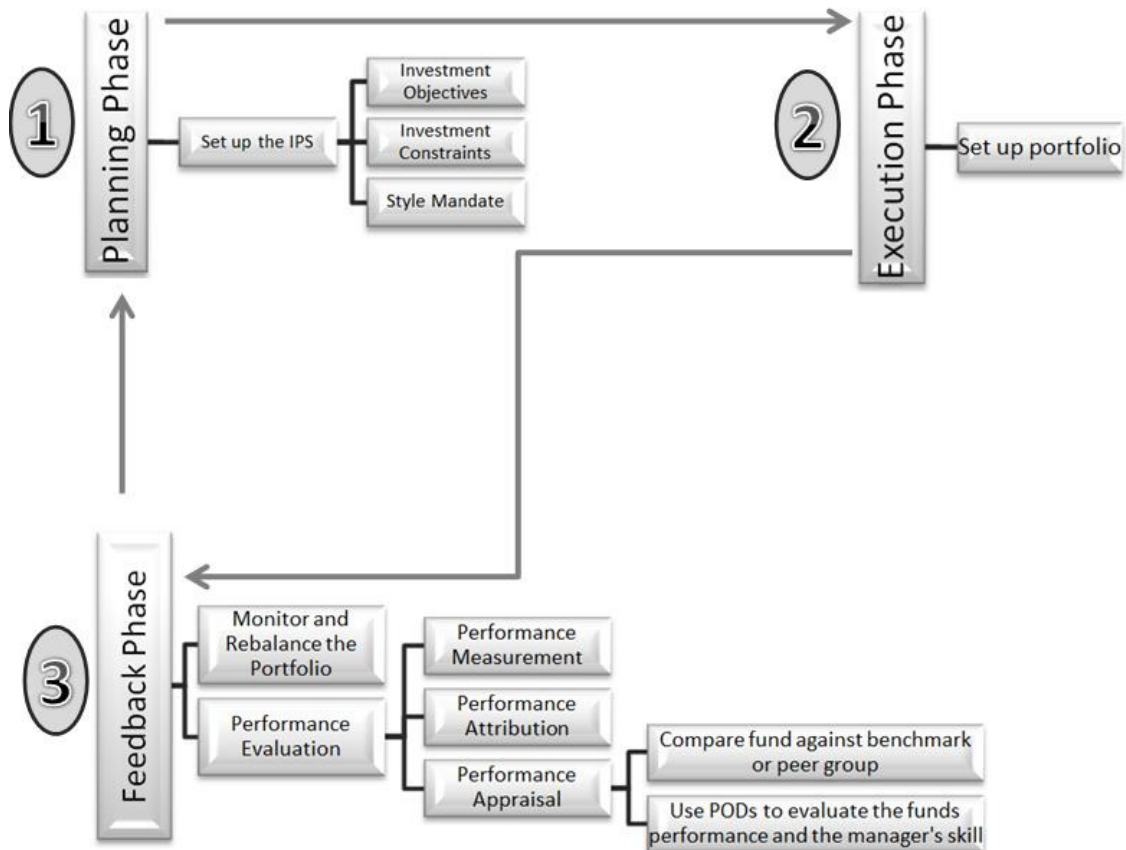


Figure 2.2: The Portfolio Management Process - Summary

2.3 BENCHMARKS AND PEER GROUP COMPARISONS

There are two performance evaluation methods which are mainly used in practise: namely benchmarks and peer group comparisons. According to a survey¹¹ done by the Investment Management Consultants Association (IMCA), 90% of the respondents use peer group comparison and 95% use benchmarks (specifically Broad Market Indices) when they perform performance evaluation (Surz, 2003b). Thus, most of the respondents use both methods for performance evaluation (Van Heerden & Botha, 2012).

The Chartered Financial Analyst (CFA) Institute provides criteria for benchmarks used to evaluate investment performance. These criteria were set forth by Richards and Tierney's consulting firm Nuveen Investments (formerly known as Richards and Tierney Inc.). Table 2.5 contains a summary of the criteria.

¹¹ The survey was done amongst 700 institutional investors and consultants in the USA. (Surz, 2003b)

Table 2.5: Criteria for a 'Good' Benchmark According to CFA

| Criteria | Description |
|---|---|
| 1. Unambiguous | It is required that a benchmark is clear and precise. It is however often the case that performance standards, requirements and especially client expectations are extremely ambiguous. The benchmark's mandate has to specify specific and quantifiable measures such as the name and weight of each security to ensure that the benchmark is unambiguous. (Rousseau & Zwonnikoff, 2002: 12-17) |
| 2. Investable | For a benchmark to be investable and viable it must be possible to replicate or track the benchmark. (Rousseau & Zwonnikoff, 2002: 12-17) |
| 3. Measurable | If the benchmark's performance and behaviour cannot be measured or studied regularly it will be very difficult to beat the benchmark. The benchmark should thus be updated as frequently as possible. Some peer group benchmarks are updated quarterly. These benchmarks are often not measurable and their behaviour is mostly unclear which renders the practical use of these benchmarks pointless. These benchmarks will also be much more volatile due to the sudden large jumps that will occur in the performance of the benchmark. These sudden large jumps occur because of the infrequency of the data updates. (Rousseau & Zwonnikoff, 2002: 16) |
| 4. Appropriate | The prominent and fundamental risk and performance characteristics of the benchmark and the portfolio should be similar to accurately represent the approach that the manager follows. For instance, a growth benchmark cannot be used to determine the performance of a value fund. (Rousseau & Zwonnikoff, 2002: 12-17) |
| 5. Reflective of Current Investment Opinions | A manager must have an informed opinion on each constituent on the benchmark if he/she wants to beat the benchmark. It will be quite difficult to manage a portfolio against the benchmark if the portfolio manager only has an informed opinion on about 40 shares but there are 200 constituents on the benchmark. According to Rousseau and Zwonnikoff (Rousseau & Zwonnikoff, 2002: 14) this leads to the very problematic question of whether the ALSI actually complies with the criteria in question, since it is very difficult for an average-sized team of managers to have a truly informed opinion on each one of the constituents. Due to the concentration ¹² (which will be discussed in detail in Section 2.4.1) of the market, the team will have an informed opinion on about 86 per cent of the ALSI if the manager has an informed opinion on the top 40 constituents of the ALSI (weighted by market capitalization). In this case the FTSE/JSE All Share Top 40 Index (ALSI-40) would be a much more appropriate benchmark. Baily (1992) proposed that a benchmark will be appropriate if at least 80 to 90 per cent of the stocks in the manager's portfolio are reflected in the benchmark's constituents. |
| 6. Specified in Advance | It is extremely difficult to replicate or take a position against a benchmark if the benchmark is not specified in advance and therefore the second criteria will not be met. If the benchmark is not specified in advance, the benchmark will by definition be vague and ambiguous, thus the first criteria will not be met either. It is therefore necessary that the benchmark should be agreed upon and constructed in advance of the start of the evaluation period. |

Source: (Surz, 2003b)

There are various other criteria for a 'good' benchmark in the literature. These criteria are discussed in the Table 2.6.

¹² Both market and sector concentration exists. Market concentration is generally defined as the market's tendency to be dominated by a few large companies (Van Heerden & Saunderson, 2008) and sector concentration is when the cumulative weight of all the shares within a certain sector dominates the market (Botha, 2010: 21-25).

Table 2.6: Additional Criteria for a ‘Good’ Benchmark in the Literature

| Criteria | Description |
|-----------------------------------|---|
| Low Turnover and Stability | According to Rousseau and Zwonnikoff (2002: 14) the proportion of the market cap of the benchmark to be re-allocated during the rebalancing of said benchmark should be low. The benchmark’s performance will be more volatile and it will also be more expensive to track the benchmark if it has too much ‘churn’. |
| Positive Active Positions | Bailey (1992) defines an ‘active position’ as the difference between the portfolio’s weight in a certain security and said security’s weight on the benchmark. A manager will take a positive active position, thus overweighting the security, if the manager likes the stock. They underweight a security that they do not like or they will even put a zero weight on said security. Due to the concentration of the ALSI it forces managers to have negative active positions. For instance, BHP Billiton, one of the largest stocks on the ALSI, had a 12.27 per cent weight based on market capitalization on 28 June 2013. It would be very difficult for a manager to overweight BHP Billiton if they like the stock. In South Africa the regulation of funds places limitations on the maximum weight that a fund is allowed to have in a single stock which thus forces the manager to take a negative active position on BHP Billiton. |
| Beatable | It must be possible to beat an appropriate active benchmark. If the benchmark is not beatable one should rather track it passively as it is of no use otherwise. As Rousseau and Zwonnikoff (2002:16) said, “If you can’t beat it, you cannot use it for active purposes.” |
| Fair | Rousseau and Zwonnikoff (2002: 17) defines a fair benchmark as a benchmark where “the probability of beating the benchmark has to be the same as the probability of underperforming the benchmark (i.e. 50%)”. In other words, there must be a realistic chance that the manager can beat the benchmark otherwise the benchmark is not fair. |

Source: (Rousseau & Zwonnikoff, 2002)

The above criteria should rather be seen as guidelines instead of rules. A ‘good’ benchmark can be created by finding compromises and by creating a benchmark based on those criteria that suits the specific needs of the situation. (Rousseau & Zwonnikoff, 2002: 17)

As was mentioned before, there are two main methodologies used when performing performance evaluation, namely benchmarks and peer group comparisons. These methodologies will now be discussed individually in more detail.

2.3.1 Broad-Market Indices

A benchmark is a reference portfolio against which a portfolio or fund is compared in order to determine whether the portfolio or fund performed better or worse than the reference portfolio. (Amenc & Le Sourd, 2003: 43) The portfolio or fund manager’s skill to outperform the Broad-Market Index is also measured when comparing the portfolio or fund against the Broad-Market Index. The Broad-Market Index methodology is a practical and low cost alternative method for active management. (Surz, 1994) Selecting the appropriate Broad-Market Index however, is extremely important.

Bodie, Cane and Marcus (2001: 43-51) discusses three types of stock market indices, as discussed in Table 2.7.

Table 2.7: Types of Stock Market Indexes

| Index | Description |
|-----------------------|---|
| Price-Weighted | The weight of each share is the price of said share. This is problematic since those shares with the highest prices will carry the highest weight for no theoretical reason. The weight of a share is reduced when a stock split occurs. e.g. The Dow Jones Industrial Average |
| Value-Weighted | The index is calculated by computing the total market value of each of the shares in the index in question and then calculating the proportional weight. The market value is the number of outstanding shares multiplied by the corresponding market price. Changes in the market cap of the large companies will have a greater effect than changes in the market cap of the smaller companies. e.g. The JSE All Share Index (ALSI) |
| Equal-Weighted | The index is calculated by assigning an equal weight to each of the constituents, regardless of the stock's market price or value. Changes in large and small firms will therefore have the same effect on the index. e.g. The Standard and Poor 500 Equal Weighted Index (EWI) |

Source: (Bodie, Kane & Marcus, 2001: 43-51)

According to Rousseau and Zwonnikoff (2002: 17) a Broad-Market Index is considered to be appropriate if a large portion of the stocks included in the portfolio corresponds with the stocks included in the Broad-Market Index. This is illustrated in Figure 2.3. Amenc and Le Sourd (2003: 43-49) also state that the constraints of the Broad-Market Index and the fund should be more or less the same.

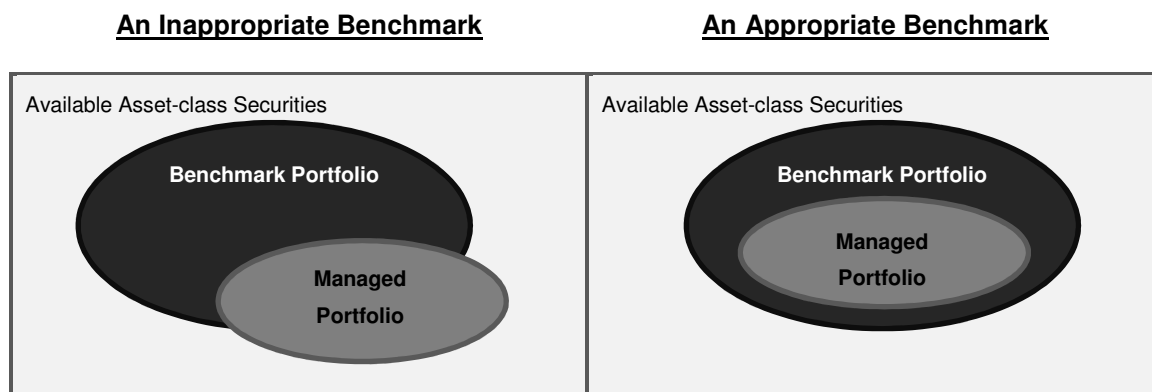


Figure 2.3: An Appropriate vs. an Inappropriate Benchmark

Adapted From: (Bailey, 1992)

The problem however, is that such a Broad-Market Index does not really exist. If the wrong Broad-Market Index is used it can either reflect poorly on the fund manager or it can create the illusion that a manager is performing adequately when in fact he/she is not. It is therefore necessary to find an appropriate and unbiased benchmark. (Botha, 2010: 17-18)

Broad-market indices, such as the JSE All Share Index (ALSI) in South Africa, are commonly used as a benchmark. The ALSI is the best reflection of the investable universe in the South African market and therefore it is used as a benchmark. Using indices as benchmarks is the most popular

performance evaluation method of the two since it represents a manager's investable universe to a large extent (Rousseau & Zwonnikoff, 2002: 17-18). The return of the portfolio is compared against the return of the Broad-Market Index to determine whether an investment manager added value. If the risk-adjusted return on the portfolio is higher than the risk-adjusted return on the Broad-Market Index during a time period, then the manager did indeed add value to the portfolio.

2.3.1.1 Criticism against Broad-Market Indices

Rousseau and Zwonnikoff (2002: 4) summarizes the problem very nicely with their statement that finding an appropriate Broad-Market Index which will suit the needs of every investor is equivalent to finding a pot of gold at the end of the rainbow. They also concluded that the ALSI is not an ideal benchmark but most professional fund managers still use it as a benchmark due to the lack of a more appropriate benchmark.

Regulation allows active funds to keep a certain weight in cash or cash equivalent investments during times where the equity market is quite volatile. It is therefore inappropriate to compare said fund against a stock-only market index as it is not representative of the fund's investable universe. Due to the investment in cash, these active funds will lag behind the market in bull markets. (Rousseau & Zwonnikoff, 2002: 17)

A very important problem is the market concentration (which will be discussed in detail in Section 2.4.1) in certain Broad-Market Indices. Market capitalization weighted indices such as the ALSI are highly concentrated and therefore they are very sensitive to the movements of the largest constituents. Regulation however limits the weight that a fund may hold in a specific stock. (These regulations will be discussed in more detail in Section 2.4.2.) A highly concentrated Broad-Market Index is thus not representative of the fund's investable universe because investors cannot replicate the index due to the limitations placed on the weighting of the stocks.

The constituents of the Broad-Market Index also pose a problem because certain stocks are excluded from the Broad-Market Index although it is in the manager's investable universe. The ALSI Top 40 consists of only large cap stocks and therefore the ALSI Top 40 will not be considered an appropriate benchmark if a fund manager includes small cap stocks in the portfolio, since the index is not the best representation of the fund's investable universe.

According to Rousseau and Zwonnikoff (2002: 17) the ability to take active positions and formulate informed opinions based on broad-market indices as well as their stability should be considered carefully.

2.3.2 Peer Group Comparisons

Peer group comparison is when different fund managers that have the same investment style or invest in the same asset classes are compared against each other. (Amenc & Le Sourd, 2003: 49-

50) It is one of the oldest examples of a benchmark. It is however also the most controversial performance evaluation method due to the biases related to the use of peer group comparison. (Rousseau & Zwonnikoff, 2002: 18)

According to Baily (1992) peer group comparisons emerged due to their naïve appeal and their convenience. It is naïvely appealing for the users of peer group comparisons to compare different managers even if said managers have very different styles, constraints and valuation methods. These benchmarks are also quite convenient as it is easy to obtain the data due to the fact that consultants marketed the data so much as a part of their service. The usage of peer group comparisons is therefore quite cheap.

Both Amenc and Le Sourd (2003: 49-50), and Botha (2010: 18) stated in their research that similar portfolios are compared against each other according to the division of the portfolios into different styles based on their market capitalization, the amount of growth stocks in the portfolio, the amount of value stocks in the portfolio, etc. In other words, each manager is placed in a pre-specified pigeonhole and the managers in each pigeonhole is compared and ranked based on their performance (Surz, 1996). Based on these rankings one can determine which manager performed the best for the period in question.

Weber (2007: 17-18) uses the following explanation to illustrate peer group comparison. Consider a scenario where a portfolio, say P , with a return (denoted by R_p), is compared against m peer group portfolios. Let the returns of the m peer group portfolios be denoted by $R_{p1}, R_{p2}, \dots, R_{pm}$. One possible approach is where portfolio P can be ranked based on its performance against the peer group portfolios by counting all the portfolios which has a return that is higher than the return of portfolio P . Thus,

$$Position(P) = \# \{i = 1, 2, \dots, m : R_{pi} > R_p\}.$$

The manager that is ranked in the first place is seen as the best manager and the worst manager is the manager who is ranked in the last position.

The accuracy of using peer group comparisons can be questioned by looking at their conceptual shortcomings, the different bias's (which will be discussed in Sections 2.3.2.1 to 2.3.2.4) and the failure to pass tests relating to the quality of the benchmark. (Bailey, 1992) The main problem underlying the use of a peer benchmark is that it is not possible to specify said benchmark in advance. Managing money against the benchmark is therefore extremely impractical since the benchmark is not investable. (Rousseau & Zwonnikoff, 2002: 17) Consensus funds attempts to

replicate the so-called median manager¹³ although such a manager may not exist and therefore the created fund is not a good reflection of the reality.

Peer benchmarks do however have one advantage over broad-market indices because managers are all required by regulation to follow the same guidelines. For instance, they are all limited by the maximum portion they are allowed to invest in a specific share. A peer benchmark will thus better reflect these guidelines when compared to a broad-market index benchmark that is concentrated (which will be discussed in Section 2.4.1). (Bailey, 1992)

2.3.2.1 Criticism against Peer Group Comparisons: Classification Bias

A conceptual shortcoming according to Baily (1992) is that different fund managers have different investment philosophies, risk profiles and investable universes. When ranking and comparing these portfolios it is assumed that the managers who follow the same mandate and style have the same opportunity set from which the portfolio must be constructed. Most portfolio managers however use a blend of styles. The “pigeonhole” classification can therefore lead to the misrepresentation of a manager’s unique style (Surz, 1996).

Many managers is not “style pure”, thus they do not follow one specific style but rather a blend of styles. If these managers are categorized in a specific style peer group the portfolio will underperform the style index in question if the style is in favour and the portfolio will outperform the style index if the style is out of favour. Thus, when comparing different fund managers, one clearly compares apples with oranges. As Baily (1992) put it, “What exactly is manager X expected to add value to, the apples or the oranges or fruit salad?”

Classification bias has different effects as styles change and therefore instead of causing the skill of managers to change, it causes the rankings of the funds to change. (Surz, 2006) The reason for this is that the bias has different effects due to the performance of a specific style within a certain time period. According to Surz (2003b), peer groups have their own unique sets of idiosyncratic distortions. Due to this, a portfolio will be ranked differently within different peer groups even if the peer groups in question have the same mandate (e.g. large cap value).

When comparing fund managers one should compare apples with apples. In other words, for the benchmark to be considered appropriate, a large portion of the stocks included in the portfolio and the corresponding benchmark should overlap. A median manager will therefore definitely not be considered appropriate as it will not cover the investable universe in question. (Bailey, 1992; Rousseau & Zwonnikoff, 2002: 19-20)

¹³ A median manager is the “manager” of the median fund of a peer group. For instance, if a peer group is divided into sections based on the P/E ratio of each fund and 15 is the average P/E ratio, then the median manager’s fund will have a P/E ratio of 15. (Rousseau & Zwonnikoff, 2002: 18-20)

2.3.2.2 Criticism against Peer Group Comparisons: Composition Bias

Composition bias arises when a database has a concentration of certain fund types and when it contains only a small number of the available funds (Surz, 1996). A portfolio can thus be part of a large group of similar funds on one database but on another database it is listed along only a few similar funds. It is thus possible for a manager to be ranked as a “good” manager in its peer group according to the one database but according to the ranking of the other database the manager might be ranked as a “not so good” manager. (Botha, 2010: 25-27)

In an example found by Eley (2004), a manager was compared against the peer groups of two different peer group providers. The first provider had a sample of 66 funds which could be compared against the fund in question while the second fund used 318 funds. The manager was ranked in the 24th percentile according to the first data provider and in the top 43rd percentile according to the second data provider. The difference is due to the difference in the sample sizes of the two data providers. However, according to Van Heerden and Botha (2012), composition bias may have a bigger influence in developed markets than it does in the South African market. The reason for this is that the South African market is much smaller in size.

2.3.2.3 Criticism against Peer Group Comparisons: Survivorship Bias

Those fund managers that perform poorly in comparison with their peers, either get fired or they make drastic changes to their funds. According to Baily (1992) an upward bias appears in the median universe when managers leave the fund management industry. If however, they choose to rather restructure their fund, it leads to more volatility in the median universe. Baily (1992) found that annually survivor bias can lead to a 150 basis points overstatement of the median. This could lead to a significant decrease in the alpha value of the manager in question.

It is also possible for funds to be liquidated or merge, which would cause the fund to be excluded from a peer group provider's database. The funds were however originally part of the database and were used to rank the funds on the day in question. The remaining funds will thus have a worse ranking than before the funds were removed from the database.

The best way to understand the survivorship bias is the marathon analogy that Ronald Surz (1996; 2003a) used. He asked that if there are 1000 runners in a marathon but only 100 runners actually successfully finish the race, is the runner that came in the 100th position last or is he/she in the top 10 per cent? According to Surz the runner is in the top decile (the top 10 per cent). The same question arises when funds are excluded from a peer group provider's database.

2.3.2.4 Criticism against Peer Group Comparisons: Period Under Review

The period which is used to compare funds against each other has quite a significant influence on the ranking of a fund. (Botha, 2010: 25-27) Consider the data available for the general domestic

equity funds and specifically the Momentum Value Fund as available on the Equinox website on 19 August 2013. This is shown in Table 2.8. Over a 1 month and 3 month period the fund was ranked in the first position (out of 56 funds). However, by extending the period to six or 12 months the ranking drops to the 56th position. The fund was thus ranked in the last position for the six and 12 month periods. For the three and five year periods the fund was ranked in the first position once again despite the big drop for the previous three periods. By extending the period under review it becomes evident that the ranking of the fund varies quite a bit for the various periods under review.

Table 2.8: Momentum Value Fund Rankings on 19 August 2013

| Fund | 1 Month | 3 Months | 6 Months | 12 Months | 2 Years | 3 Years | 5 Years |
|---------------------|----------------|-----------------|-----------------|------------------|----------------|----------------|----------------|
| Momentum Value Fund | 1 | 1 | 56 | 56 | 53 | 1 | 1 |

Source: (Equinox.co.za - unit trusts online. 2013)¹⁴

It is clear that the rankings are quite volatile when the period under review is changed. The important question to ask according to Botha (2010: 25-27), is whether it is possible to identify the top performing fund manager who shows skill consistently based on a survey performed in this manner?

2.4 PORTFOLIO MANAGEMENT IN THE SOUTH AFRICAN MARKET

The Johannesburg Stock Exchange (JSE) is the exchange in South Africa on which securities, derivatives, commodities as well as certain other financial derivatives are exchanged. The JSE is one of the top 20 exchanges in the world based on the market capitalisation of said exchanges. (JSE)

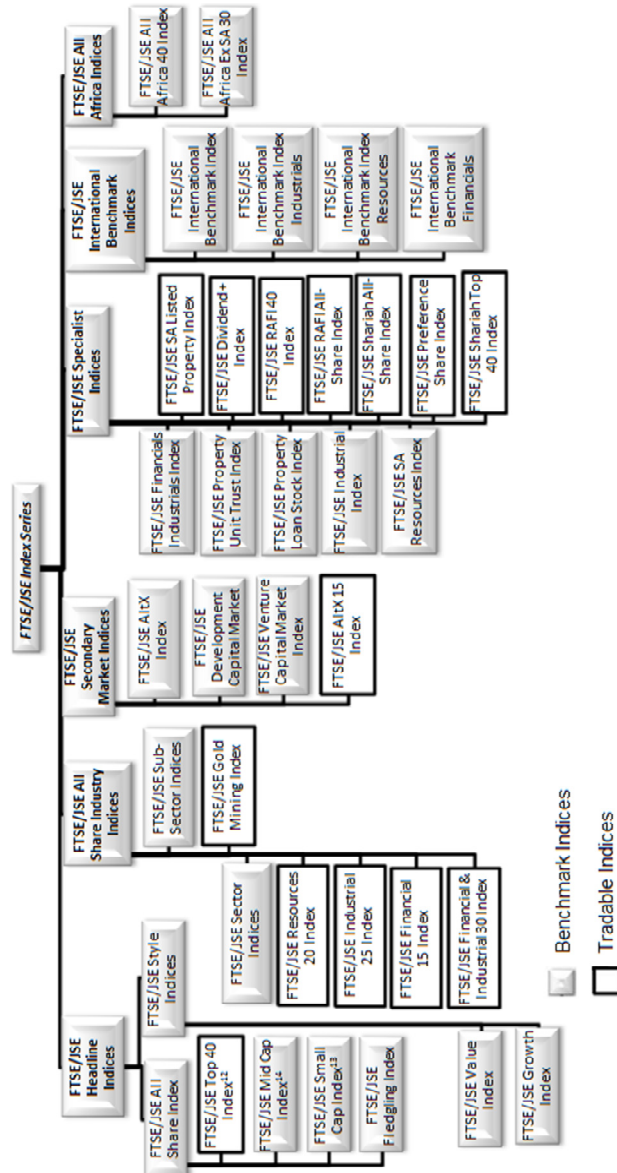
The FTSE/JSE index series consists of all the shares in South Africa that investors can invest in. There are various indices on the FTSE/JSE index series as shown by Figure 2.4. Note that the FTSE/JSE Africa Index Series includes Namibian Indices (JSE). In this study the focus will be on value, core and growth shares. A share is considered to be a growth share if the company has a sustainable and high earnings growth rate. These companies usually have a high Price to Earnings (P/E) ratio, Price to Book-Value (P/B) or Price to Sales (P/S) ratio. (Maginn, Tuttle, Pinto & McLeavey, 2007: 433-434)

Value shares on the other hand, are shares which have a price that is considered to be cheap relative to the earnings or the assets per share. The price is considered to be cheap if the Price to Earnings (P/E) ratio of the company is low when compared to the P/E of the market, if the Price to Book Value (P/B) ratio of equity is relatively low in comparison with the market value or if the share

¹⁴ Equinox is a website which provides a database consisting of certain key data of almost every unit trust and money market fund which are available in South Africa. Equinox was bought by PSG Group Limited. (Equinox.co.za - unit trusts online. 2013)

is trading at a discount to its net asset value. (Maginn, Tuttle, Pinto & McLeavey, 2007:429-433) A core share is one part growth and one part value.

Figure 2.4: FTSE/JSE Africa Index Series Family Tree



Source: (JSE)

¹⁵ Large Cap shares are those shares which have a large market capitalization. (Maginn, Tuttle, Pinto & McLeavey, 2007: 434-435) A share is considered to be a large cap share if the share is one of the top 40 market constituents on the JSE Stock Exchange according to market capitalization. These shares are included in the FTSE/JSE Top 40 Index. (JSE; *Equinox.co.za - unit trusts online*. 2013)

¹⁶ A share is considered to be a small cap share if the company is an established small company or if the company is an emerging company in its initial phase of life. The market capitalization of these companies is too small for them to be included in either the large or mid cap indices. (Maginn, Tuttle, Pinto & McLeavey, 2007: 434-435)

¹⁷ Mid cap shares are everything not included in small and large cap. (Maginn, Tuttle, Pinto & McLeavey, 2007: 434-435)

On 16 September 2013, approximately 86 per cent of South African funds used an index that belongs to the FTSE/JSE Index Series (or a composition of said indices) as a benchmark. 42 per cent of these users used the ALSI as a benchmark. Approximately 17 per cent of the funds used composite indices which were constructed by including indices such as the FTSE/JSE Small Cap Index, FTSE/JSE Mid Cap Index, etc. 13 per cent of the funds used some form of peer group comparison. (*Equinox.co.za - unit trusts online. 2013*)

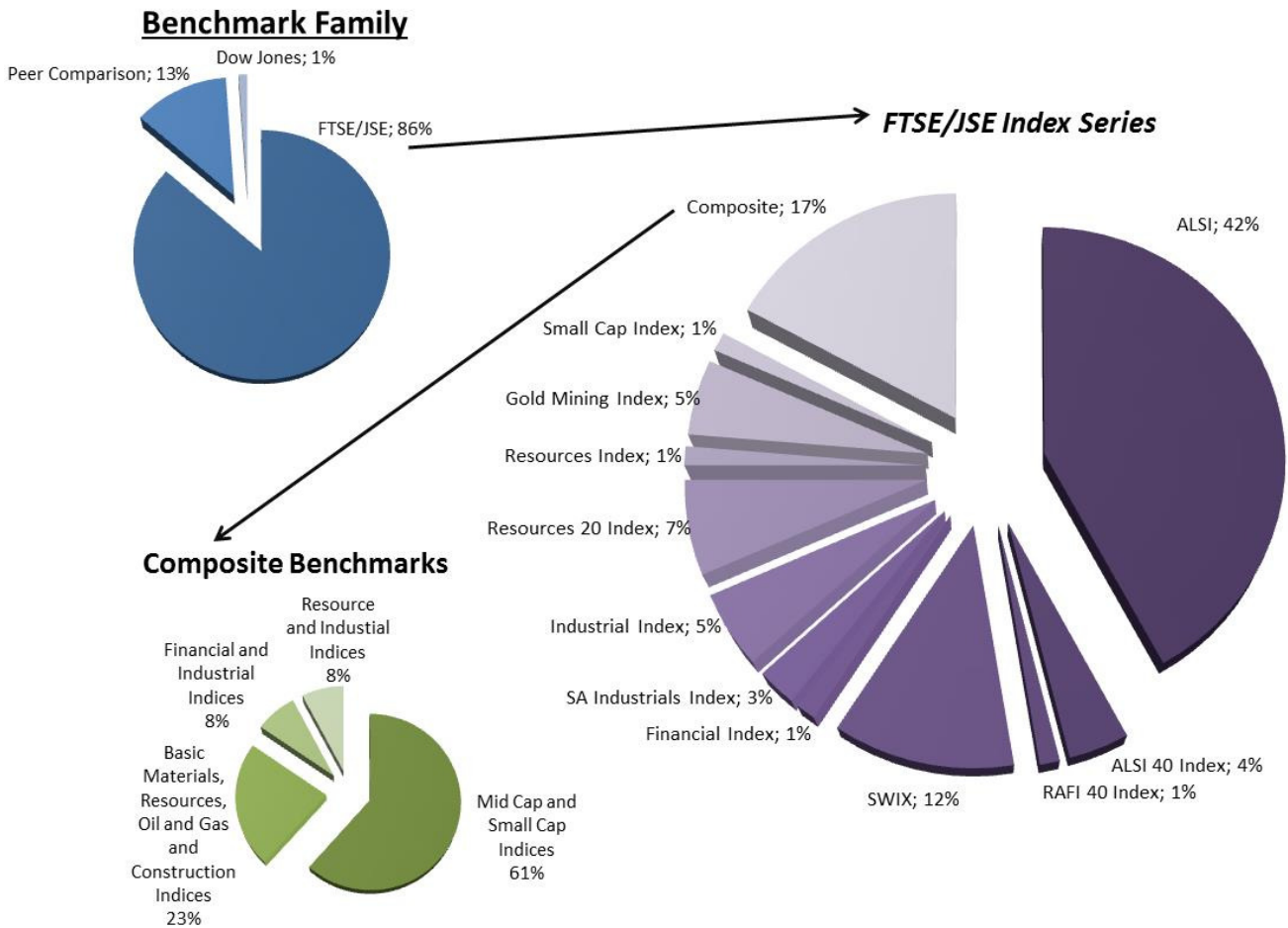


Figure 2.5: Benchmarks used by South African Funds

Data Source: Equinox

Funds have started to use composite benchmarks made up of various indices due to the need for a benchmark that is a better reflection of the fund's investable universe and to eliminate some of the problems, such as concentration, of these indices.

2.4.1 Market Concentration

According to Van Heerden and Saunderson (2008), market concentration is generally defined as the market's tendency to be dominated by a few large companies. As was mentioned in Section 2.3.1 Broad-Market Indices such as the ALSI are usually used in South Africa as a benchmark. It

was also pointed out that a very important part of the criticism against the ALSI is its high levels of market concentration. This section studies the market concentration of the South African market and specifically the ALSI.

According to a study done by Roll (1992), South Africa has the third highest market concentration level in the world as measured by the Herfindahl-Hirschman Index. South Africa also has the highest equity index variance level as measured by the standard deviation. The high level of market concentration as measured by the Herfindahl-Hirschman Index was again proven by Bradfield and Kgomari (2004). Furthermore, they also showed that the index and the shares dominating the index tend to move in the same direction. This is indicated by the high level of correlation that is evident between the shares. The combined effect of the high market concentration level and the high correlation between shares is that the risk of the portfolio tends to increase significantly. According to Bradfield and Kgomari (2004), nearly one third of the risk of the ALSI is due to the high levels of concentration. They also found that a manager can reduce the risk of his/her fund or portfolio by one tenth if the manager constructs a portfolio which is less concentrated than the ALSI.

In Table 2.5 it was mentioned that a benchmark has to be investable to be considered an appropriate benchmark. For the benchmark to be considered investable it must be possible to replicate or track the benchmark. Botha (2010: 21-25) states that by replicating the benchmark, the portfolio manager will be able to perform in line with said benchmark and thus the portfolio will at least not underperform when compared against the benchmark in question. The manager will however have to contain the exact same constituents at the exact same weights as the benchmark.

In an attempt to reduce the risk of the portfolio the average equity manager constructs his/her portfolio in such a way that the portfolio is less concentrated than the ALSI. Van Heerden and Saunderson (2008) however showed that due to this, outperforming the ALSI during periods where there is a bull market is extremely difficult. Furthermore, they showed that it becomes almost impossible to beat the ALSI during a bull market as the tracking error increases. The opposite is also true. Thus, it will be relatively easy to beat the benchmark during a bear market.

Outperforming (or underperforming) the ALSI does not necessarily indicate that the manager has skill (or a lack thereof). Van Heerden and Saunderson (2008) asks the important question that if the ALSI is not the best way to measure the performance of a fund or the skill of a manager, is there a broad-market index that is better suited for these purposes? The ALSI is however currently the most used benchmark in South Africa despite its high levels of concentration.

Figure 2.66 illustrate the cumulative percentage of the ALSI based on its constituents as on the 28th of June 2013. The ALSI had 165 constituents on the day in question.

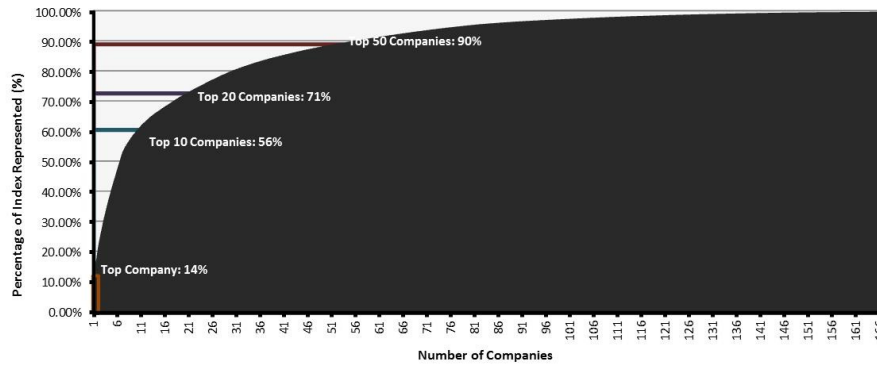


Figure 2.6: Percentage of the ALSI represented by its Constituents on the 28th of June 2013

Adapted From: (Botha, 2010: 22)

Data Source: JSE

Figure 2.6 clearly shows the high level of market concentration in South Africa. On 28 June 2013 the top company, in terms of market capitalization, had a 14 per cent weight. In other words, 12 per cent of the South African market is made up of one share. By including the top 10 shares in the portfolio, 61 per cent of the ALSI are represented in the portfolio. This clearly indicates that there is a very high level of market concentration in the market. A portfolio consisting of the top 50 shares is a good proxy for the ALSI since the top 50 shares represent approximately 89 per cent of the ALSI. If the dominating sectors, and specifically the dominating shares within these sectors, perform well, said portfolio will perform well. The market as a whole will also perform well since the created portfolio represents 89 per cent of the market.

Figure 2.7 indicates how the weights (in terms of market concentration) of the top company, the top 10 companies, the top 20 companies and the top 50 companies fluctuated between March 2010 and June 2013.

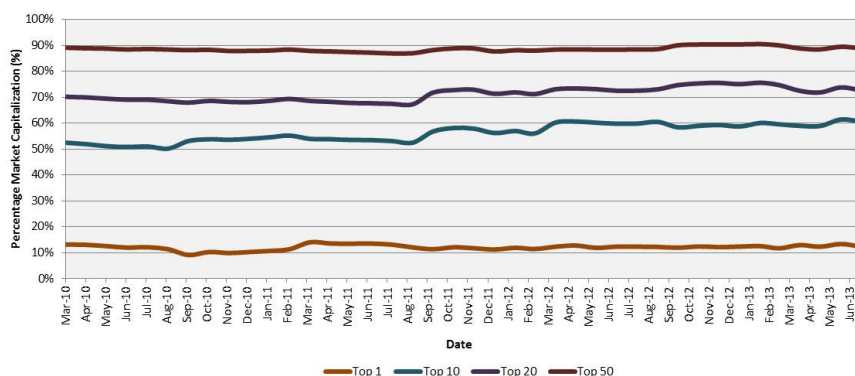


Figure 2.7: Percentage of the ALSI represented by its Constituents on 28 June 2013

Data Source: JSE

The South African market also has high levels of sector concentration¹⁸. The sector concentration for the top 50 shares based on the market cap as on the 28th of June 2013 is shown in Figure 2.8.

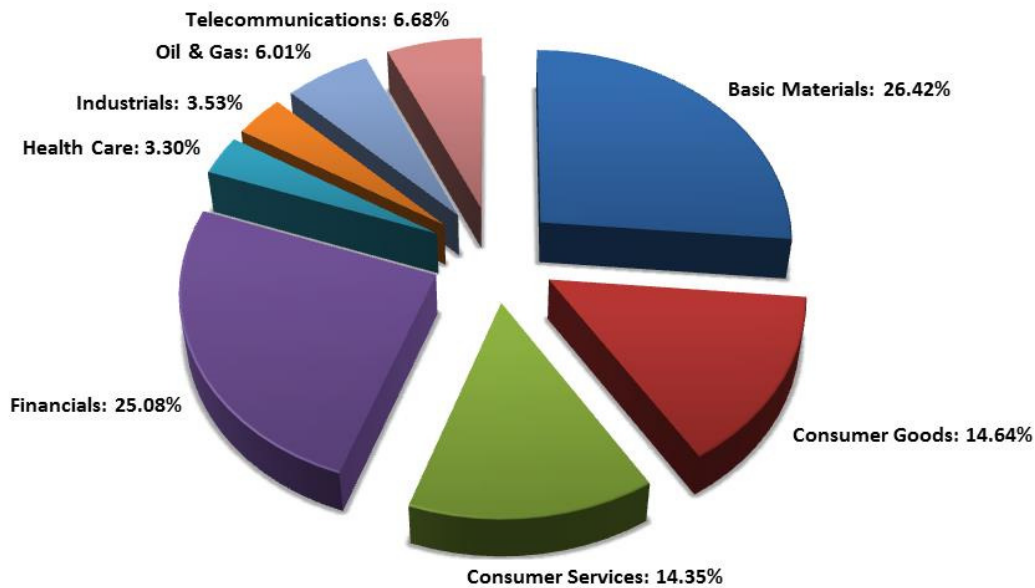


Figure 2.8: Sector Representation of the Top 50 Constituents on the ALSI as on the 28th of June 2013

Adapted From: (Botha, 2010: 22-25)

Data Source: JSE

The basic materials sector is the most dominant sector in the South African market when considering the top 50 shares based on market cap. The second largest sector is the financial sector, followed by the consumer goods and services sectors. Between July 2012 and June 2013 the basic materials sector remained the largest sector in the South African market. The financial sector was the second largest sector for July 2012 and June 2013. The variation in these weights is shown in Figure 2.9. In section 2.3 it was mentioned that there should not be a lot of variation in the constituents of the benchmark for the benchmark to be appropriate. Clearly from Figure 2.9 it is evident that there is quite a bit of variation in the ALSI's constituents.

¹⁸ Sector concentration is when the cumulative weight of all the shares within a certain sector dominates the market. (Botha, 2010: 21-25)

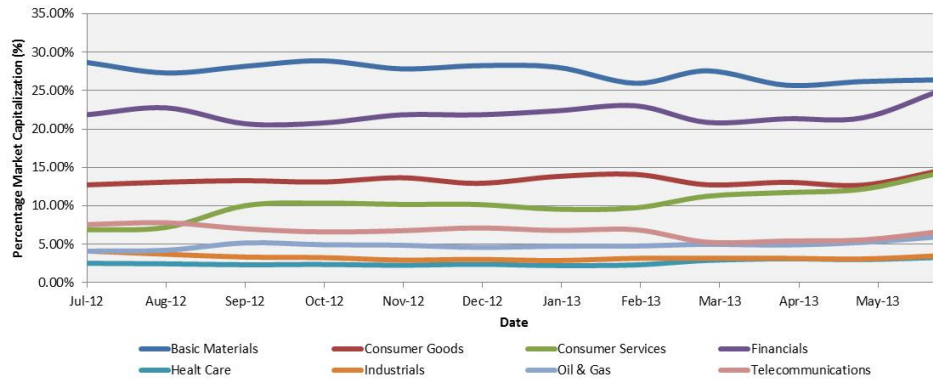


Figure 2.9: Sector Concentration Weight Variation Between July 2012 and June 2013

Data Source: JSE

A fund manager can construct a portfolio that performs quite in line with the ALSI by narrowing the fund's investable universe from approximately 160 shares to 50 shares or even 20 shares and to specifically include those shares included in the basic materials and financial sectors in the portfolio. Creating a portfolio consisting of the top 50 shares will, however, lead to some risk.

Correlation¹⁹ is an important measure of risk, as was discussed in Section 2.2.3.1. A low correlation between two securities, portfolios or funds leads to diversification benefits because the assets do not perform in the same way. In this case, the poor performance of one security, portfolio or fund can be offset by another security, portfolio or fund with a good performance.

As Botha (2010: 21-25) points out, it is unnecessary to include all 50 shares due to the high level of market and sector concentration. Thus, the correlation between the top 10 constituents of the ALSI (in terms of market capitalization) as on the 28th of June 2013 is studied now since it will make up most of the created portfolio. The correlation matrix in Table 2.9 is based on the daily returns of the shares in question for the period 2 July 2012 to 28 June 2013.

¹⁹ Correlation is a statistical measure which measures the strength of the linear relationship between two shares, portfolios or funds. The correlation has a value between -1 and +1. The value 0 indicates that there is no correlation between the two variables and thus there is no linear relationship between the two variables. A correlation of +1 indicates that there is perfect positive correlation between the two variables and thus the two variables will move in tandem with one another. A correlation of -1 indicates that there is perfect negative correlation between the two variables and thus if the one variable move in one direction then the other variable will move in the opposite direction. (Marx, Mpofo, van de Venter & Nortjé, 2006: 250)

Table 2.9: Correlation Matrix of the Top 10 Constituents as on the 28th of June 2013

| | BIL | SAB | CFR | NPN | AGL | SOL | MTN | OML | SBK | SLM |
|-----|---------|--------|---------|--------|---------|--------|--------|--------|--------|--------|
| BIL | 1.0000 | | | | | | | | | |
| SAB | 0.3080 | 1.0000 | | | | | | | | |
| CFR | 0.0388 | 0.0569 | 1.0000 | | | | | | | |
| NPN | 0.0632 | 0.0133 | 0.3604 | 1.0000 | | | | | | |
| AGL | -0.0462 | 0.0659 | 0.4619 | 0.4820 | 1.0000 | | | | | |
| SOL | 0.5336 | 0.2512 | 0.0188 | 0.0387 | 0.0077 | 1.0000 | | | | |
| MTN | 0.2126 | 0.1859 | -0.0745 | 0.0294 | -0.0411 | 0.2911 | 1.0000 | | | |
| OML | -0.0469 | 0.0658 | 0.3881 | 0.3934 | 0.4933 | 0.0108 | 0.0083 | 1.0000 | | |
| SBK | 0.2160 | 0.1714 | 0.0700 | 0.1424 | 0.1240 | 0.2513 | 0.3849 | 0.1293 | 1.0000 | |
| SLM | 0.3082 | 0.3111 | -0.0205 | 0.0375 | -0.0246 | 0.3650 | 0.3553 | 0.0039 | 0.4695 | 1.0000 |

Data Source: INet

The red values in Table 2.9 indicate a perfect positive correlation. The lighter the colour of the correlation value becomes, the less correlated the shares are. The table indicates that the shares tend to be correlated more positively and therefore the shares will tend to move in the same direction (Van Heerden & Saunderson, 2008). Similar to the study done by Botha (2010: 24), the above results indicates high levels of market and sector concentration as well as high levels of correlation.

These high correlation levels have an influence on the risk of the portfolio (Van Heerden & Saunderson, 2008). The portfolio will tend to perform in line with the performance of any one of the shares included in the portfolio. In this case the portfolio will have a level of risk which is close to the risk level of a portfolio consisting of only one of the shares in the correlation table. A lot of diversification benefits which can be obtained by including shares with a low correlation will thus be lost. According to Botha (Botha, 2010), due to these reasons, most professional portfolio managers construct portfolios that are less concentrated and which have less correlation between the shares so that the risk of the portfolio will decrease. The ALSI may however perform better than the portfolio if the dominating shares or sectors included in the ALSI performs well. This could lead to the portfolio underperforming the ALSI. The important question that Botha asks is, "Is this underperformance due to poor skill?" The underperformance relative to the ALSI should not have anything to do with the manager's skill since the above discussion clearly indicates that the ALSI is not an appropriate benchmark.

Indices such as the Capped All Share and Capped Top 40 indices have been developed to reduce to concentration problem in South Africa. Despite the fact that these benchmarks will produce better performance evaluation results, managers still choose to use the ALSI as a benchmark since the ALSI is the best representation of the market as a whole. (Rousseau & Zwonnikoff, 2002:

4) As Botha points out in his research, the ALSI has been used as benchmark for several years and therefore managers continue to use it because they will lose their track records²⁰ of the past years if they decide to change their benchmark. (Botha, 2010: 20)

2.4.2 Johannesburg Securities Exchange (JSE): Style Indices

The JSE launched its own set of style indices in August 2004. Each style index is based on a specific investment style, namely: growth, value or core. These indices can be used as benchmarks for those funds that follow a growth, value or core mandate (Van Heerden & Botha, 2012). Surz (1996), however points out that although using a benchmark that specifically relates to the manager's specific style is a significant evolution in the performance evaluation process, this does not solve the evaluation problem entirely. The reason for this is that the categorization of a share as value or growth is based on different methods.

The JSE follows a method where a share can be classified as both a value and a growth share (Van Heerden & Botha, 2012:13). For instance, on the 28th of June 2013 MTN Group was classified as 75 per cent value and 25 per cent growth. This is problematic because MTN Group is included in the growth index but that does not necessarily mean it is included in the growth manager's portfolio since the manager may define said share as either value or growth. If the manager defines MTN Group as a value share, MTN Group will not be eligible for inclusion in the manager's growth portfolio. The benchmark will therefore include constituents that are not included in the manager's investable universe. This could lead to biased performance and skill interpretations.

2.4.3 Regulations for Funds in South Africa

The unit trust industry in South Africa is regulated by the Financial Services Board (FSB) based on the Collective Investment Schemes Act (CISCA). CISCA is used to regulate all investment schemes which aim to combine the investments of multiple investors into a single managed vehicle. Unit trusts are required to send the FSB annual reports as well as the portfolio's details once every three months. Through these regulations portfolios are monitored to make sure they do not falsify results, that the managers follow their mandates and that the liquidity of the portfolios are not too high for long periods of time. There are thus good regulations and controls in place in the South African unit trust industry. (*Regulation and operation; Equinox.co.za - unit trusts online*. 2013)

Unit trust funds are classified based on three tiers. The first tier distinguishes between domestic and non-domestic portfolios based on their required holdings. This is shown in Figure 2.10.

²⁰ Track records contain the comparison between the portfolio's performance and the benchmark's performance over the years. (Botha, 2010: 20)

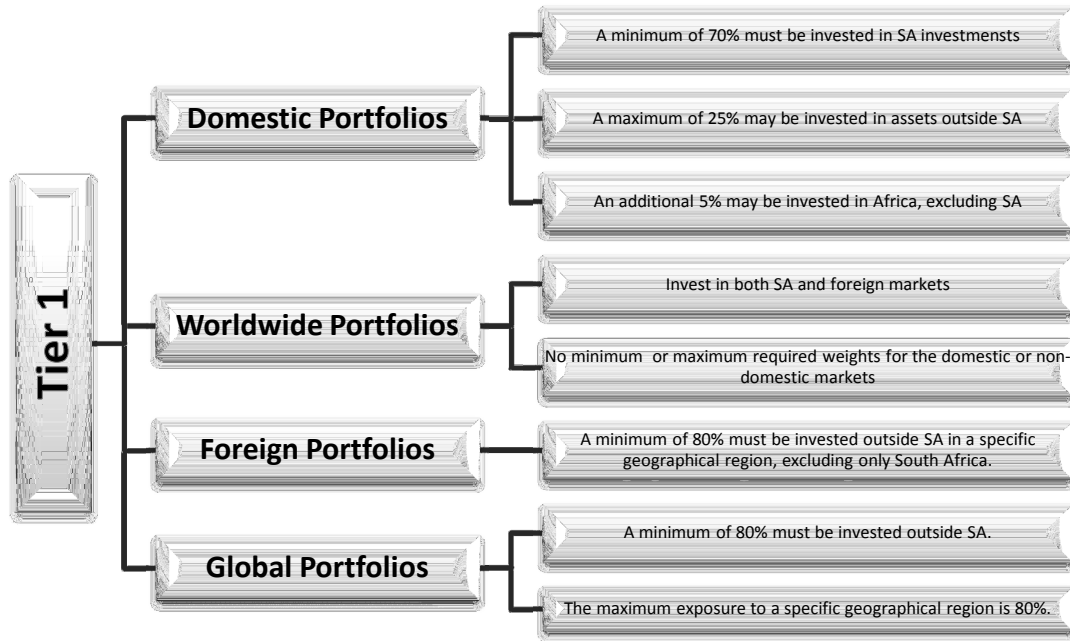


Figure 2.10: Tier One – The Classification of South African Regulated Collective Investment Portfolios

Source: (Equinox.co.za - unit trusts online. 2013; ASISA, 2013)

The domestic funds are further sub-categorized in Tier 2 which is shown in Figure 2.11. In this paper only domestic equity portfolios are of interest (as indicated by the black block in Figure 2.11) and therefore only the domestic equity portfolios are studied in more detail.

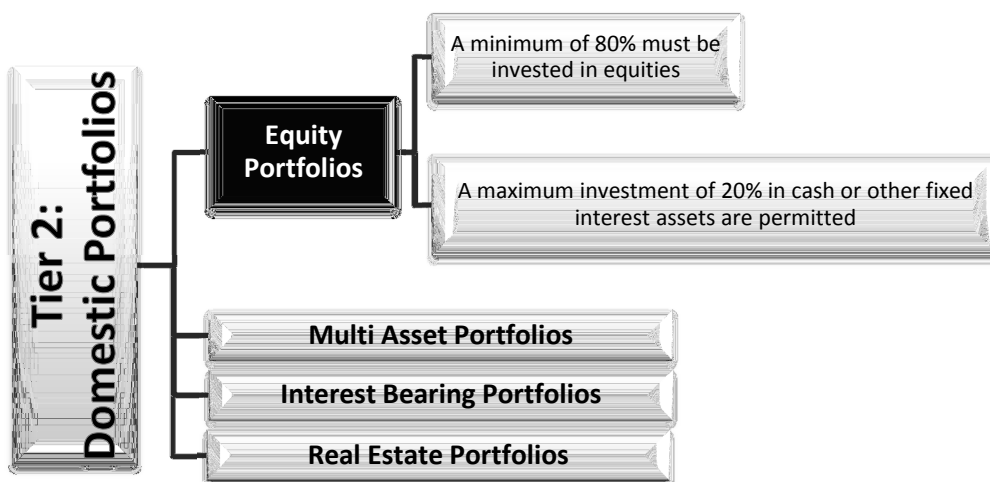


Figure 2.11: Tier Two – The Classification of South African Regulated Collective Investment Portfolios

Source: (ASISA, 2013)

The equity and derivative instruments included in the portfolio must conform completely to the investment requirement of each category at all times. As seen in Figure 2.11, funds are allowed to

have a maximum investment of 20% in cash or other fixed interest investments. Funds tend to invest in cash if equities experience a volatile period. All equity funds have to meet the requirements set out in Figure 2.11. There are nine different unit trusts categories categorized according to fund objective as shown in Figure 2.122.

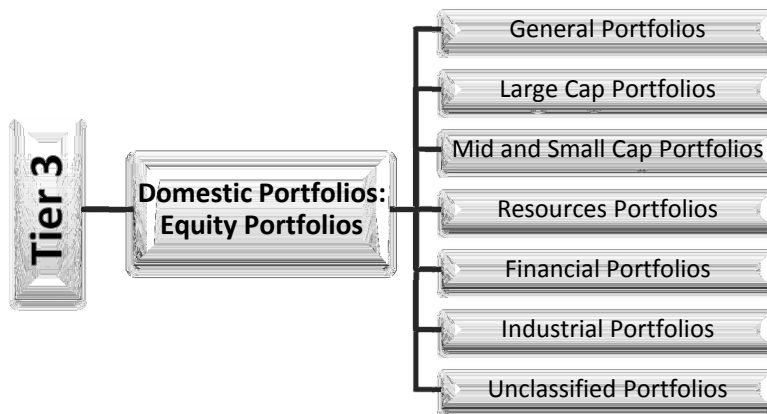


Figure 2.12: Tier Three – The Classification of South African Regulated Collective Investment Portfolios

Source: (ASISA, 2013)

The fund categories shown in Figure 2.11 are defined in Table 2.10.

Table 2.10: Domestic Equity Portfolio Classification

| Portfolio | Description |
|--------------------------------|--|
| General | These portfolios invest in smaller, mid and large cap shares across all the industries on the JSE. The portfolios do not have a specific theme or investment style. The primary objective of the portfolios is to generate medium to long-term capital growth. Benchmark: FTSE/JSE All Share Index (ALSI) |
| Large Cap | Large Cap portfolios must invest at least 80% of the portfolio in shares that have a large market capitalization. These shares are included in the FTSE/JSE Top 40 Index. By investing in said shares the portfolio seeks long-term growth. Benchmark: FTSE/JSE Top 40 Index |
| Mid and Smaller Cap | These portfolios are restricted to make new investments in fledgling, small and mid-cap shares only. The portfolio will thus have a minimum investment of at least 80 per cent in fledgling, small and mid-cap shares (companies not listed on the ALSI Top 40 Index) at all times. Benchmark: FTSE/JSE Mid Cap Index |
| Resources | The portfolios must invest at least 80% in companies across the Oil and Gas as well as the Basic Materials industries on the JSE Stock Exchange. Benchmark: FTSE/JSE Resources Index |
| Financial | These portfolios invest at least 80% in shares listed on the Financials Index on the JSE. A fund may invest a maximum of 10% in companies which have similar business activities as those in the financial sector but falls outside the sector. Benchmark: FTSE/JSE Financials Index |
| Industrial | These portfolios invest a minimum of 80% in companies across the Industrials industry on the JSE Stock Exchange or in similar sectors on international stock exchanges. The industrials sector includes all shares listed on the ALSI except those listed on the FTSE / JSE Oil and Gas, Basic Materials and Financial indices. Benchmark: FTSE/JSE All Share Industrial Index |
| Unclassified Portfolios | These portfolios invest according to the specifications set out in their mandates. These specifications describe in which single industry the portfolio invests or whether the portfolio invests in shares based on a common theme or activity. The mandates thus contain the unique nature of each portfolio. Due to the unique nature of each portfolio, these portfolios cannot be categorised within the aforementioned portfolio groups and their returns cannot be compared against one another. |

Source: (ASISA, 2013, Equinox)

Section six of the Unit Trust Act consists of further provisions to safeguard the fund. These safeguards are shown in Table 2.11. Furthermore, the portfolio may only include up to five per cent of the aggregate market value of a certain company's securities²¹. Lastly, at least five per cent of a fund's value should be invested in liquid assets.

²¹ Any cash amounts included in the portfolio will be considered as part of these assets.

Table 2.11: Maximum Investment per Constituent

| Criteria | Maximum Investment in a Single Share |
|---|--------------------------------------|
| A fund is only allowed to invest the maximum investment per share if the aggregate market value of all the securities included in the portfolio plus the value of any cash amounts which is part of the portfolio has a market capitalization in excess of R20 billion. | 15% |
| A fund is only allowed to invest the maximum investment per share if the aggregate market value of all the securities included in the portfolio plus the value of any cash amounts which is part of the portfolio has a market capitalization between R2 billion and R20 billion. | 10% |
| A fund is only allowed to invest the maximum investment per share if the aggregate market value of all the securities included in the portfolio plus the value of any cash amounts which is part of the portfolio has a market capitalization of less than R2 billion. | 5% |

Source: (ASISA, 2013)

These regulations should be taken into account when creating the appropriate benchmark because it will affect the investable universe of each fund.

2.5 PORTFOLIO OPPORTUNITY DISTRIBUTIONS (PODS)

Ronal J Surz²² introduced an alternative performance evaluation method which is called portfolio opportunity distributions (PODs). According to Surz (2003b) PODs is an unbiased benchmark in a virtual reality. A set of possible portfolios that the portfolio manager can invest in given his/her opportunity set is created at random by using Monte Carlo Simulation²³. Thousands of random portfolios are generated based on the managers opportunity set in order to determine a range of possible outcomes. Random weights are assigned to the constituents of the opportunity set by applying Monte Carlo Simulation and then the return of the generated portfolio is recorded. This is done numerous times (usually 10,000) and the return is recorded each time, thus leading to the range of possible outcomes. (Surz, 1996)

PODs combine certain aspects of peer group comparisons and benchmarks. These traditional benchmarks can only be used to measure the performance of the manager relative to the index or the manager's peers. PODs on the other hand can be used to measure the manager's performance and determine the manager's skill by considering whether the manager made good or bad investment decisions. This is done by comparing the actual performance of the manager against the performance that he/she would have achieved if he/she had made different investment decisions. (Surz, 1996; Surz, 1994) According to Botha (2010: 28-30), a manager's portfolio will

²² Ronald J Surz is currently a consultant at eVestment in the United States. He also developed Surz Style Pure which will be used in subsequent discussions and analyses.

²³ Monte Carlo Simulation is a simulation technique which is used to sample random outcomes. This is done by running various trial runs or simulations using random variables. (Hull, 2009: 267)

perform better depending on the quality of the manager's skill. The manager's skill will also be better depending on his ability to make the correct investment decisions.

As was mentioned in previous sections, each portfolio has a set of requirements and constraints which should be met. These requirements and constraints are incorporated when PODs are created for each manager. The created set of PODs represents a full range of the possible opportunities that the manager have. (Surz, 1998). By doing this it is possible to determine whether the manager used his/her opportunities optimally and also what affect the constraints has on the portfolio. Changes in the portfolio's constraints can lead to changes in the manager's opportunity set. The new opportunity set can be used to create a new set of PODs. By comparing the new set of PODs against the manager's portfolio, it is possible to determine the effect of the constraint. (Botha, 2010: 28-30)

2.5.1 The Idea behind PODs

Surz (1994; 1996; 2006) explains the idea behind PODs by using the "dartboard game", which was inspired by the book "A Random Walk Down Wall Street" by Burton Malkiel (1999) which was originally introduced by the Wall Street Journal. Basically a blindfolded monkey constructs random portfolios of shares. The monkey throws darts at the financial section of a newspaper that contains the list of shares. The idea behind the "dartboard game" is to then determine whether the monkey can outperform a skilful fund manager by playing the game. Numerous random portfolios can be set up by playing the "dartboard game". These portfolios represent a range of the possible outcomes that would have occurred if the manager had made different investment decisions for the period in question. This range of returns is then compared against the return of the portfolio for the same period, in a statistical manner, to determine how well (or poorly) the portfolio compares against the "monkey" portfolios.

PODs are created in the same way; the only difference is that instead of selecting shares from the newspaper, the "monkey" selects the shares from the fund's opportunity set. The opportunity set takes into account the manager's investment style and constraints as set out in the fund's IPS. The resulting portfolios are thus realistic representations of the possible outcomes that the manager could have achieved given the fund's opportunity set for the period under consideration. (Van Heerden & Botha, 2012)

The returns of each one of the portfolios are documented for each period and together the returns form a distribution of returns for the period in question. These returns indicate the range of possible returns that the manager could have obtained given the various possible investment decisions he/she could have made. The distribution of returns is called the "portfolio opportunity distribution" for said period. The distribution is then divided into four quartiles where each quartile represents a certain level of success or failure. The return of the portfolio of the manager in question is then

compared (and plotted) against these returns to determine how well the manager made use of his/her opportunity set. (Van Heerden & Botha, 2012) The returns of the thousands of random “monkey” portfolios are depicted in Figure 2.13. Note that Figure 2.14 is just an example for illustrative purposes.

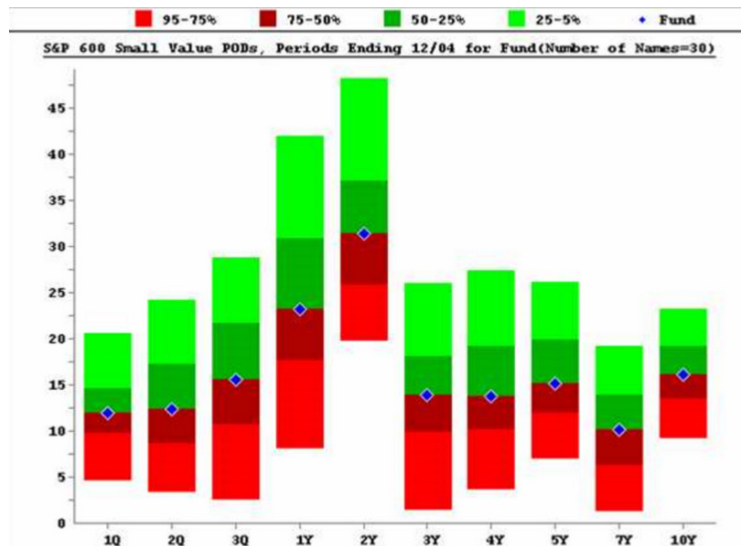


Figure 2.13: PODs based on the S&P 600 Small-Cap Value Index

Source: (Surz, 2006)

The bars in Figure 2.13 represent the manager’s PODs during the different periods under review. The median of each POD (or bar) is the return of the index for the period in question²⁴. The difference between the return of the fund in question and the median return (the return of the benchmark) is the value that the manager added (or subtracted) due to his/her security selection ability and the style rotation (or deviation). The ranking of the fund’s return against the return of the “monkey” portfolios is the significance of the value the manager added or subtracted to the fund. (Surz, 1996; Surz, 1998; Surz, 2006)

According to Surz (2006), the bars in Figure 2.14 represent the degrees of failure or success. The blue diamond on each bar indicates where the return of the manager is ranked compared to the “monkey” portfolios. Figure 2.133 shows that in each POD case the manager performed in line with the median of his/her opportunity set. In other words, the fund in question tracked the S&P 600 Small-Cap Value Index. If this was the fund’s aim, the fund was successful. If the fund however wanted to outperform the S&P 600 Small-Cap Value Index, the fund failed to meet its requirement.

If the manager falls within the top 25 per cent of the bar, the statistician has a 75 per cent confidence that the return in said period significantly indicates success. (Surz, 1996; Surz, 1994) Managers who consistently fall within the top 25 per cent (indicated by the light green area) of each

²⁴ If Monte Carlo Simulation is constructed appropriately then the benchmark will always be ranked as the median of the returns. (Sharpe, 1991)

bar shows consistent skill in selecting those shares from the opportunity set that outperforms. It also indicates that the manager was able to assign the correct weights to the selected shares. By doing this the manager was able to beat the benchmark and to end up in the top 25 per cent of all the possible portfolios he could have invested in for the period in question. If the manager falls within the bottom quartile (the bottom 75 per cent to 95 per cent) it is an indication that the manager did not make optimal investment decisions in the construction of the portfolio.

2.5.2 Advantages of PODs

The aim of PODs is to eliminate the problems that are experienced with the use of traditional benchmarks and peer group comparisons. According to Surz (1994), benchmarks and peer group comparisons are not able to determine whether the observed return on the portfolio is a significant occurrence. The two methodologies do however contain some features that are desirable and these features should thus be maintained. PODs therefore combines the traditional benchmark and peer group comparison methodologies by incorporating their advantages and eliminating their shortcomings.

2.5.2.1 Elimination of Problems Related to Indices

As was mentioned in Section 2.3.1.1, there is criticism against the appropriateness of the use of Broad-Market Indices as benchmarks. Each portfolio has its own set of requirements and constraints as was discussed in the portfolio management process. These constraints limits the size of the investment that a manager may make in each asset and it also limits the range of assets that the portfolio may include. Therefore, the constraints limit the manager's opportunity set. It is therefore important that these constraints are incorporated when creating a benchmark, which PODs does in fact do. (Botha, 2010: 28-32; Weber, 2007)

As required by regulation, a part of these constraints are in place to eliminate concentration in portfolios and to require funds to diversify their portfolios. The created PODs are therefore less concentrated and more diversified than the ALSI and the portfolio is thus compared against other portfolios which are a better reflection of the manager's own construction approach. (Van Heerden & Botha, 2012)

It was mentioned in Section 2.4.2 that there is also style index bias in the use of the JSE's style indices. The manager's opportunity set will be misrepresented if the constituents of the index representing the manager's investment style are used for the manager's opportunity set. PODs create mutually exclusive indices based on the constituents of the manager's unique opportunity set and therefore the bias is eliminated because the simulated portfolios include only those shares that are available for inclusion in the manager's portfolio. The created POD is therefore a much better representation of the manager's investment style. (Van Heerden & Botha, 2012)

2.5.2.2 Elimination of Problems Related to Peer Group Comparisons

The comparison of the portfolio against the PODs universe is unbiased and the POD universes can be obtained immediately, thus eliminating some of the most crucial problems associated with peer group comparisons. A POD universe can be created quickly while on the other hand, the data of peer groups takes quite some time to be collected. (Surz, 1994)

As was mentioned in Section 2.3.2, there is criticism against the appropriateness of the use of peer group comparisons when performing performance evaluation. Some of the key points of criticism are the various biases that arise. By using PODs it is possible to eliminate some of these biases. Since the manager's opportunity set is known, it is possible to simulate thousands of random portfolios by applying Monte Carlo Simulation. (Surz, 1998) These random portfolios can be compared against each and every portfolio, thus eliminating composition bias. (Botha, 2010: 28-32)

It was mentioned in Section 2.3.2 that similar portfolios are compared against each other according to the similarities of the portfolios based on their styles, constraints and strategies. PODs follow a similar strategy, however with PODs the portfolio is compared against simulated portfolios which represent possible portfolios that he/she could have invested in since they are simulated from the same opportunity set as the portfolio (Surz, 1998). Thus, the simulated portfolios have the same investment style and mandate constraints as the portfolio under evaluation. The classification bias is thus eliminated because all the portfolios in question are based on the same constraints and styles.

The created distribution of returns for each period approximately represents all the possible portfolios that the manager could have invested in given the fund's opportunity set. The manager's portfolio is compared against each and every portfolio for the period in question. Those portfolios that have poor returns are not excluded from the analysis and therefore the survivorship bias is also removed. (Van Heerden & Botha, 2012)

2.5.3 Criticism against PODs

The exact constraints applicable to the portfolio in question have to be known in advance so that it is possible to simulate the appropriate PODs. These constraints are mostly known and are set out in the portfolio's IPS. According to Botha (2010: 28-32), another possible investment constraint is the amount of risk that the portfolio is allowed to take. This is however quite a vague constraint, which is problematic when the random portfolios are simulated and would probably require further assumptions.

The portfolio, of which the performance is to be measured, is compared against the random portfolio simulated by the PODs methodology. This is similar to the peer group comparison method where the portfolio is compared against the portfolios of its peers. Botha (2010: 28-32) stated in his

research that investors wish to compare the performance of different managers against one another but that PODs will not help with this approach. He also states that this argument does not hold if the user has a clear understanding of how PODs work. It is possible to create thousands of portfolios by applying PODs on the same opportunity set. The set of created portfolios will eventually include all the possible portfolios that managers with similar opportunity sets could have invested in. Thus, by using the PODs methodology the manager's performance is compared against the performance of other managers as well as the performance of any portfolio that could have been constructed but was not.

The portfolios which are created using the PODs methodology are based on a buy-and-hold strategy²⁵. The transactions made by the portfolio manager during the evaluation period are thus ignored. Active managers however alter their portfolios on a regular basis and therefore some argue that this is not a real world situation. However, Botha (2010: 28-32) points out that by using the buy-and-hold strategy PODs are able to determine the manager's skill by comparing the return that the manager actually obtained against the return that the manager could have obtained. The PODs portfolio's return thus indicates the return that the manager would have obtained if he applied more skill and thus made better decisions. According to Botha (2010: 28-32) a manager with an active trading strategy who consistently makes the correct investment decisions will fall within the top 25 per cent of his/her PODs. If this is the case then the manager does indeed have skill.

It is easier to understand peer group comparisons and using indices as benchmarks than understanding PODs. According to Botha (2010: 28-32) another point of criticism against PODs is that one has to have knowledge of mathematics, statistics and computer simulation processes to be able to develop PODs and interpret the results. Thus, PODs are more complicated than traditional methodologies.

2.5.4 Surz Style Indices

Surz (1994) Style Indices consists of the break-up of a large data base according to the size of the stocks and then by its aggressiveness. The break-up of the data set based on size is done according to the market capitalization of each stock. This leads to three groups, namely: large-cap, mid-cap and small-cap stocks. The break-up is done according to the criteria set out in Figure 2.14. The three groups are further broken down into three additional groups, namely: growth, core and value shares. This break-up is done based on the orientation of each share in question. The shares are classified as value, core and growth shares according to an aggressiveness measure.

²⁵ A buy-and-hold portfolio is when the portfolio is set up at the beginning of the evaluation period and is then kept unchanged throughout the evaluation period.

The aggressiveness measure is a function of the share's dividend yield and its PE ratio. (Surz, 1996)

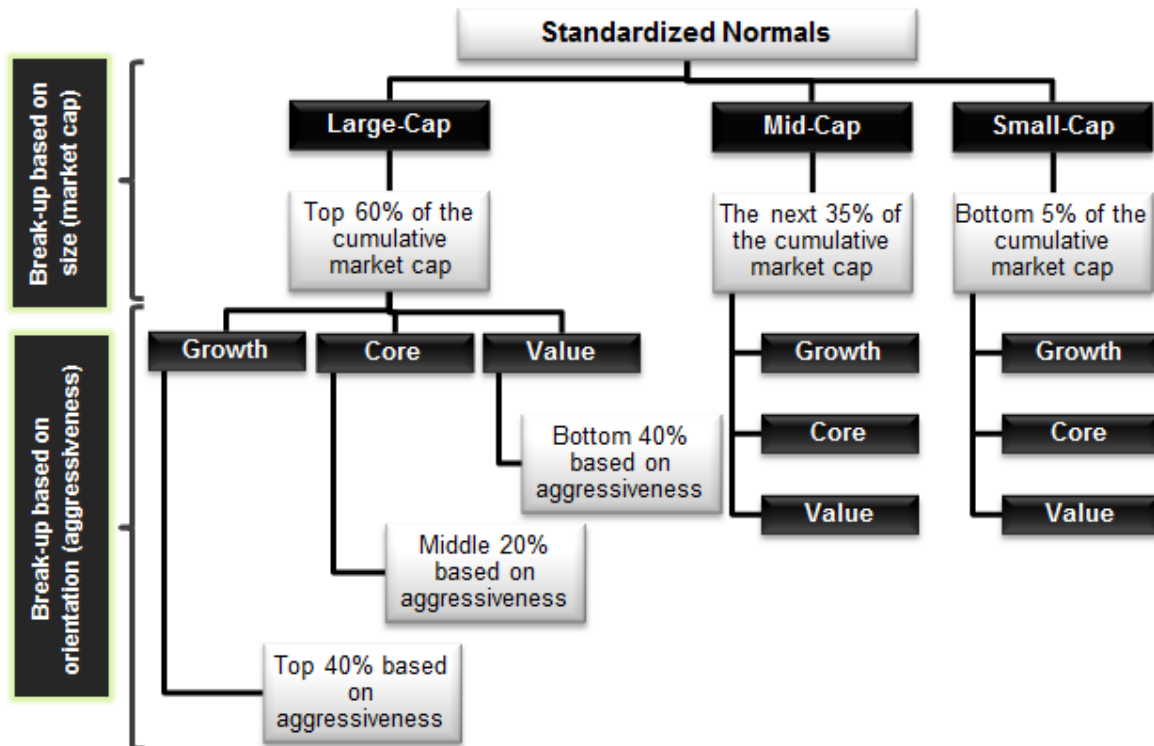


Figure 2.14: Surz Style Indices

The style of any manager can be specified according to these styles. The manager has a weighted combination of these standardized normals, where the weights of the standardized normals sum to 100 per cent. Thus, nine different styles are created, as shown in Table 2.12. (Surz, 1996)

Table 2.12: Surz Style Indices Break-up

| Break-up based on Size (Market Cap) | | | |
|--|------------------|----------------|------------------|
| Break-up based on Orientation (Aggressiveness) | Large-Cap Growth | Mid-Cap Growth | Small-Cap Growth |
| | Large-Cap Core | Mid-Cap Core | Small-Cap Core |
| | Large-Cap Value | Mid-Cap Value | Small-Cap Value |

In order to create the styles mentioned in Table 2.12 it is required that the standardized normals are statistically independent, mutually exclusive and exhaustive. A POD universe can be constructed for each style by using the appropriate weighting of the standardized normals. The result is a style proxy which can be used as a benchmark and to determine the skill of the portfolio

manager. The portfolio and the manager's skill are therefore assessed against its unique opportunity set. (Surz, 1996)

The South African market is quite small against the market of the United States of America (where the above styles were created). Due to this reason and the high levels of concentration in the South African market, the application of the above styles have to be adapted for the South African market.

2.6 SUMMARY

The portfolio management process is an integral part of the investment environment and has evolved extensively over the last century. An important step in the portfolio management process is performance evaluation. Performance evaluation is used to determine whether a portfolio performed adequately or not. There are two traditional methods which can be used to evaluate the performance of a portfolio, namely: peer group comparisons and Broad-Market indices (which are used as benchmarks).

There is, however, various problems related to these traditional approaches. There are various biases related to the use of peer group comparisons. Each portfolio should be compared against their respective passive alternatives and therefore it does not matter how well a certain peer group performed. If a manager does not like how he compares within a certain peer group he/she can simply choose to be compared against another peer group, thus it is easy to influence the results. Furthermore, peer group comparison cannot separate the effect of the style from the effect of skill due to biases. Thus, success cannot be distinguished from failure. (Surz, 1998)

Broad-Market Indices on the other hand have their own unique problems such as the high levels of market concentration, lack of diversification and certain biases. The South African market has extremely high levels of sector and market concentration as was discussed in Section 2.4.1. The constituents of the index also pose a problem due to the fact that some shares are excluded from the index. Furthermore, the JSE's style indices have their own biases due to the classification of the constituents as growth or value shares.

Rousseau and Zwonnikoff (2002: 5) summarises the problem at hand by asking the question, "Is it possible to find the Holy Grail of an overall, unbiased benchmark that meets all the criteria of a 'good' benchmark and hence can be used by any type of fund manager over any holding period?" Ultimately, this is the question that this research paper aims to answer. According to Rousseau and Zwonnikoff's research, static benchmarks (of which the ALSI is an example) is in fact not considered to be appropriate since the quality of the benchmark does not stay consistent over time.

It is therefore necessary to find a more appropriate method to evaluate the portfolio's performance. According to Ronal J. Surz (2003b), in order to find an appropriate benchmark it is necessary to use the tools of virtual reality and go where no index or peer group has gone before. Surz is a performance consultant from the US who introduced a new method called Portfolio Opportunity Distributions (PODs) (Surz, 1998). This makes it possible to properly evaluate the manager's skill and the fund's performance by applying the PODs methodology. With peer group comparisons and index valuation it is only possible to determine how the manager performed compared to the peer group or index. With PODs however, it is also possible to determine whether the generated returns are due to the investment decisions the manager made given the unique mandate of the fund. (Van Heerden & Botha, 2012)

PODs randomly generate thousands of possible portfolios based on the opportunity set available to the manager by using Monte Carlo Simulation. This leads to a range of possible outcomes which were possible for the manager given the various investment strategies he/she could have followed based on his/her opportunity set. The actual return of the manager's portfolio is then compared against the range of possible outcomes to determine how well the manager made use of his/her opportunity set.

The PODs method is quite flexible and therefore it is possible to create a set of PODs for each manager based on the best representation of his/her opportunity set. The created PODs can also incorporate each manager's specific mandate limitations. The range of possible outcomes created by the PODs methodology thus truly reflects the possible outcomes that the manager could have generated given his/her mandate and opportunity set. PODs therefore minimize the biases and problems related to the two traditional performance evaluation methods.

The advantages of using the PODs methodology far exceed the criticism raised against it. By applying PODs, it is possible to determine whether the manager shows consistent skill in selecting the appropriate shares and assigning the correct weights to said shares. By comparing the created PODs against the return of the fund in question, it is possible to determine whether the observed result is good or bad based on the fund's unique opportunity set. There are no benchmarks, indices or peer group universes that can offer this insight and therefore PODs will become increasingly favourable.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

The PODs methodology is used in this research paper to reconstruct Figure 2.13 for South African fund managers based on their opportunity set. The methodology used is based on the research done by Ronald J. Surz (1994; 1996; 2003a; 2006) and Van Heerden and Botha (2012). The construction of PODs makes it possible to determine how the manager performed as well as whether the manager shows true skill in using the investment opportunities available to him/her. This will provide investors with an evaluation method which could potentially be superior in comparison with the traditional methods (i.e. indices and peer group comparisons) and which would possibly enable them to make better investment decisions regarding investments in South African equity funds.

Each fund aims to maximize its returns while minimizing the risk of the portfolio at the same time. The PODs methodology is implemented to evaluate the dynamics²⁶ of the fund and to compare it against the dynamics of all the possible portfolios that the fund could have invested in given its opportunity set. This will provide an indication of how well the fund performed in comparison to the market.

The aim is to compare the performance of the fund against the performance of all the possible portfolios it could have invested in. Thousands of random portfolios are simulated for this purpose where each portfolio is based on the opportunity set. Together, the simulated portfolios create a range of possible outcomes that the fund could have achieved given its opportunity set.

Comparing the dynamics of the fund against the dynamics of the range of possible outcomes (instead of just one index such as the ALSI) is important. The range of possible outcomes is a better reflection of the market dynamics of the market as a whole. An index represents only one portfolio and therefore it is not a good proxy of the entire market's market dynamics. A lot of the information underlying the market will thus be lost if a single index is used. The PODs methodology could therefore be more useful since it will provide investors with a broader knowledge regarding the potential of the market as a whole rather than the performance of a single possible portfolio. The PODs method thus provides the investor with insight in both the up- and downside of the market (Pouchkarev, 2005).

²⁶ The market dynamics of a portfolio (or market) refers to its return and risk during a period as well as the relationship between said risk and return. (Botha, 2010: 49)

The first step in the process is to find the fund's opportunity set. It is important to remember that each fund's opportunity set is based on its unique investable universe and constraints. Thus, it is a realistic set of possible investments that the fund can actually invest in.

3.2 DATA COLLECTION AND DATA ANALYSIS

The ALSI is used as the South African market's equity proxy since it contains every share listed in South Africa and therefore it is the best representation of the South African equity market. Periodic information is available regarding the constituents listed on the exchange. These periodic listings of the constituents are provided by the JSE and consist of monthly data for the period from June 2010 to June 2013. The constituent data is used to determine which shares to include in the investable universe for a specific evaluation period. The simulated portfolios will be generated based on the market capitalization of these constituents. The simulation process is explained in Section 3.3.2.

The market dynamics of each simulated portfolio is required. It is therefore necessary to calculate the return and standard deviation of each portfolio. In order to do so, the return and standard deviation of each constituent as well as its corresponding weight is required. The daily closing prices²⁷ of each constituent are used to calculate this data set. The closing prices are available on INET. The daily log returns is then calculated based on these closing prices by applying Equation (2.6).

As was mentioned before, the data set is broken down in terms of the Surz Style Indices. The data set is first divided into three categories based on size. For this purpose the market capitalization of each constituent is obtained from the JSE and each constituent's corresponding weight is calculated based on this market capitalization.

Prior to 2002 when the FTSE Group and the JSE formed a partnership, the values and weights of the constituents of the ALSI was calculated based on the market cap of each share. Since the partnership the values and weights of the ALSI are calculated based on the free float market cap²⁸ of each constituent. The weight of each share is the share's market cap (free float after 2002) as a percentage of the total market cap (free float after 2002). The weights are calculated with the following formula,

$$x_{i,t} = \frac{(\text{free-float}) \text{ market cap of asset } i \text{ at time } t}{\text{total } (\text{free-float}) \text{ market cap at time } t} \quad (3.1)$$

where:

²⁷ The closing prices for each constituent listed on the JSE between 1 April 2010 and 28 June 2013 are used to create the returns data set.

²⁸ Free float shares are those shares that are freely available for investors to invest in. Thus, those shares that are specified to certain individuals or groups of individuals are excluded. The free float market cap of each share is calculated as the number of free float shares times the share price. (Botha, 2010: 50-51)

- $x_{i,t}$ = The weight of asset i at time t .

Secondly, each of the three categories is further divided into three sub-categories based on a measure of aggressiveness. The aggressiveness measure (as was discussed in Section 2.5.4) of a share is determined as a function of its dividend yield and its PE ratio and is done as follow,

$$Aggressiveness_{i,t} = Dividend Yield_{i,t} + PE Ratio_{i,t} \quad (3.2)$$

where:

- $Aggressiveness_i$ = The aggressiveness measure of the i^{th} share at time t .
- $Dividend Yield_{i,t}$ = The dividend yield of the i^{th} share at time t .
- $PE Ratio_{i,t}$ = The P/E ratio of the i^{th} share at time t .

The dividend yield and P/E ratio of each constituent is obtained via INET.

3.3 METHODOLOGY

The performance evaluation is done based on the three methods mentioned in this paper so far, namely: indices, peer group comparison and PODs²⁹. This is done for comparison purposes in order to determine which method is superior. The aim is to determine whether PODs is indeed a better performance evaluation method to examine the performance of South African funds and their managers.

Each fund has its own mandate and constraints which has an influence on its opportunity set. The constituents of the ALSI together with the fund's mandate and constraints will be used to create the fund's own unique opportunity set. The opportunity set of each fund is divided into nine categories known as Surz Style Indices. PODs will then be created for the fund for various periods based on the fund's opportunity set as well as for the Surz Style Index categories.

3.3.1 Investment Styles: Surz Style Indices

The market is divided into different style mandates as defined by Surz Style-Indices (discussed in Section 2.5.4). However, due to the unique nature and the extremely high levels of concentration in the South African market the indices will be defined a bit differently than those defined by Surz for the US market. The dataset is still broken down in terms of the size first and then by orientation. The only alteration is in the way that the data set is broken down according to the size criteria. This leads to nine mutually exclusive indices (Van Heerden & Botha, 2012) as shown in Figure 3.1.

²⁹ The comparison of the fund's performance against the performance of the benchmark index or peer group is purely done for comparison purposes and is therefore not explained or done in detail. The PODs methodology is the main method being studied and therefore it is the only method which is explained and performed in detail.

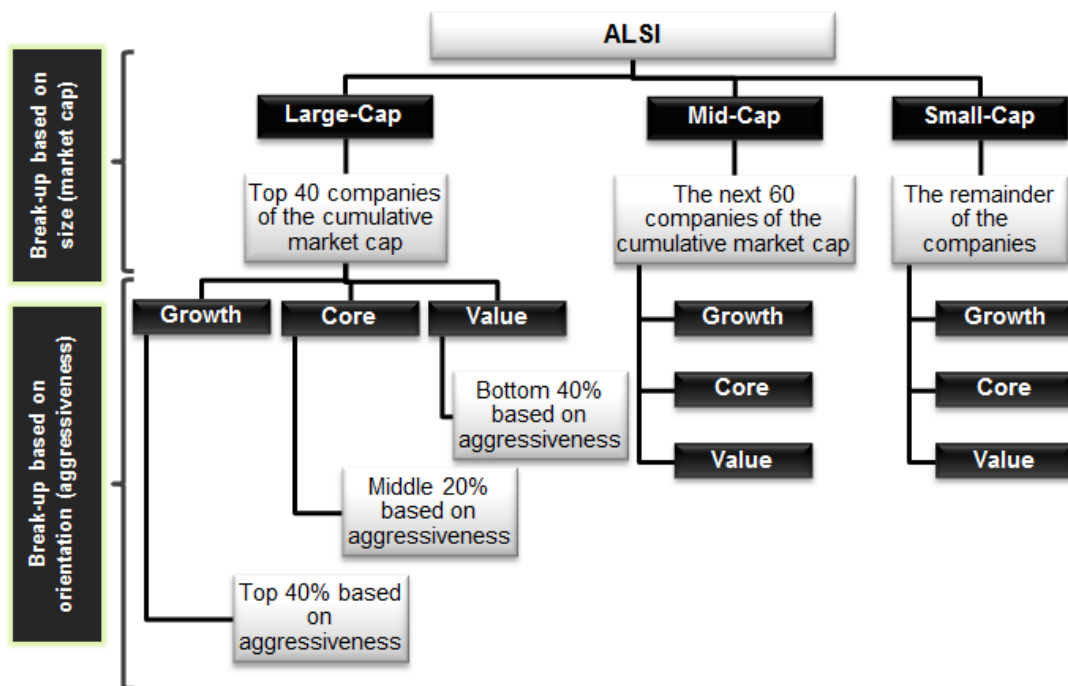


Figure 3.1: Surz Style Indices – The South African Application

As was mentioned before, the ALSI is used as the South African market's equity investable universe. The ALSI is broken down based on Surz's Style-Indices to create the nine different style indices. A dataset containing the constituents for each period, as well as their corresponding market cap and dividend yield, is created.

The data set is then first broken down in terms of the size (market cap) by sorting the data set in descending order based on the market cap of the constituents. The top 40 constituents are then assigned to the large-cap category. Thus, the FTSE/JSE Top 40 Index is used for the large-cap sector as it contains the top 40 constituents as listed on the ALSI. The next 60 constituents are assigned to the mid-cap category. The remaining constituents are assigned to the small-cap category. This process is set out in Figure 3.1.

The large-cap, mid-cap and small-cap sectors are then broken down further in terms of orientation into growth, value and core sectors. Thus, a total of nine sectors are created. The break-down based on orientation is done based on an aggressiveness measure. As was mentioned in Section 3.2, the aggressiveness measure of each constituent is a function of the P/E ratio and dividend yield for said constituent.

Each large-cap, mid-cap and small-cap sector is then broken down further in terms of the orientation (aggressiveness) by first sorting each sector in descending order based on the aggressiveness of the constituents. The top 40 per cent of the constituents are assigned to the growth category. The next 20 per cent of the constituents are assigned to the core category and

the value category consists of the last 40 per cent in each of the large-cap, mid-cap and small-cap categories. This process is also set out in Figure 3.1.

Funds classify themselves based on their style. These style mandates are not always very accurate, especially in a relatively small market such as South Africa. The exposure of a fund to the nine Surz Style Indices must thus be determined by studying the actual data in order to determine the style mandate of the fund. In other words, the proportion of the fund that is 'invested' in each Surz Style index has to be determined. The combination of these weights best explains the fund's style blend and the resulting return of the fund. Thus, by calculating the weights it is possible to assess more accurately exactly what the fund's investment style is since the investment style of the fund is determined by studying the fund's style blend over time.

There are two methods which can be used to determine a fund's style blend, namely, Returns-Based Style Analysis (RBSA) and Holdings-Based Style Analysis (HBSA). RBSA calculates the fund's exposure to various asset classes or indices by applying regression analysis on the returns of the asset classes or indices against the returns of the fund. HBSA on the other hand, uses the fund's actual holdings to determine the fund's exposure to the various asset classes or indices it has invested in. Since HBSA uses the fund's actual holdings it will be more accurate. The HBSA approach however requires the actual holdings of the fund, which is quite difficult to obtain. The data required for RBSA is easy to obtain and it is relatively easy to perform the analysis. RBSA will therefore be applied in order to determine the fund's style blend. (Botha, 2010: 43-47)

3.3.1.1 Returns-Based Style Analysis (RBSA)

RBSA is a statistical analysis approach introduced by W.F. Sharpe (1988; 1992). Based on this approach regression analysis is used to determine the fund's exposure to the nine Surz Style indices. The regression is set up with the fund's actual return as the dependent variable since the fund's return is dependent on the returns of the nine style indices. The returns of the nine style indices are therefore the independent variables. It is important that the input indices are set up in the appropriate way. The created indices must be mutually exclusive and all the constituents must be included in the creation of the indices. This means that each constituent must be assigned to only one index. This will lead to the minimization of the correlation between the indices. (Lucas & Riepe, 1996)

The RBSA model follows as,

$$R_t = \sum_{j=1}^m \beta_{jt} I_{jt} + \epsilon_t, \text{ for } t = 1, 2, \dots, T \quad (3.3)$$

where:

- R_t = The return of the portfolio at time t .

- m = The number of indices³⁰.
- β_j = The j^{th} exposure at time t , which shows the fund return's sensitivity to the return of j^{th} index.
- I_{jt} = The return of the j^{th} index at time t .
- ϵ_t = The noise term at time t .
- T = The number of evaluation periods.

A customised benchmark can be calculated for the fund under evaluation once the exposures have been calculated. The customised benchmark is based on the fund's style mandate as it incorporates the fund's exposure to the different indices. The performance of this benchmark is then compared against the performance of the fund. (Lucas & Riepe 1996)

The exposure of the fund under evaluation to each of the nine Surz Style Indices is determined for six month intervals over a three year period. As was mentioned before, the constituents are known for semi-annual intervals between March 2005 and March 2010. Daily returns are calculated for each half-year based on the daily returns of the constituents included in the index and the weights³¹ of these constituents. Sub data sets are thus created where each data set contains daily returns for the six month period. These returns are used to perform the regression analysis over the six month interval. The same is done for the period between April 2010 and June 2013. For this period however, monthly data is available regarding the constituents included on the index. These monthly periods are then combined to create six month intervals.

The exposure to each fund can be seen as the fund's investment in the index and therefore it can be seen as weights, provided that they sum to one. In other words, they represent the proportion of the fund that is exposed to each Surz Style Index. These coefficients therefore have to sum to one to ensure that the fund is fully invested. Thus,

$$\sum_{i=1}^m \beta_{jt} = 1 \quad (3.4)$$

where:

- m = The number of indices.
- β_j = The j^{th} exposure at time t , which shows the fund return's sensitivity to the return of j^{th} index. The j^{th} factor loading is the weight of the j^{th} constituent.

Furthermore, the assumption is made that a fund is not allowed to short sell the indices. The fund is however allowed to not invest in an index at all, thus resulting in a zero weight for said index.

³⁰ Note that in this case there are nine Surz Style Indices and therefore $m=9$.

³¹ The weights are calculated based on the market capitalization of the constituents and stays constant over the semi-annual period.

Thus, a fund has to have a positive weight allocation or a zero weight allocation in each index. An inequality constraint is therefore placed on the factor loadings, namely,

$$0 \leq \beta_{jt} \leq 1, \text{ for } j = 1, 2, \dots, m \quad (3.5)$$

The model in Equation (3.3) can be rewritten in terms of matrices and vectors. This is done as follows,

$$\underline{r} = X\underline{\beta} + \underline{e} \quad (3.6)$$

where:

- \underline{r} = The $n \times 1$ vector of fund returns where n is the number of observations in the data set under evaluation³².
- X = The $n \times m$ matrix containing the returns of the indices where m is the number of indices³³.
- $\underline{\beta}$ = The $m \times 1$ matrix containing the sensitivity (weights) of the fund to the various indices.
- \underline{e} = The $n \times 1$ vector containing the error terms.

The goal is to solve the betas in the above equation. This can be done by minimizing the mean square errors subject to the constraints mentioned in Equations (3.4) and (3.5). For this purpose the error vector is written in terms of \underline{r} , X , and $\underline{\beta}$.

$$\underline{e} = \underline{r} - X\underline{\beta} \quad (3.7)$$

The minimization of the mean square errors therefore follows as,

$$\begin{aligned} \min_{\beta} \{ \underline{e}'\underline{e} \} &= \min_{\beta} \{ (\underline{r} - X\underline{\beta})'(\underline{r} - X\underline{\beta}) \} \\ &= \min_{\beta} \{ \underline{r}'\underline{r} - 2\underline{r}'X\underline{\beta} + \underline{\beta}'X'X\underline{\beta} \} \\ &= \min_{\beta} \{ -2\underline{r}'X\underline{\beta} + \underline{\beta}'X'X\underline{\beta} \} \end{aligned} \quad (3.8)$$

In order to solve $\underline{\beta}$ in Equation (3.8) it is necessary to use Quadratic Programming.

3.3.1.2 Quadratic Programming

Quadratic Programming aims to solve a quadratic problem of the following form,

$$\min_x \left\{ \underline{f}'\underline{x} + \frac{1}{2} \underline{x}'H\underline{x} \right\} \quad (3.9)$$

where:

³² In this study $n = 751$ observations are used for the period between the end of June 2010 and June 2013.

³³ Note that there are nine Surz Style Indices and therefore $m=9$.

- A $n \times m$ matrix where n is the number of observations in the data set under evaluation and m is the number of indices.
- $\underline{f} = A m \times 1$ vector.
- $\underline{x} = A m \times 1$ vector containing the unknown coefficients.

Equation (3.9) can be solved subject to certain constraints. Possible constraints are,

$$\begin{aligned} A \underline{x} &\leq \underline{b} \\ Aeq \underline{x} &= \underline{beq} \\ \underline{lb} &\leq \underline{x} \leq \underline{ub} \end{aligned} \quad (3.10)$$

where:

- $\underline{x} = A m \times 1$ vector containing the unknown coefficients where m is the number of indices.
- $A = A p \times m$ matrix containing the coefficients of the x_i variables (for $i = 1, 2, \dots, n$) of the inequality constraints where p is the number of inequality constraints³⁴.
- $\underline{b} = A p \times 1$ vector containing the constant of each inequality equation.
- $Aeq = A q \times m$ matrix containing the coefficients of the x_i variables (for $i = 1, 2, \dots, n$) of the equality constraints where q ³⁵ is the number of equality constraints.
- $\underline{beq} = A q \times 1$ vector containing the constant of each equality equation.
- $\underline{lb} = A m \times 1$ vector containing the lower bound value of each x_i , for $i = 1, 2, \dots, n$.
- $\underline{ub} = A m \times 1$ vector containing the upper bound value of each x_i , for $i = 1, 2, \dots, n$.

MATLAB has a function called “quadprog” for this purpose. The “quadprog” function is therefore implemented as follows,

³⁴ The only inequality constraints are that each constituent must have a weight that falls between 0 and 1. This is incorporated with the \underline{lb} and \underline{ub} vectors. There are thus no inequality constraints to be incorporated through the use of the matrix A and the vector \underline{b} and therefore $p = 0$.

³⁵ The only equality constraint is that the weights must sum to one and therefore $q = 1$.

Table 3.1: Implementation of Quadratic Programming in MATLAB

| “quadprog” Function | Section 3.1.1.1 Scenario | Implementation |
|--|---|--|
| \underline{x} | $\underline{\beta}$ | The $\underline{\beta}$ vector contains the sensitivities of the fund to the various indices which are the values to be solved. This is the \underline{x} vector in the MATLAB function. |
| $\frac{1}{2} \underline{x}' H \underline{x}$ | $\underline{\beta}' X' X \underline{\beta}$ | In this case $\frac{1}{2} H = X' X$, where X is the matrix containing the daily returns of the indices. Therefore, $H = 2 X' X$ |
| $-2 \underline{r}' X \underline{\beta}$ | $\underline{f}' \underline{x}$ | In this case $\underline{f}' = -2 \underline{r}' X$, where \underline{r} is the vector containing the daily returns of the fund under evaluation. |

Source: MATLAB

A rolling period regression can be performed in order to plot an Exposure Distribution Area Graph. The Exposure Distribution Area Graph provides a good indication of the fund's style mandate over time. A six month period rolling regression is used to plot the Exposure Distribution Area Graphs.

According to Lucas and Riepe (1996), it is possible to obtain an Exposure Distribution Area Graph which indicates inconsistency in the fund's style mandate over time. Creating a benchmark for such a fund is quite difficult since the benchmark will have to change constantly to incorporate the constant style changes.

As was mentioned before, the exposures of the fund to the indices are calculated for six month periods over a three year time interval. In other words, a constant exposure to each of the nine indices is calculated for the six month periods. These exposures are used to calculate the PODs graphs in further analyses.

3.3.2 Simulation of Random Portfolios

As was mentioned before, the fund's performance is compared against the performance of all the possible portfolios it could have invested in. In order to compare the fund against all the portfolios it could have invested in, it is necessary to simulate these portfolios. In this study 10,000 such portfolios are simulated for each of the nine Surz Style Indices on a monthly basis.

A set of weights are simulated for each Surz Style Index for each period. These weights are simulated based on the fund's opportunity set, where the opportunity set is based on the constituents listed on the ALSI for the period under evaluation as well as the fund exposures calculated in the previous section. These weights are then used along with the actual returns of the fund to calculate the market dynamics of each simulated portfolio.

The return of each random portfolio is calculated by multiplying the simulated weight of each constituent with its corresponding return and then adding all these products together³⁶. This is done according to the following formula,

$$R_j^p = \sum_{i=1}^n x_{i,j} R_{i,j}, \text{ for } j = 1, 2, \dots, 10\,000 \quad (3.11)$$

where:

- R_j^p = The return of the j^{th} randomly simulated portfolio.
- n = The number of constituents on the ALSI for the evaluation period.
- $x_{i,j}$ = The randomly simulated weight of the i^{th} constituent.
- $R_{i,j}$ = The return of the i^{th} constituent.

The overall return is calculated by multiplying the exposure of the fund to each Surz Style Index with the return (calculated using Equation (3.11)) of a random portfolio in the index and then adding the subsequent returns together.

The standard deviations (as a measure of the portfolio's risk) are calculated as well by applying Equation (2.10). The return and standard deviation of each portfolio represent the dynamic of said fund. All the portfolios together then represent the range of dynamics available in the market.

The weights used in the calculations are simulated based on the constraints applicable to the fund under evaluation. The incorporation of these constraints is discussed next.

3.3.2.1 Incorporating the Constraints

The constraints mentioned in Chapter 2 have to be implemented in the simulation process. Due to the high levels of concentration in the South African market, funds are required by regulation to have a certain maximum investment in a single constituent. In order to meet the requirements as set out by the FSB (and other regulating bodies in South Africa), the maximum weight (say δ_i) is set equal the various maximum capital exposures as imposed by these regulating bodies. Let x_i denote the weight in the i^{th} share, then,

$$x_i \leq \delta_i \quad (3.12)$$

If the simulated portfolios are created solely based on the breakdown based on size and orientation, it would lead to some portfolios being unrealistic. The reason for this is mainly due to the concentration in the market. The simulation algorithm can create portfolios that allocate a zero (or almost zero) weight to the top constituents. As Botha (2010: 51) points out, the shares with the largest market cap weights are the drivers of the market and therefore very few (if any) portfolio managers will actually assign a zero weight to these shares. It is therefore necessary to exclude these portfolios from the simulation process by incorporating constraints which would eliminate

³⁶ The returns can be added together because log returns are additive.

them from being simulated. It is therefore necessary to impose minimum capital allocation or to including constraints on certain constituents.

If the fund must have a minimum capital exposure to a certain share, then a certain minimum weight is assigned to said share, say α_i . Thus, each of these weights should satisfy the following inequality,

$$x_i \geq \alpha_i \quad (3.13)$$

As set out by regulation, a maximum capital exposure weight of 15 per cent is imposed on the constituents with a market capitalisation of R20 billion or more, or an amount or conditions as discussed in Section 2.4.3. A minimum weight of five per cent is assigned to the top five constituents in this share class for each evaluation period. This ensures an investment of at least five per cent in each of these constituents. A minimum weight of two percent is assigned to the remainder of the constituents in this share class.

Regulations in South Africa place similar restrictions on the other constituents as well. This is shown in Table 3.2.

Table 3.2: Minimum and Maximum Capital Constraints

| | Minimum Capital Exposure (α_i) | Maximum Capital Exposure (δ_i) |
|--|---|---|
| The top 5 constituents with a market capitalisation of R20 billion or more, or an amount or conditions as discussed in Section 2.4.3. | 5% | 15% |
| The remainder of the constituents with a market capitalisation of R20 billion or more, or an amount or conditions as discussed in Section 2.4.3. | 2% | 15% |
| Constituents with a market capitalisation between R2 billion and R20 billion, or an amount or conditions as discussed in Section 2.4.3. | 0% | 10% |
| Constituents with a market capitalisation of less than R2 billion, or an amount or conditions as discussed in Section 2.4.3. | 0% | 5% |

Source: (ASISA, 2013)

The opportunity set is set up based on the exposure that the fund has to the nine Surz Style Indices. If the fund does not have an exposure to the index, then the constituents included in the index does not form part of the fund's opportunity set. An excluding constraint is therefore placed on these constituents. A zero weight is assigned to the constituents that is not included in the opportunity set,

$$x_i = 0 \quad (3.14)$$

It is assumed that the funds are not allowed to short sell and therefore all weights have to be zero or positive. In other words, each weight must meet the following inequality requirement,

$$0 \leq x_i \leq 1 \quad (3.15)$$

Furthermore, no assumptions are made regarding the risk of the portfolios and therefore no risk constraints are incorporated. Lastly, the sum of the weight must be equal to one to ensure that the fund is fully invested. Thus,

$$\sum_i x_i = 1 \quad (3.16)$$

The weights should be rebalanced periodically to ensure that the above constraints are met at all times.

3.3.3 PODs: Studying Market Dynamics

The return and risk dynamics of the simulated portfolios are studied to determine whether the portfolio performed well and if it is a more efficient portfolio. Furthermore, the PODs methodology is compared against the traditional performance evaluation methods.

3.3.3.1 Return Dynamics

Traditionally the fund returns are compared against the returns of the benchmark index or against similar funds in its peer group. These traditional methods however have various limitations, as was pointed out. The only available information according to the traditional methods is how well (or poorly) the fund compared against its benchmark or against similar funds in its peer group. It does not say anything about the possible returns that the fund could have generated given its own unique opportunity set.

PODs can be used to study the return dynamics of a portfolio in order to obtain a better picture of how the fund performed given all the possible outcomes available to said fund. The returns of the simulated portfolios (calculated in Section 3.3.2) create a POD for the period being studied. The process can be repeated for various periods to create a set of PODs over time. Each POD (for each period) represent all the possible returns that the fund could have obtained given the various portfolios it could have invested in based on the opportunity set. The fund's return is added to the PODs plot for each evaluation period.

PODs are created for each of the nine Surz Style Indices for each period under evaluation. Each POD is compared against the corresponding portion of the fund's return, which is the result of the fund's investment in said index. By doing so it is possible to determine how well the fund manager exploited the opportunities available in each of the nine different equity categories (e.g. large-cap growth, mid-cap core, small-cap value, etc.).

3.3.3.2 Risk Dynamics

Traditionally the risk of the fund is compared against the risk of the benchmark (in this case the ALSI). For each random portfolio that was created via the simulation process, a corresponding

standard deviation was calculated in Section 3.3.2. The set of standard deviations leads to the risk distribution of the simulated portfolios. The risk dynamics can be studied by studying the risk distribution.

The PODs methodology is used to create a distribution of all the possible risk levels the fund could have obtained given the fund's opportunity set. The actual risk of the fund is then compared against the risk distribution of the simulated portfolios to see how much risk the fund took compared to what it could have taken.

3.3.3.3 Combining the Risk and Return Dynamics: Market Dynamics

Risk and return are two factors that should be studied together. An investor or portfolio manager will aim to maximize returns while at the same time he/she will aim to minimize the underlying risk. The comparison of the market dynamics of the fund and the market is done in the form of an 'efficient space'. In an 'efficient space', the actual return and risk of the fund is compared against the return and risk of the simulated portfolios. By doing so it is possible to determine how efficient³⁷ (or not) the portfolio is compared to how efficient (or not) it could have been given the other possible portfolios it could have invested in. A portfolio is considered to be efficient if it has a higher return and a lower risk level than most of the simulated portfolios, since the simulated portfolios represent all the other possible outcomes for the same opportunity set and mandate constraints. Efficient portfolios are thus considered to be superior to most of the other portfolios in the 'efficient space' and therefore it can be concluded that the manager of the fund has exceptional skill when it comes to the construction of the portfolio. By comparing the portfolio's dynamics with the market's market dynamics it is possible to obtain a better understanding of how the fund performed relative to the market.

Traditionally the return and risk of a fund is compared against that of the benchmark or peer groups. According to Botha (2010: 56) however, with this traditional method some of the market information remains hidden. The evaluation of the fund's performance only consists of the comparison against the fund's benchmark index. Thus, the results only indicate how well (or poorly) the fund compared against the index. There are however various other outcomes available in the market which the fund could have obtained given different investment decision (based on the opportunity set). It is possible to unlock the hidden information by incorporating the PODs methodology to compare the dynamics of the fund against the dynamics of all the possible outcomes it could have achieved.

The return and risk of the fund is compared against the return and risk of the simulated portfolios. By doing so it is possible to determine how efficient the fund is against all the possible portfolios it

³⁷ An efficient portfolio will have a higher return for the same risk level or it will have a lower risk level for the same return level. (Van Heerden & Botha, 2012)

could have invested in. The percentage of simulated portfolios that the fund has outperformed on a risk-adjusted basis is calculated for each period. These percentages are then compared across the various evaluation periods for all the funds under evaluation. By doing so it is possible to determine which fund manager outperformed the majority of the random portfolios on a consistent basis across the entire evaluation period. The fund managers are then ranked based on their consistent outperformance.

Together, the dynamics of the simulated portfolios represent a distribution of the dynamics available in the market. By comparing the dynamics of the fund against said distribution, it is possible to determine how well the fund performed and how much risk the fund took in comparison to the risk underlying market. A PODs plot is created which incorporates the risk of the fund and the portfolios.

3.6 SUMMARY

PODs are used to evaluate the performance of the fund in question. The method enables the user to compare the fund's performance against all the possible performance outcomes available to it in the market. It is also possible to determine the ability of the fund manager to consistently outperform (or underperform) the market.

Performance evaluation is also done based on the traditional approaches in order to determine which method is superior. The fund managers are therefore ranked based on the comparison of their risk-adjusted performance relative to their benchmark indices and peers for the same evaluation periods as was used to create the PODs results. The results of the various methods are compared in order to determine which method is superior.

CHAPTER 4

FINDINGS

4.1 INTRODUCTION

Various funds are studied in this chapter based on the methodology explained in Chapter 3. PODs is used to evaluate the performance of nine equity unit trust managers, of which five are classified as value managers and four are classified as growth managers. The performance of the funds as well as the skill of the fund managers is studied over the evaluation period. The period between July 2010 and June 2013 will be used as a test period to see whether the funds performed in the predicted manner.

10,000 random portfolios are generated based on the opportunity set available to the funds given the regulation requirements in the South African equity market. The performance of the funds is compared against the performance of these simulated portfolios by comparing the actual return and risk of the portfolio against that of the simulated portfolios. The fund of a highly skilled manager would consistently outperform most of the simulated portfolios over time in terms of the risk and return of the fund. PODs provide the user with an indication of how well (or poorly) the fund performed in comparison with its benchmark and also how well (or poorly) the manager exploited the investment opportunities available to him/her.

The fund performance is also evaluated by comparing the performance of the fund to its benchmark and to its peer groups. The results of the three methods are compared in order to determine which method is superior. A multi-period evaluation is done to determine the consistency of the fund's investment style and performance as well as the consistency of the fund manager's skill.

4.2 VALUE FUNDS

Five value funds are studied in this section. The funds to be studied are:

- Investec Value Fund
- Momentum Value Fund
- Nedgroup Investments Value Fund
- Sanlam Investment Managers (SIM) Value Fund
- Stanlib Value Fund

Traditionally the returns of the funds would be compared against the returns of the fund's benchmark or against the returns of its peers. Figure 4.1 shows the returns of the five value funds against the ALSI.

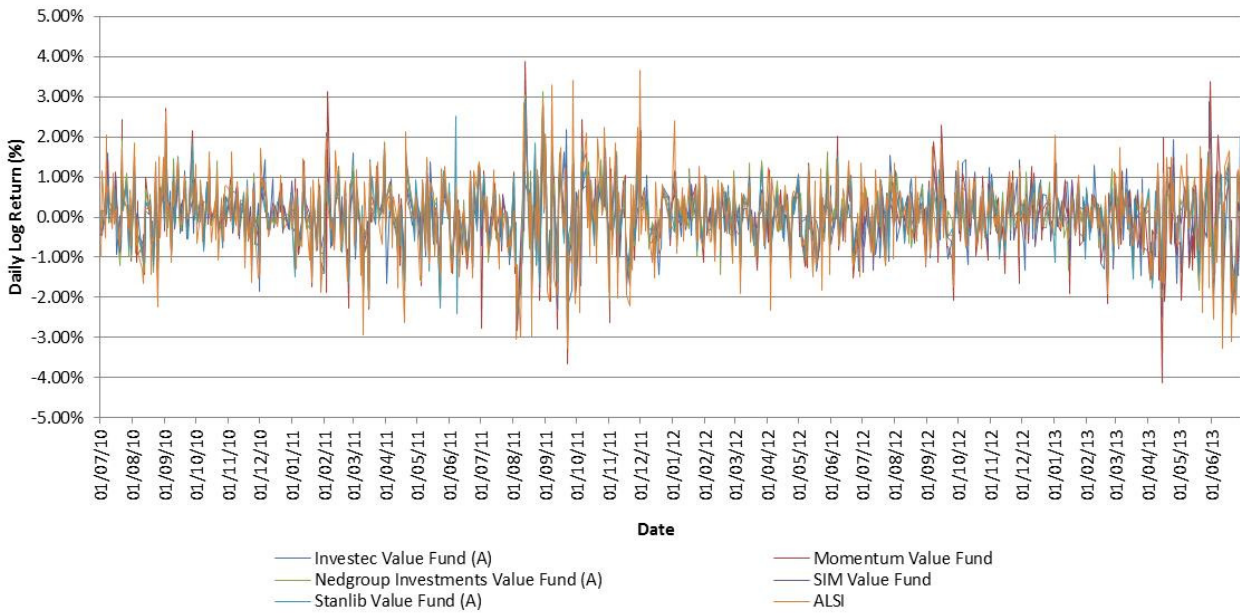


Figure 4.1: The Returns of the ALSI vs. The Value Funds

The standard deviations of the funds and the ALSI can be plotted as well.

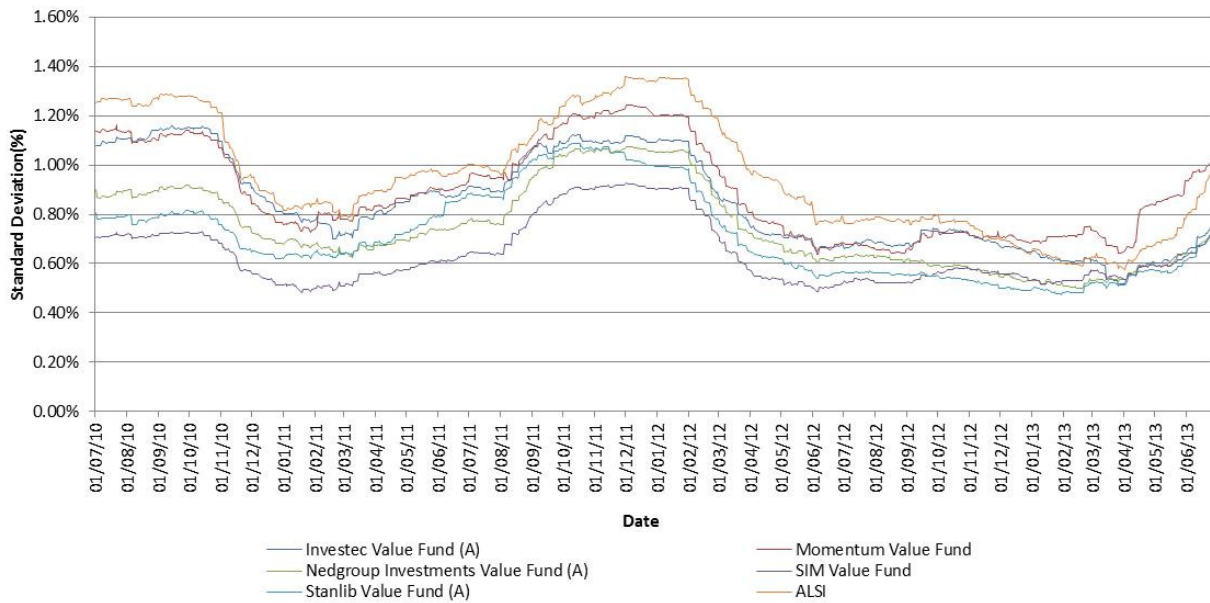


Figure 4.2: The Risk of the ALSI vs. The Value Funds

The returns and standard deviations seem to move in unison. It is, however, difficult to make a conclusion regarding the performance of a fund by studying the returns and standard deviation in this way. Another way of plotting the return and risk is to combine the return and risk plots. The annualized returns of the funds and the ALSI over the three year evaluation periods are compared against the corresponding standard deviations.

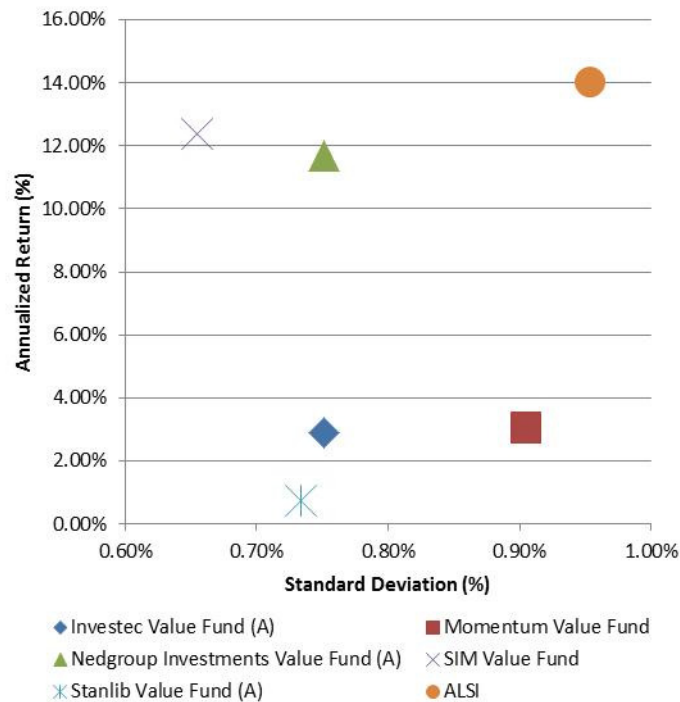


Figure 4.3: Comparing the Market Dynamics of the Value Funds against that of the ALSI

Figure 4.3 is more informative than the previous two figures. The ALSI clearly outperformed the funds based on returns. During this period, however, the ALSI also took on more risk. One possible explanation for the smaller risk levels of the funds is that the fund portfolios are less concentrated due to regulation. The regulation requirements could have an influence on the return levels as well. By studying Figure 4.3, it is, however, not possible to say with certainty why the funds underperformed or outperformed.

Figure 4.1 to 4.3 provides no insight into why the funds performed in the way that they performed or in the skill of the fund manager. This is why R.J. Surz introduced PODs. PODs will now be used to study the five value funds for the same evaluation periods.

4.2.1 Investec Value Fund

Investec Value Fund is a domestic equity fund which uses the ALSI as a benchmark. On 30 September 2013 67.99 per cent of the fund was invested in domestic equity. The fund had quite a high investment in foreign unit trusts as seen in Figure 4.4.

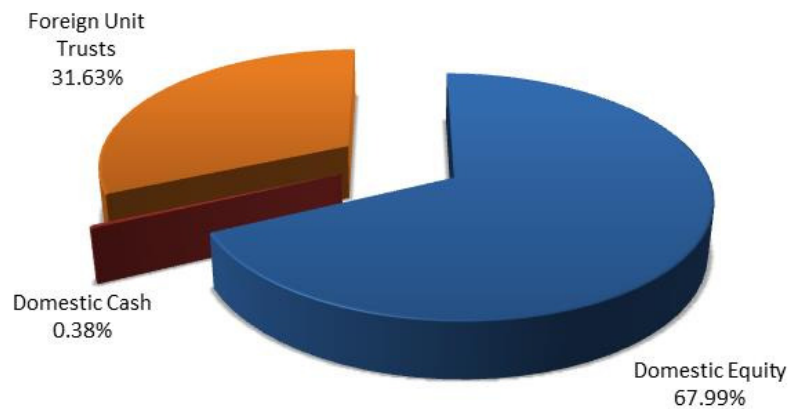


Figure 4.4: Investec Value Fund Asset Allocation – 30 September 2013

Source: (Equinox)

Investec Value Fund had quite a large exposure to the large growth sector for the first half of the evaluation period. However, during the second half of the evaluation period the funds exposure was more concentrated in the value sector as can be seen in Figure 4.5. Figure 4.5 was constructed using a rolling period Returns-Based Style Analysis (RBSA) over the evaluation period.

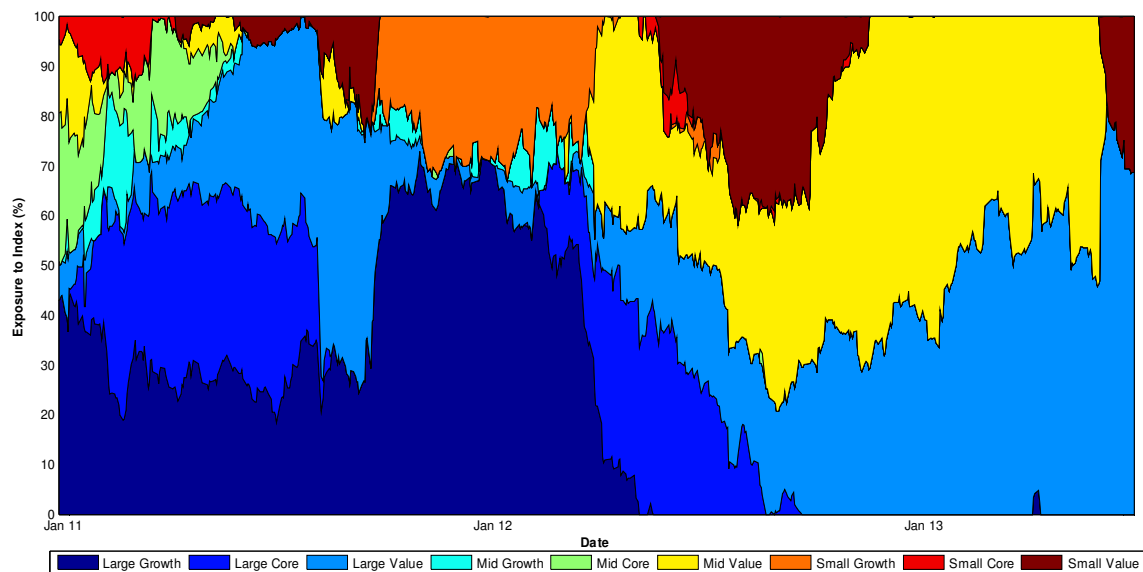


Figure 4.5: Exposure Distribution Area Graph from 1 July 2010 to 30 June 2013 – Investec Value Fund

The fund does not show a lot of consistency in its exposure to the nine Surz Style Indices. The large value sector's exposure is the only sector which remained relatively consistent. The results for the first half of the evaluation period do not support a value style mandate. As was mentioned before, the results for the second half of the evaluation period do support a value style mandate.

Constant exposures to the Surz Style Indices over six month intervals are required for the PODs calculations. This is provided in Figure 4.6. Once again it can be seen that over the first half of the evaluation period the fund had more exposure to core and growth sectors than to value sectors. During the second half of the evaluation period the fund had exposure to mostly value sectors.

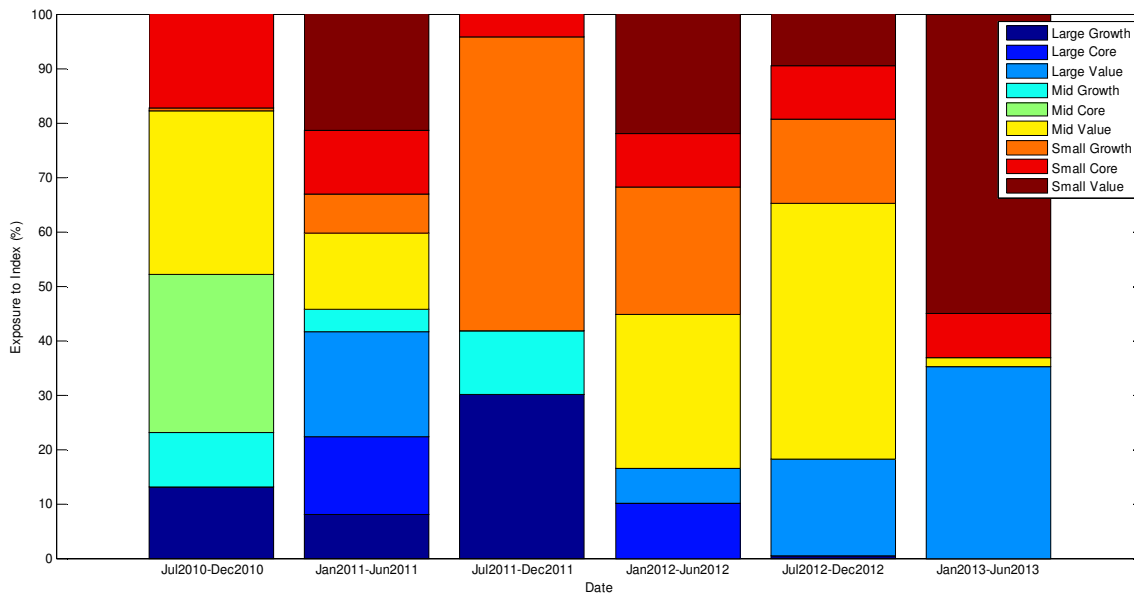


Figure 4.6: Investec Value Fund Exposures between 1 July 2010 and 30 June 2013

The next step is to study the PODs of the fund. The PODs for the Surz Style Indices are studied first. The first POD is for the fund's exposure to the large value index for the period between January 2013 and July 2013. The minimum return that the fund could have generated is -8 per cent and the maximum return is -4 per cent. The light green part of the POD represents the top quartile which indicates that the returns outperformed 75 per cent or more of the simulated portfolio. A manager who consistently falls within this quartile shows skill in selecting the appropriate shares to be included in the portfolio and also assigning the correct weight to said shares. The darker green region represents the second quartile. If the fund's return lies within this quartile it indicates that the fund outperformed between 50 and 75 percent of the simulated portfolios. The dark red region (the third quartile) indicates that the fund managed to outperform between 25 and 50 percent of the simulated portfolios. The light red region is the fourth quartile and indicates that if the fund managed to outperform any of the simulated portfolios; it only managed to outperform a maximum of 25 per cent of the portfolios. A manager who consistently generates returns within the light red region shows a lack of skill with regards to share selection and assigning weights to said shares. The blue dot represents the funds return relating to the specific index and evaluation period.

Given the fact that the maximum return that the fund could have generated is -4 per cent for the large value sector, the actual return of around -4 per cent is actually quite good. This indicates that

the fund manager showed skill in selecting the better shares in the index and assigning the appropriate weights. The fund had a very small exposure to the mid value index, hence the small POD. The fourth POD indicates the fund's exposure to the small value index. According to the graph the fund underperformed the minimum return that it could have generated given its exposure to the small value index. This underperformance can be explained by the fund's asset allocation in Figure 4.4. The fund manager shows skill in selecting the shares from the large value and small growth sectors. The fund manager however, does not show skill in selecting the shares to be included from the small value sector due to the underperformance. The remaining PODs can be analysed in the same way.

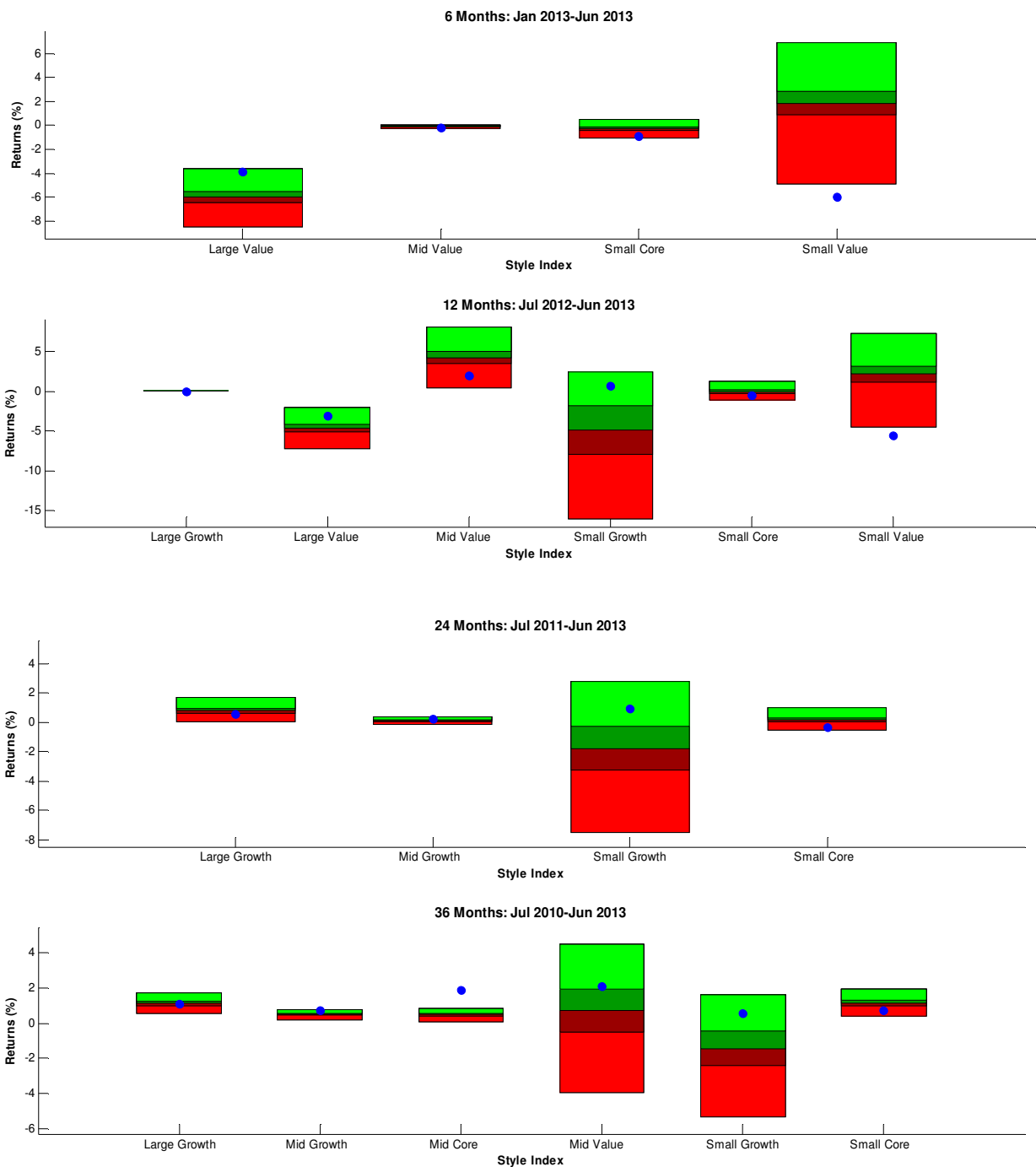


Figure 4.7: Surz Style Index PODs 1 July 2010 and 30 June 2013 - Investec Value Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

The fund invested approximately 32 per cent in other assets. More specifically, the fund invested 31.63 per cent in foreign unit trusts. The R/\$ exchange rate in Figure 4.8 shows that the R/\$ exchange rate depreciated 16.15 per cent between January 2013 and June 2013. A large portion of the fund returns could therefore be due to this investment. The depreciation in the Rand could

have had the same influence on the other periods. Using the total returns of the fund to calculate the fund's exposure to the Surz Style Indices and to create the simulated portfolios has an influence on the results since the total returns include the returns from the foreign and non-equity investments as well. It is impossible to determine the exact returns of the domestic equity investment without the holdings data of the fund.

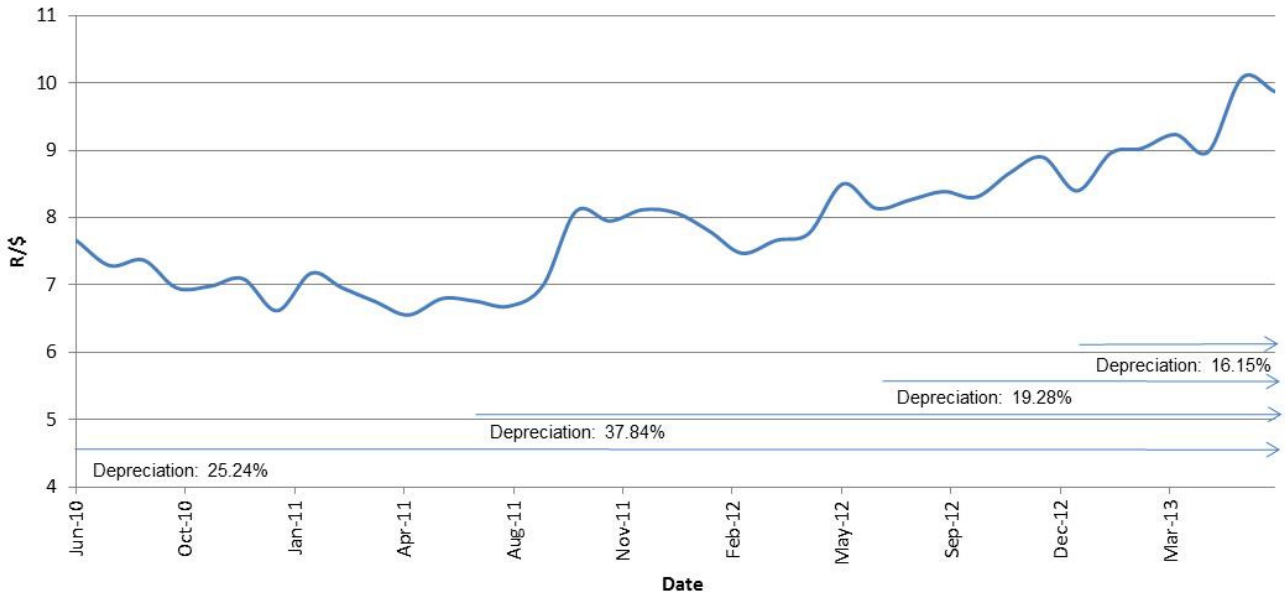


Figure 4.8: R/\$ Exchange Rate – June 2007 to June 2013

PODs can be created for the total fund returns as well. It is however, important to note that these returns include returns of the foreign and non-equity investments as well. The PODs clearly indicate that even with the returns of other investments, the fund did not perform that well against the equity returns available in the market. For the last two years the return of the fund falls in the lower quartiles. The annualized return of the fund over the three year evaluation period falls in the 50 per cent to 75 per cent category. Overall the fund manager does not show a lot of skill in setting up the fund's portfolio as the fund mostly underperforms more than 50 per cent of the simulated portfolios.

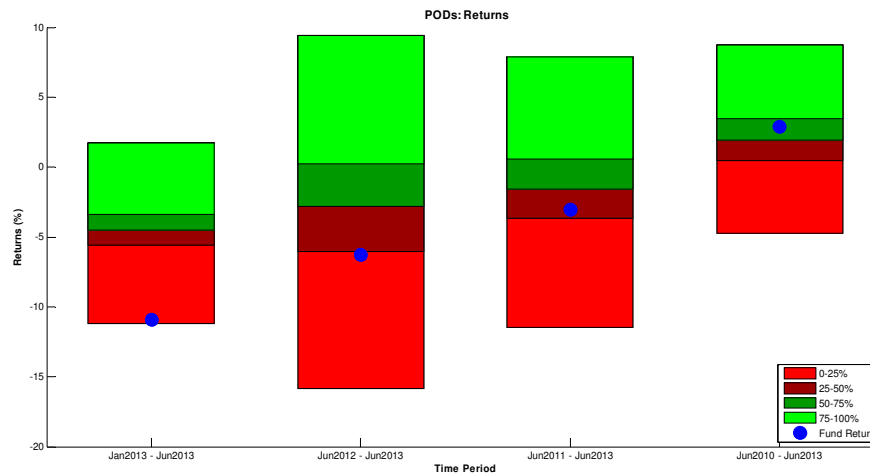


Figure 4.9: Return PODs for the Period 1 July 2010 to 30 June 2013– Investec Value Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

The risk and return of the fund and the simulated portfolios are plotted in Figure 4.10. The blue dots represent all the portfolios that the fund outperformed on a risk and return basis. The purple dots represent the portfolios that outperformed the fund or, in other words, the more efficient portfolios. The red dot represents the fund’s return. The plots clearly indicate that for the last 12 months the fund took on a lot more risk than the risk available in the equity market. This is due to the foreign investments and the corresponding currency risk.

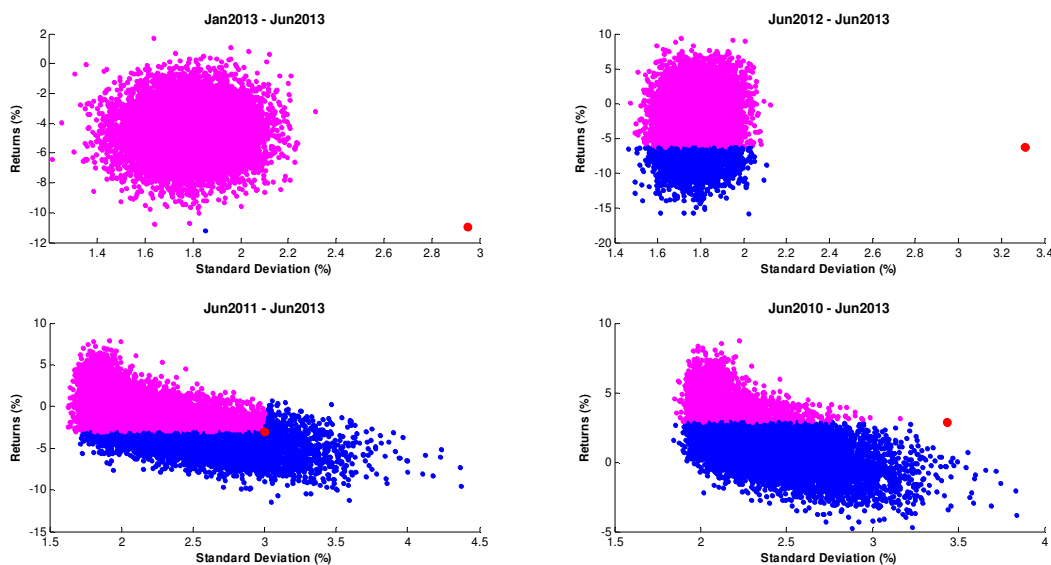


Figure 4.10: Comparing the Market Dynamics of Investec Value Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

Even with the added risk, the fund outperformed 33.3 per cent of the simulated portfolios over the two year period and outperformed 66.33 per cent of the simulated portfolios over the three year period.

Combining the PODs graphs with the risk and return plots leads to Figure 4.11. The blue block represents all the portfolios that the fund outperformed while the purple block represents the more efficient portfolios. The red dot represents the fund's return. Over the last six month period the fund underperformed most of the simulated portfolios and the fund also took on the most risk. Over the 12 month period the fund succeeded in outperforming more of the simulated portfolios but the fund still took on the most risk. Over the two and three year intervals the fund was able to outperform more of the simulated portfolios on a risk-adjusted base.

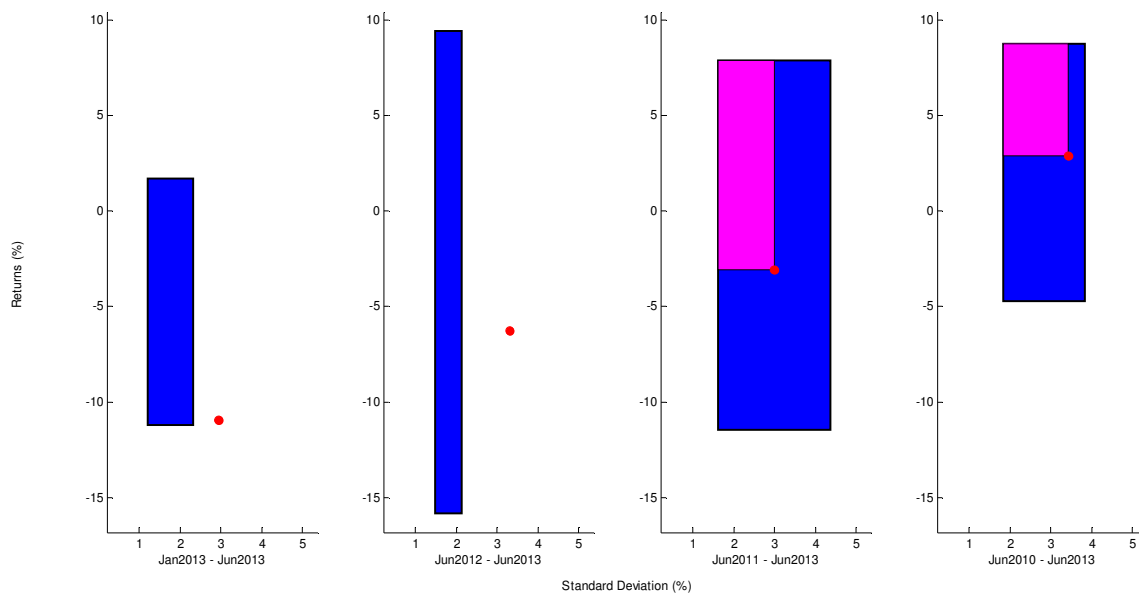


Figure 4.11: PODs - Comparing the Market Dynamics of Investec Value Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

The results indicate that the fund did not perform that well since the fund mostly underperformed most of the simulated portfolios over time. This indicates that the fund manager does not show that much skill in constructing the fund's portfolio.

The following sections are studied in exactly the same manner.

4.2.2 Momentum Value Fund

Momentum Value Fund is a domestic equity fund which uses the ALSI as a benchmark. On 30 September 2013 71.69 per cent of the fund was invested in domestic equity. 25 per cent of the fund was invested in foreign assets. The fund therefore also had quite a large exposure to the depreciation of the South African Rand.

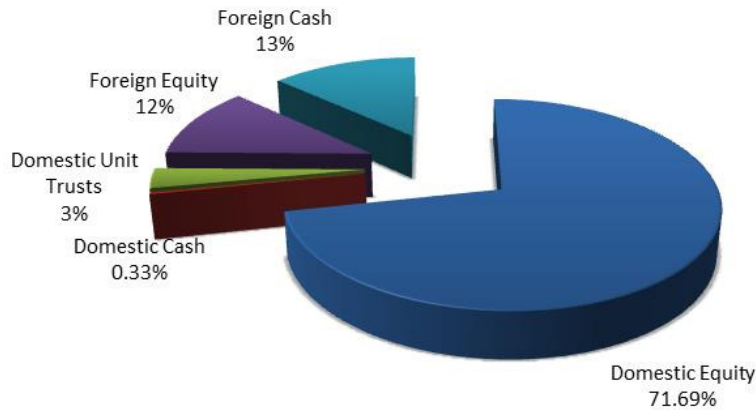


Figure 4.12: Momentum Value Fund Asset Allocation – 30 September 2013

Source: (Equinox)

Momentum Value Fund had quite a large exposure to the large value sector over the time period. During the first few months and in the middle of the evaluation period the fund had quite a large exposure to the large core sector. It also had quite a large exposure to the mid value sector during the second half of the evaluation period. Overall, the fund mostly had exposures to the value or core sectors which are consistent with a value style mandate.

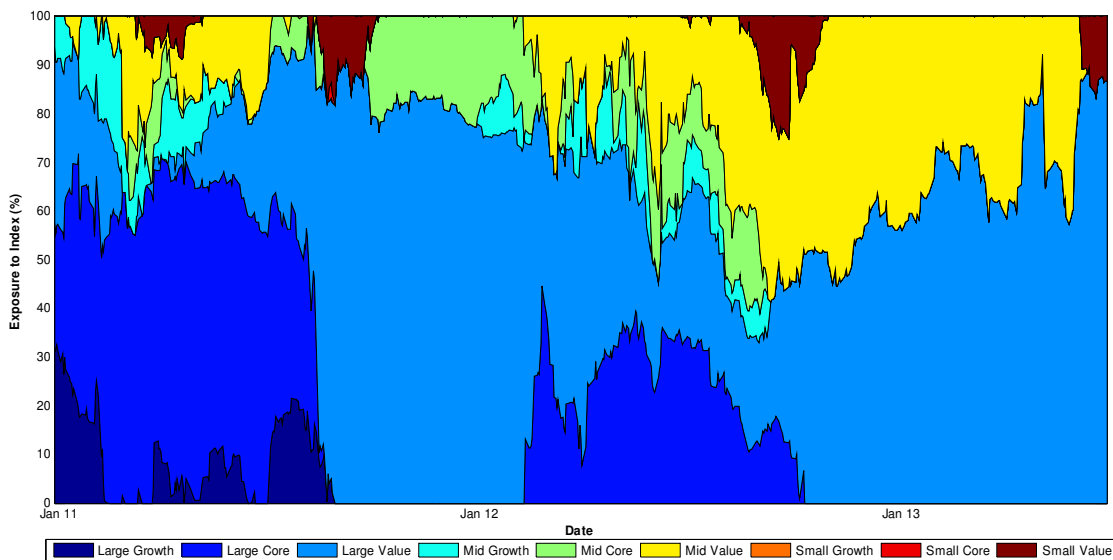


Figure 4.13: Exposure Distribution Area Graph from 1 July 2010 to 30 June 2013 – Momentum Value Fund

The fund remained relatively consistent in its style exposure over time. Figure 4.14 displays the constant six month exposures which confirm the fact that the fund mostly had exposures to the value and core indices.

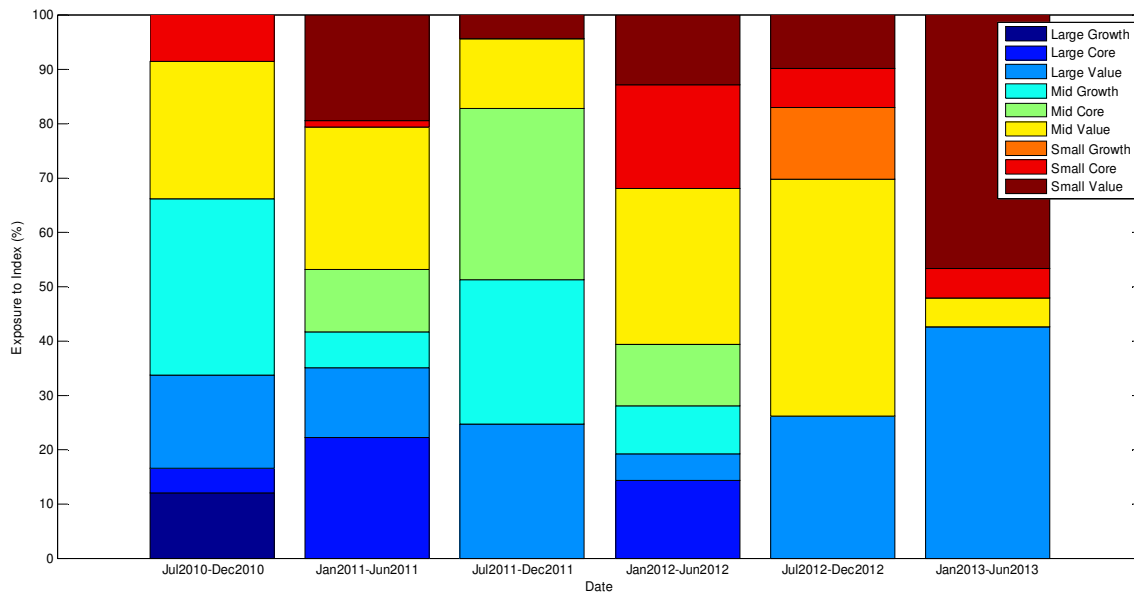


Figure 4.14: Momentum Value Fund Exposures between 1 July 2010 and 30 June 2013

Figure 4.15 indicates that the fund tends to underperform the small value sector. Just like the Investec Value Fund, the fact that the fund has such a large portion of its assets invested outside of domestic equities influences the results. The figure does however indicate that the fund manager has skill in selecting shares to be included in the mid value index over the long run. The manager, however, struggled with the share selection of the large value sector since the fund's return mostly fell in the bottom quartiles. The fund underperformed the small value sector on a constant basis.

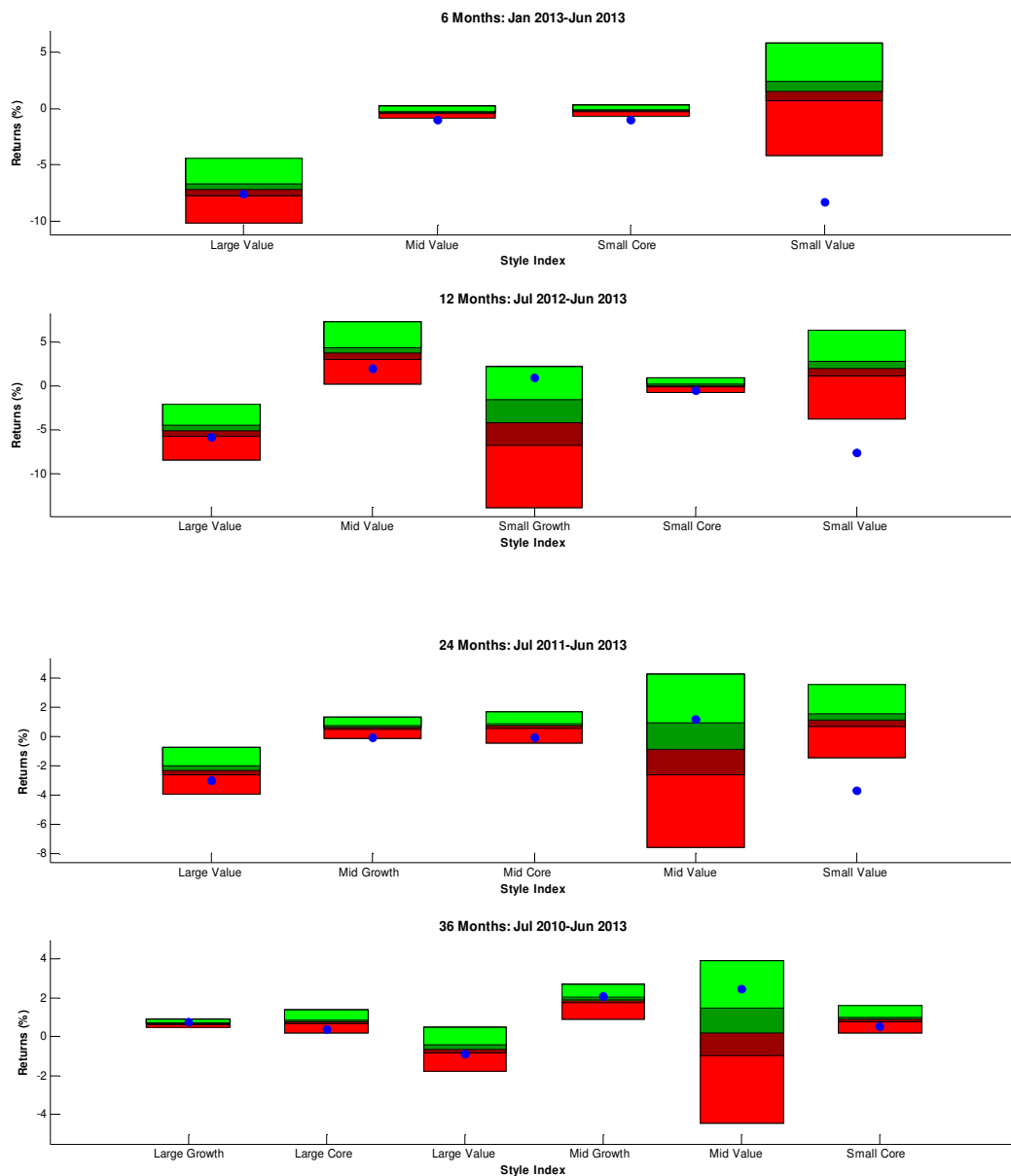


Figure 4.15: Surz Style Index PODs 1 July 2010 and 30 June 2013 - Momentum Value Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

The PODs clearly indicate that even with the returns of other investments, the fund did not perform that well against the equity returns available in the market. Over the last six month period the fund underperformed all the simulated equity portfolios. Over the longer periods the fund consistently fell in the bottom quartiles, thus indicating a lack of skill on the fund manager’s side.

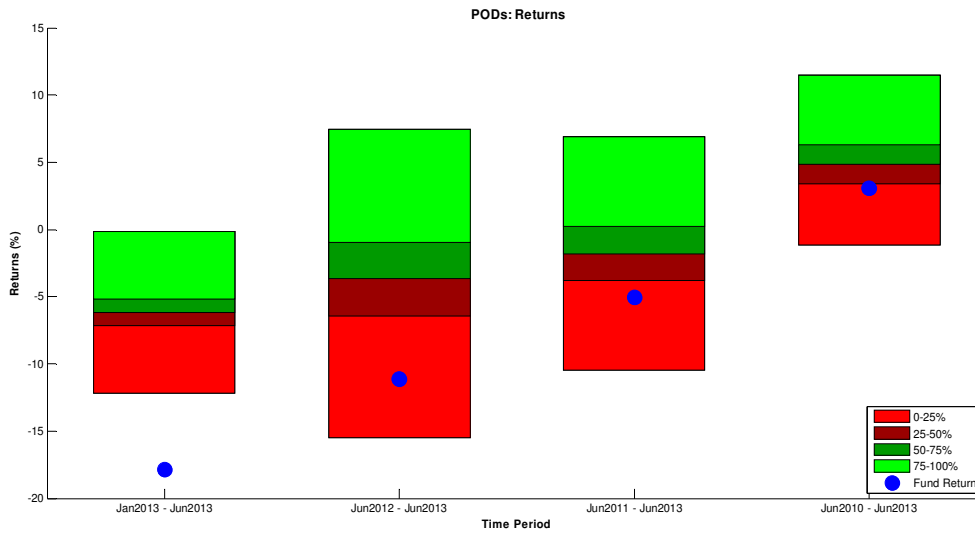


Figure 4.16: Return PODs for the Period 1 July 2010 to 30 June 2013– Momentum Value Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

Figure 4.18 confirms the fact that the fund underperformed most of the simulated portfolios over time. Over the last 12 months the fund also took on a lot more risk due to the foreign investments and the corresponding currency risk.

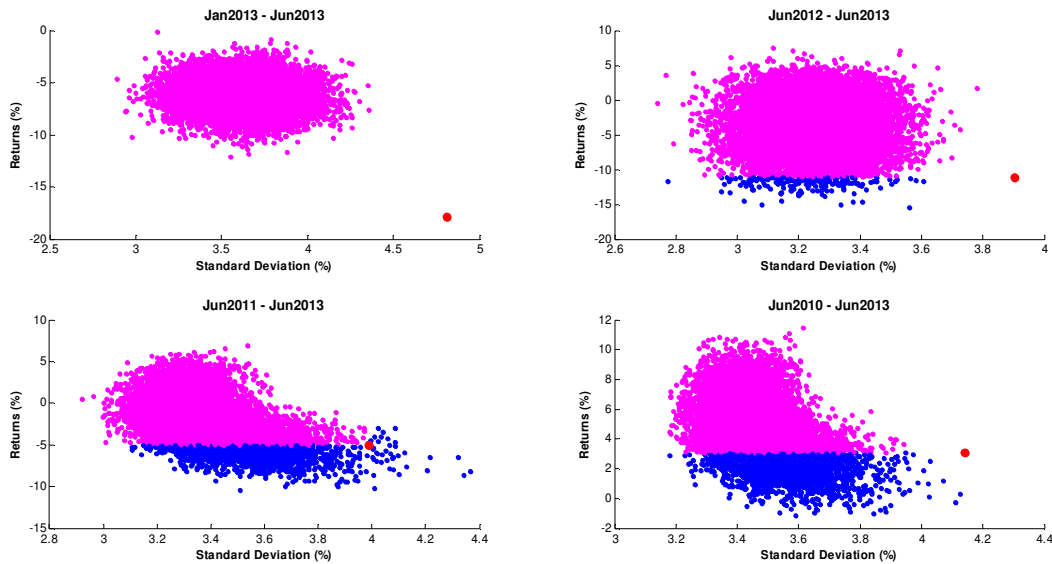


Figure 4.17: Comparing the Market Dynamics of Momentum Value Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

Over the last year the fund only managed to outperform 1.73 percent of the simulated funds. Over a three year period the fund did however manage to outperform 20.4 per cent of the simulated portfolios.

Figure 4.19 clearly shows that the fund did not perform well compared to the simulated portfolios when combining the returns and risk. The fund consistently fell in the bottom quartiles and took on a lot of risk.

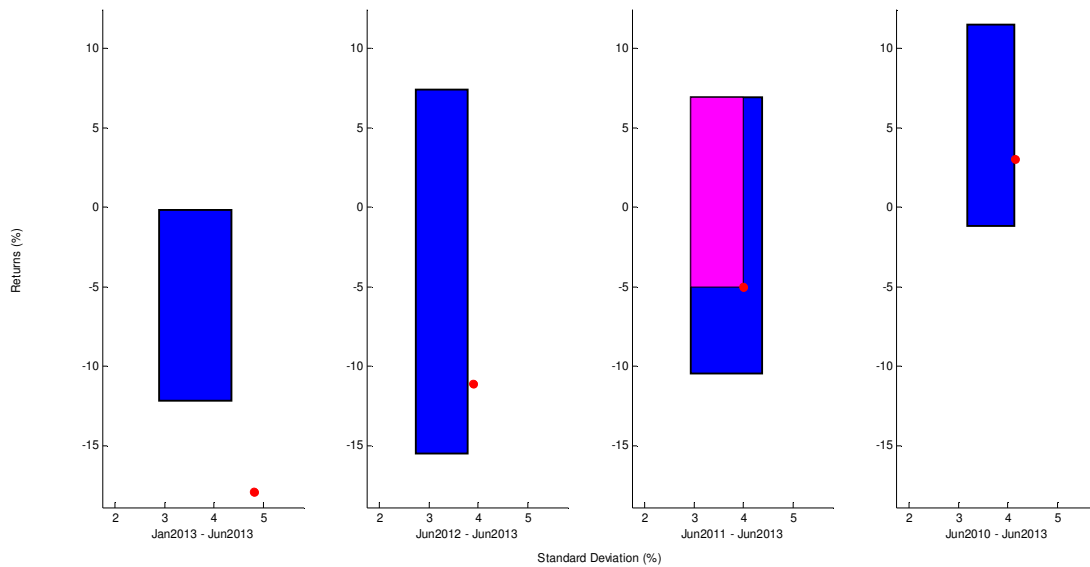


Figure 4.18: PODs - Comparing the Market Dynamics of Momentum Value Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

The above results indicate that the fund manager does not show that much skill in constructing the fund's portfolio since the fund consistently underperformed.

4.2.3 Nedgroup Investments Value Fund

Nedgroup Investments Value Fund is a domestic equity fund which uses the ALSI as a benchmark. On 30 September 2013 the fund was mainly invested in domestic equity. The only other investment that the fund had was a 3.82 per cent investment in domestic cash.

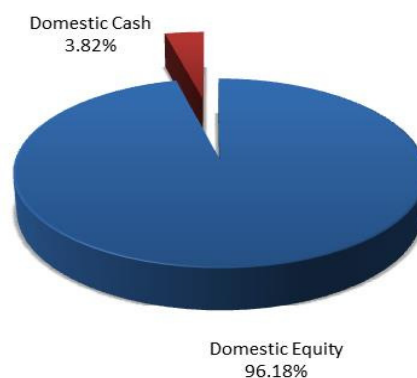


Figure 4.19: Nedgroup Investments Value Fund Asset Allocation – 30 September 2013

Source: (Equinox)

The largest exposure over time is the exposure that the fund had to the large value sector. The fund consistently had exposures to the large and mid core as well as the mid growth sectors. Overall, the fund mostly had exposure to value and core indices which are consistent with a value style mandate.

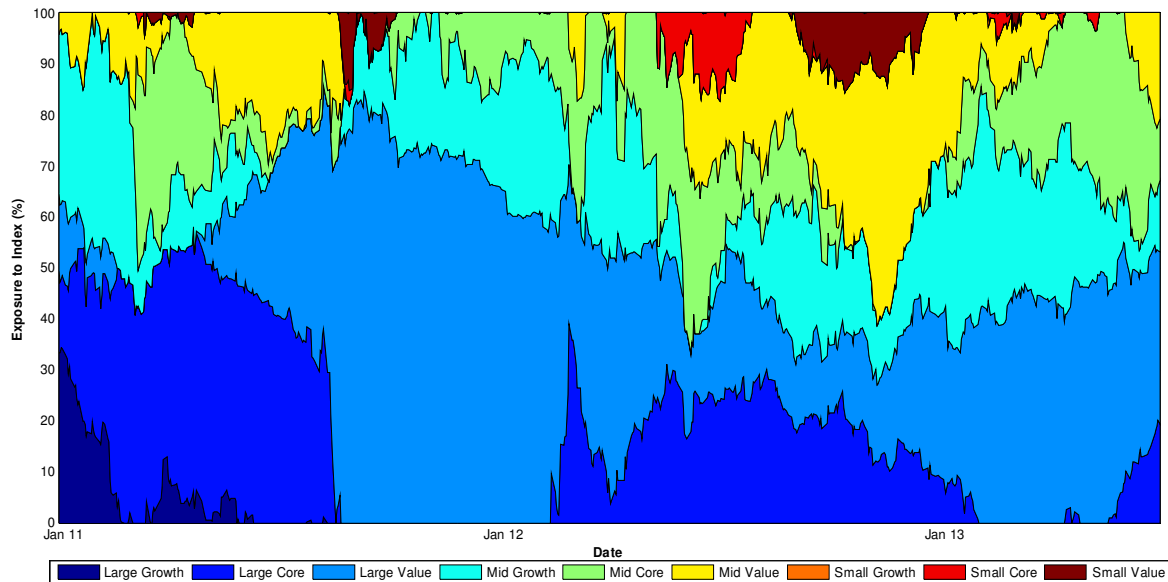


Figure 4.20: Exposure Distribution Area Graph from 1 July 2010 to 30 June 2013 – Nedgroup Investments Value Fund

The fund remained relatively consistent in its style exposure over time. Figure 4.20 confirms the fact that the fund mostly had exposures to the value and core indices. The constant six month exposures in Figure 4.21 will be used in the subsequent analyses.

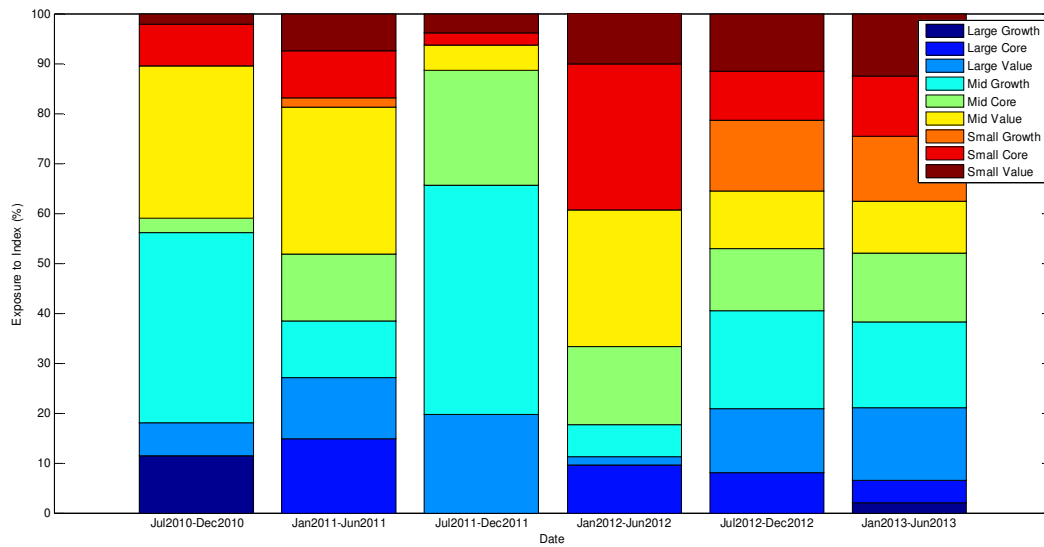


Figure 4.21: Nedgroup Investments Value Fund Exposures between 1 July 2010 and 30 June 2013

Figure 4.22 indicates that the fund tends to outperform the large value sector. The fund had a small portion invested in domestic cash besides its domestic equity investment; therefore the South African currency did not affect the returns of the fund to the same extent as the previous two funds. Over time the fund manager shows skill in selecting large value and small core shares since the fund returns compare well against the indices as shown in Figure 4.22.

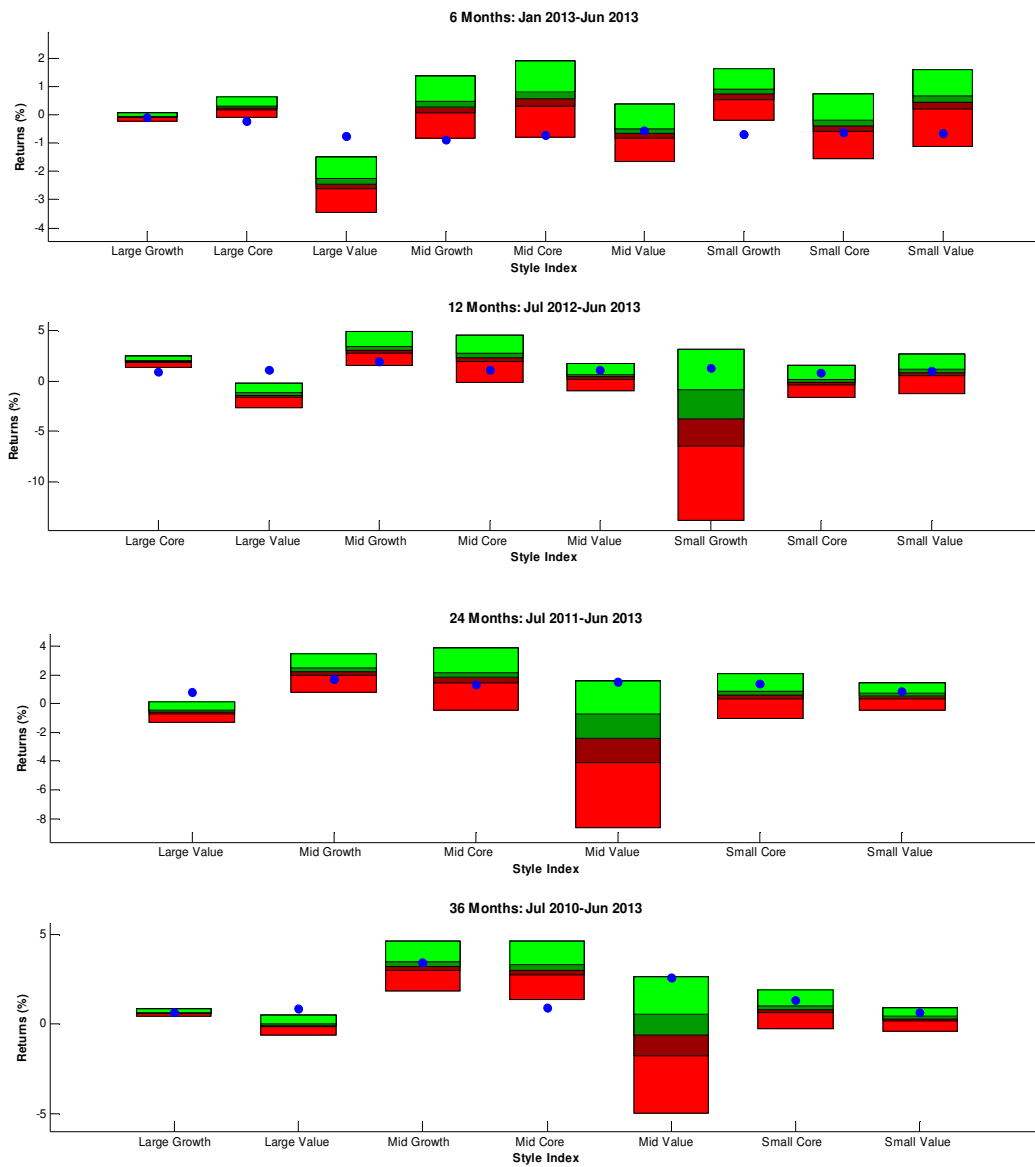


Figure 4.22: Surz Style Index PODs 1 July 2010 and 30 June 2013 - Nedgroup Investments Value Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

Figure 4.23 shows that the fund consistently performed well compared to the simulated funds, except for the last six months. The fund was able to consistently outperform the simulated portfolios over a term of 12 months or longer.

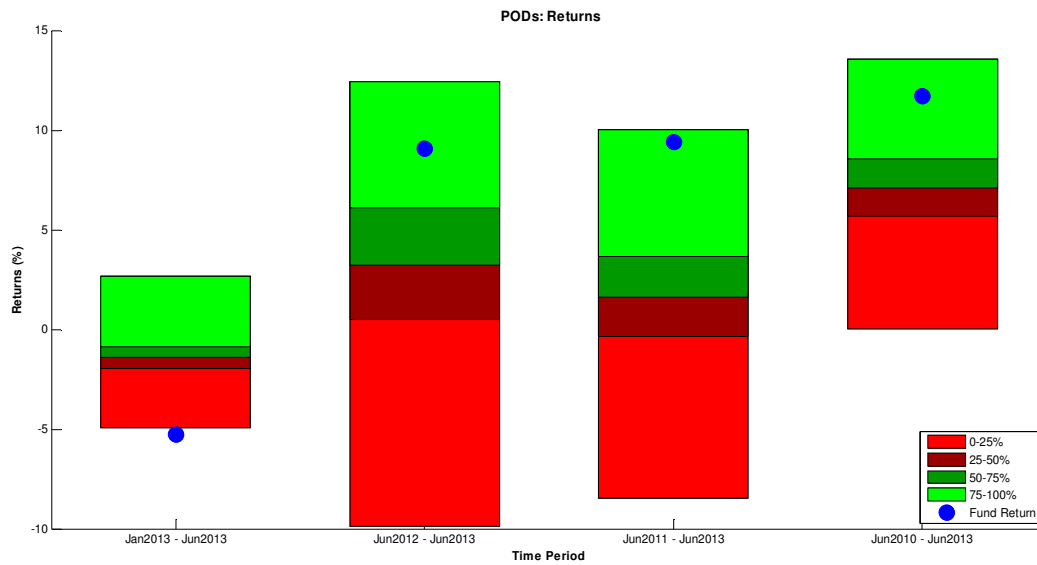


Figure 4.23: Return PODs for the Period 1 July 2010 to 30 June 2013– Nedgroup Investments Value Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

Figure 4.24 confirms the results in Figure 4.23. The fund performed well over periods of twelve months or longer, but did not perform well over the last six months. In the short term the fund took on a lot more risk, which could be because of its lower returns during this period.

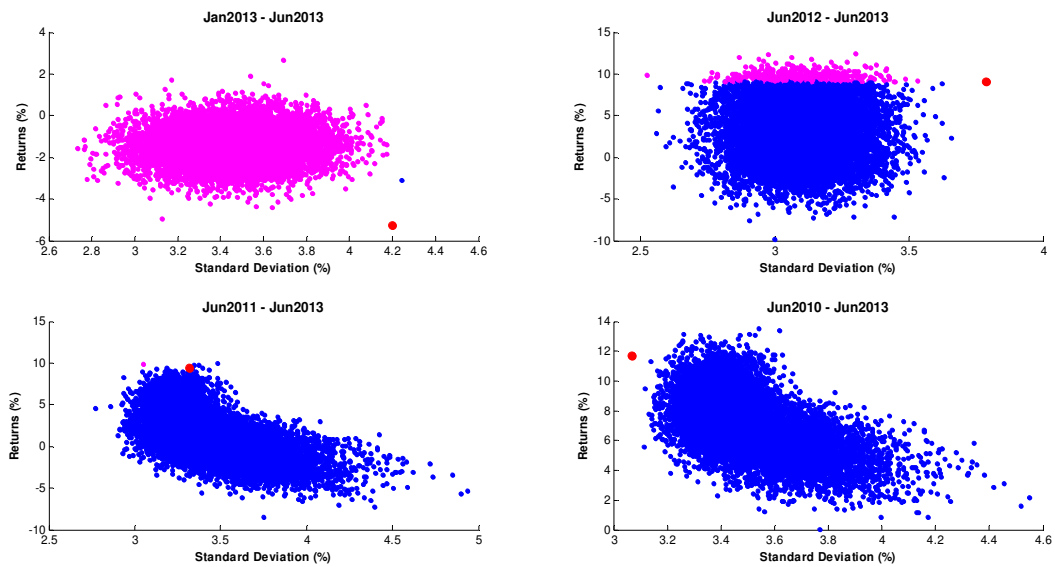


Figure 4.24: Comparing the Market Dynamics of Nedgroup Investments Value Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

Figure 4.25 shows that the fund performed quite well over the long run by always falling in the top quartile. The fund did however start taking on more risk over the short term and also generated very low returns over the last six months.

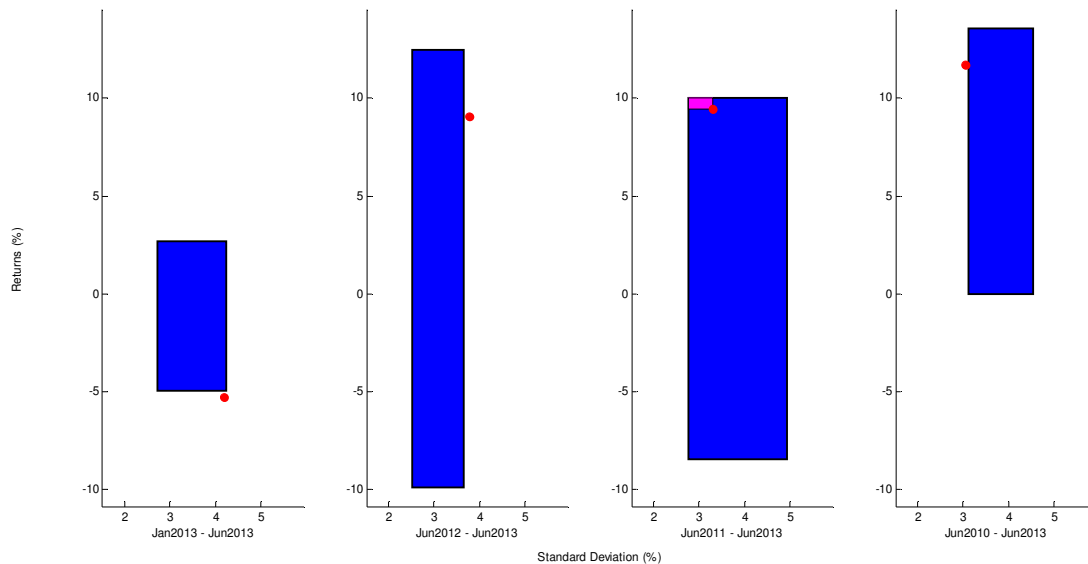


Figure 4.25: PODs - Comparing the Market Dynamics of Nedgroup Investments Value Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

The investment manager shows skill over the long term but towards the end of the evaluation period the fund performed quite bad. This indicates that the fund manager has some skill and that the last six months might have been a bad patch.

4.2.4 Sanlam Investment Managers (SIM) Value Fund

SIM Value Fund is a domestic equity fund which uses the ALSI as a benchmark. The fund had 77.09 per cent of its assets invested in domestic equities on the 30th of September 2013. The fund had 20.72 per cent of its assets invested in foreign assets.

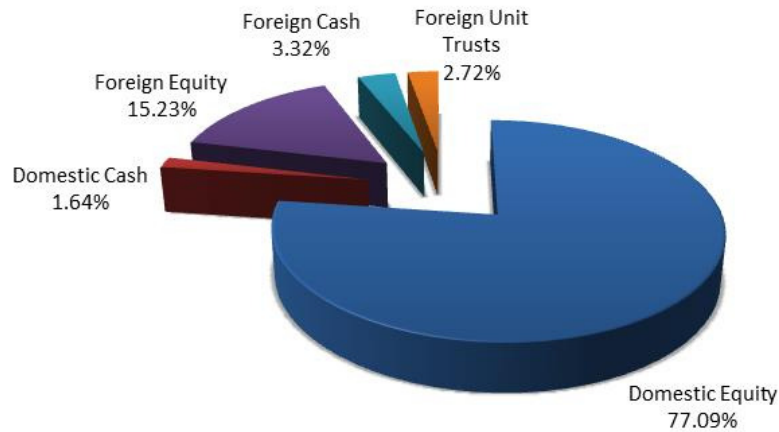


Figure 4.26: SIM Value Fund Asset Allocation – 30 September 2013

Source: (Equinox)

The largest exposure that the fund had over the evaluation period is its exposure to the large value sector. The fund also consistently had a large exposure to the mid value sector. The largest part of the fund's exposure was to value sectors which is consistent with a value style mandate.

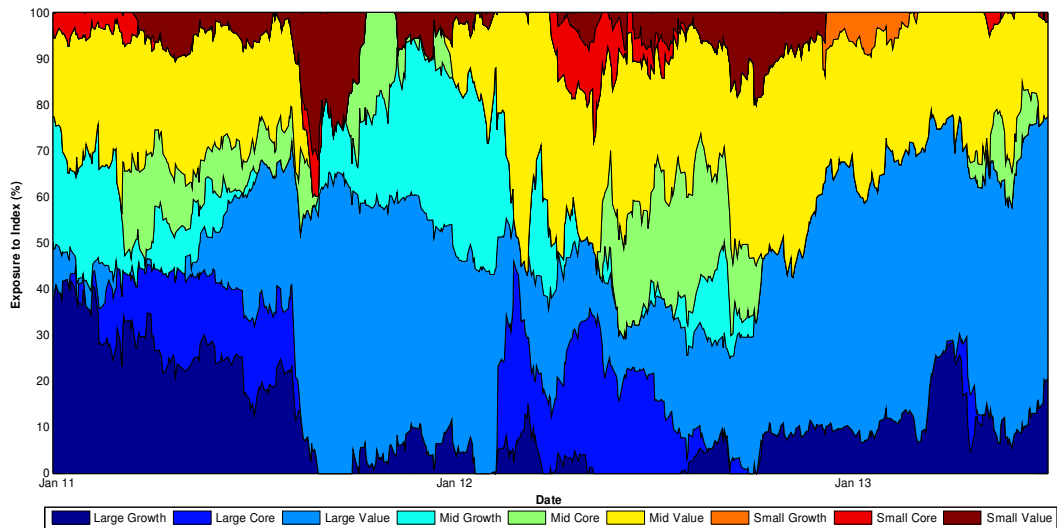


Figure 4.27: Exposure Distribution Area Graph from 1 July 2010 to 30 June 2013 – SIM Value Fund

The fund was quite consistent in its exposures over the evaluation period. Figure 4.28 indicates that the fund's constant semi-annual exposures were mainly to the value and core indices. This is consistent with a value style mandate.

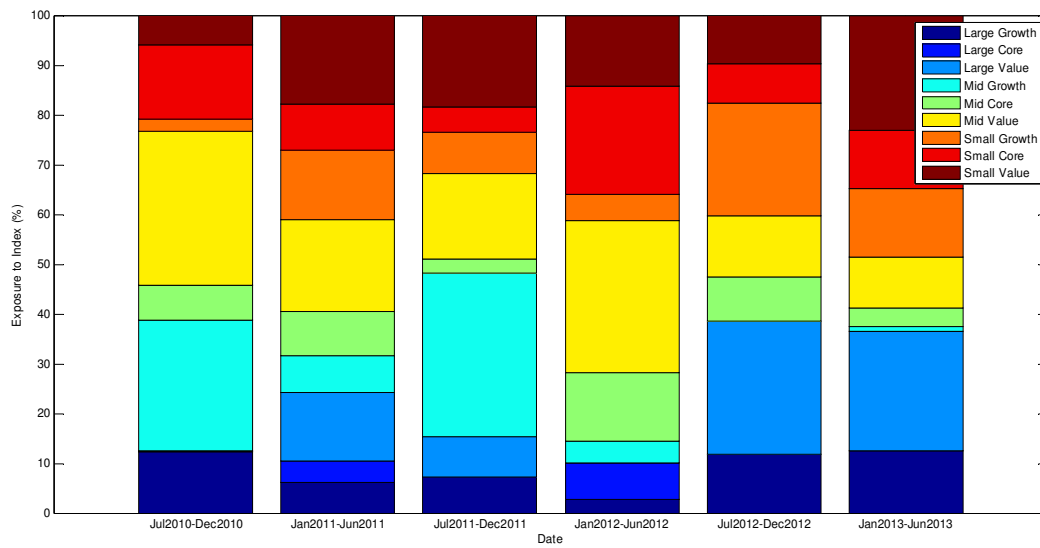


Figure 4.28: SIM Value Fund Exposures between 1 July 2010 and 30 June 2013

The fund consistently outperformed the large value sector. The fund also performed well in the small growth, small core and mid value sectors since the fund returns fell consistently in the top quartiles consistently. The fund manager showed less skill in selecting shares in the mid growth sector.

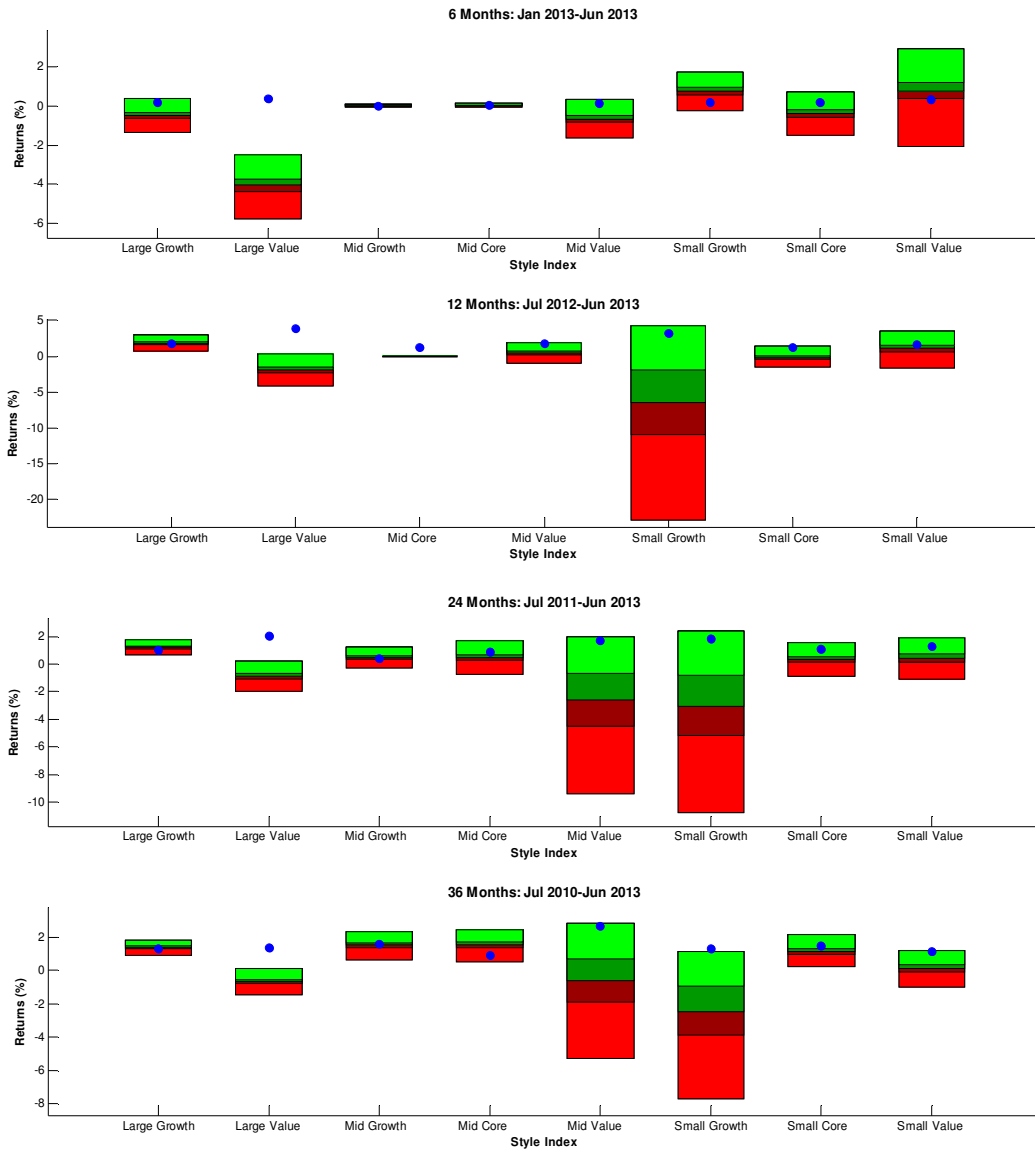


Figure 4.29: Surz Style Index PODs 1 July 2010 and 30 June 2013 - SIM Value Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

Due to the fund's exposure to foreign investments and the effect of the depreciating currency, the fund was able to consistently outperform the simulated portfolios as shown in Figure 4.30.

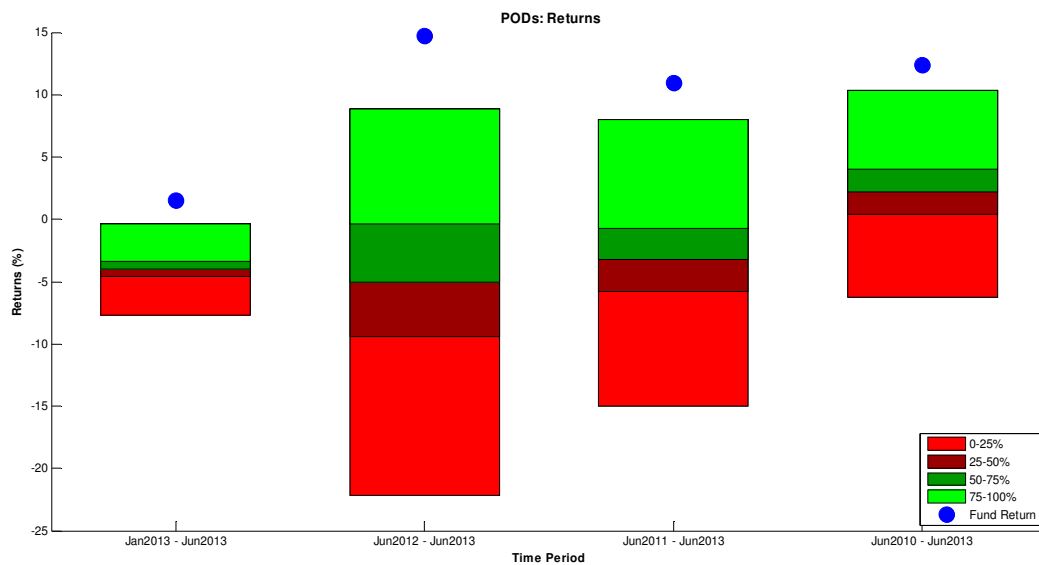


Figure 4.30: Return PODs for the Period 1 July 2010 to 30 June 2013– SIM Value Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

Figure 4.31 confirms the outperformance of the fund over each time period. It also shows that the fund took on a lot more risk over the shorter time periods. This is due to the higher foreign investment and the corresponding currency risk.

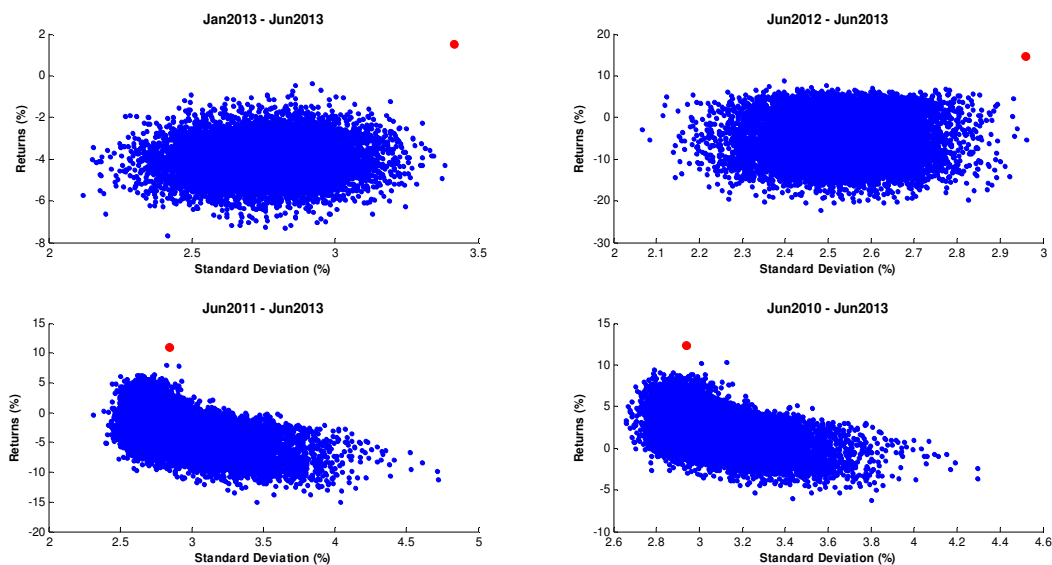


Figure 4.31: Comparing the Market Dynamics of SIM Value Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

The results in Figure 4.32 confirm these results. The fund outperformed the simulated portfolios consistently but also took on more risk over the six and 12 month periods. During the 24 and 36 month period however, the fund had low risk levels compared to the simulated portfolios.

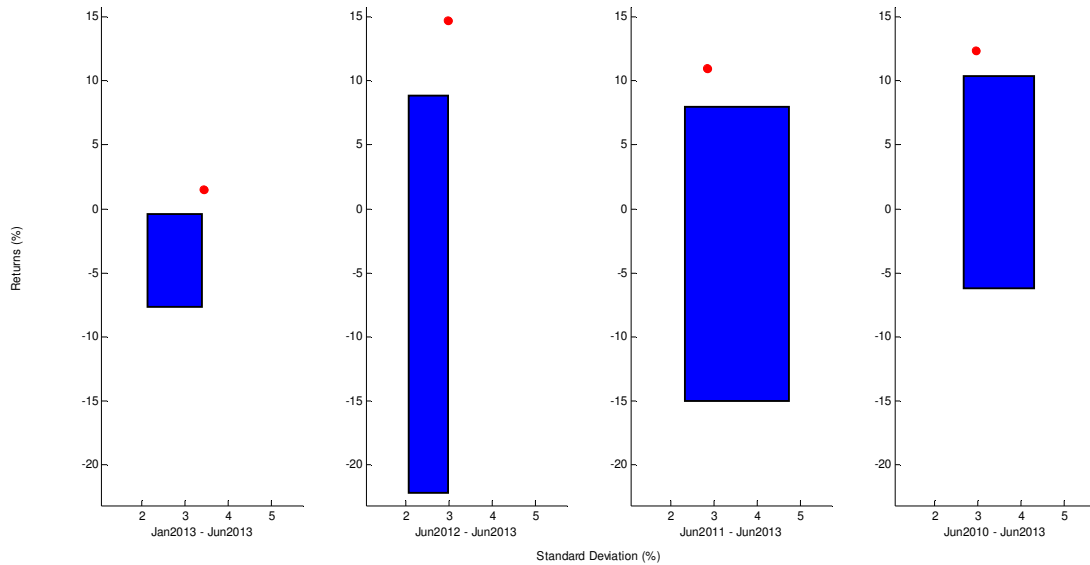


Figure 4.32: PODs - Comparing the Market Dynamics of SIM Value Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

The investment manager shows skill in selecting the appropriate assets and assigning the appropriate weights to said assets since the fund was able to consistently outperform the simulated portfolios. The outperformance is due to the large foreign investment and the corresponding depreciation in the South African Rand.

4.2.5 Stanlib Value Fund

Stanlib Value Fund is a domestic equity fund which uses the ALSI as a benchmark. On 30 September 2013 the fund had 81.80 per cent of its assets invested in domestic equities. 12.96 per cent of the fund's assets was invested in foreign assets thus leading to currency exposure.

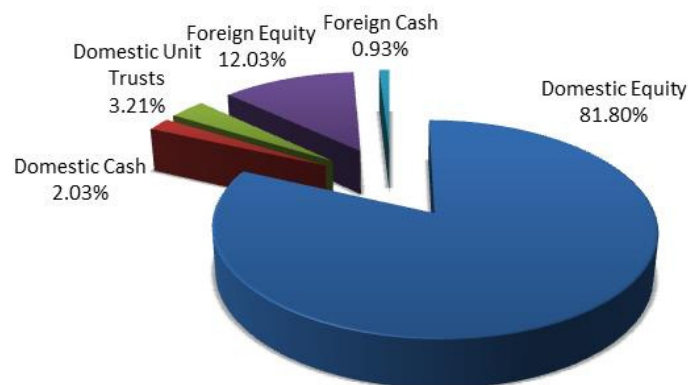


Figure 4.33: Stanlib Value Fund Asset Allocation – 30 September 2013

Source: (Equinox)

The fund had a large exposure to the large value sector for the first part of the evaluation period and a large exposure to the mid value sector for the second part of the evaluation period. Most of the fund's exposure was to value sectors which is consistent with a value style mandate.

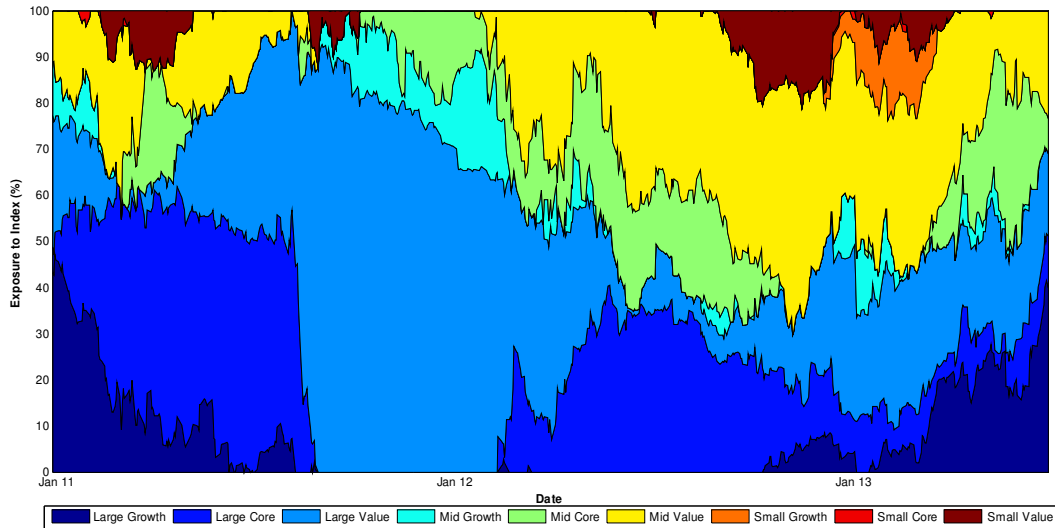


Figure 4.34: Exposure Distribution Area Graph from 1 July 2010 to 30 June 2013 – Stanlib Value Fund

There were a few large changes in the exposure but overall the fund's exposures were relatively consistent. It is clear from the constant six month exposures in Figure 4.35 that the fund mostly had exposures to the value and core sectors.

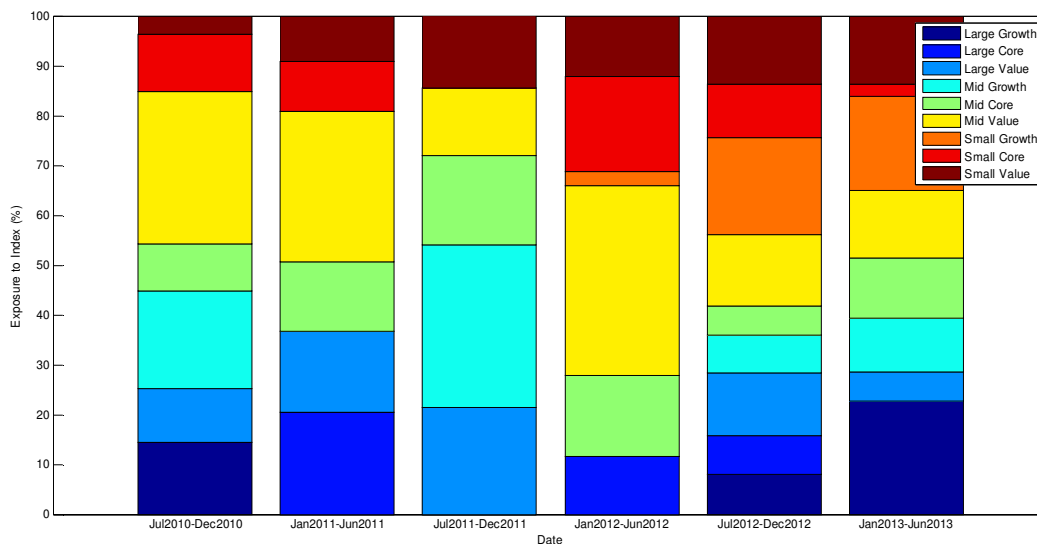


Figure 4.35: Stanlib Value Fund Exposures between 1 July 2010 and 30 June 2013

The fund consistently outperformed the large value sector. The fund also consistently performed well in the mid value sector since the fund returns fell in the top quartiles. The fund did not perform as well in the mid core and mid growth sectors.

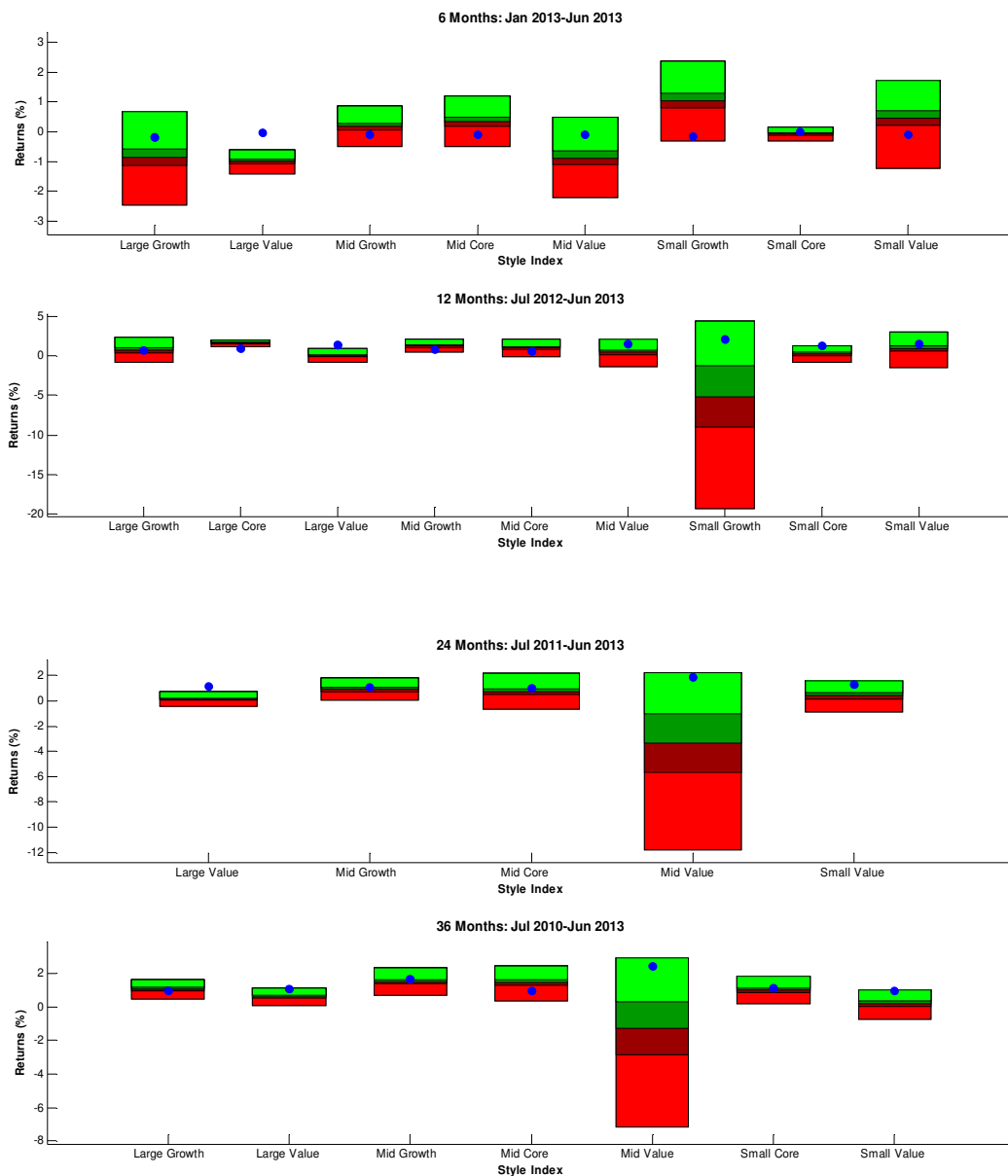


Figure 4.36: Surz Style Index PODs 1 July 2010 and 30 June 2013 - Stanlib Value Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

The fund outperformed most of the simulated portfolios over the longer time periods as seen in Figure 4.37. The fund did however not perform as well over the last six months of the evaluation period.

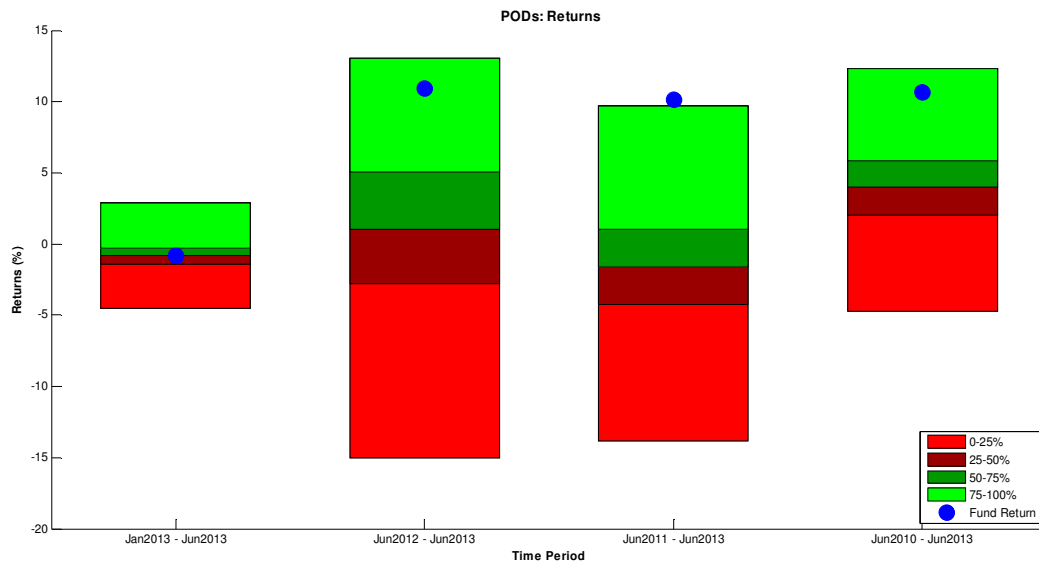


Figure 4.37: Return PODs for the Period 1 July 2010 to 30 June 2013– Stanlib Value Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

Figure 4.37 confirms the outperformance of the fund over the time periods longer than 12 months. The fund clearly took on a lot more risk over the six and 12 month periods. The additional risk is due to the foreign exposure and the currency risk associated with it.

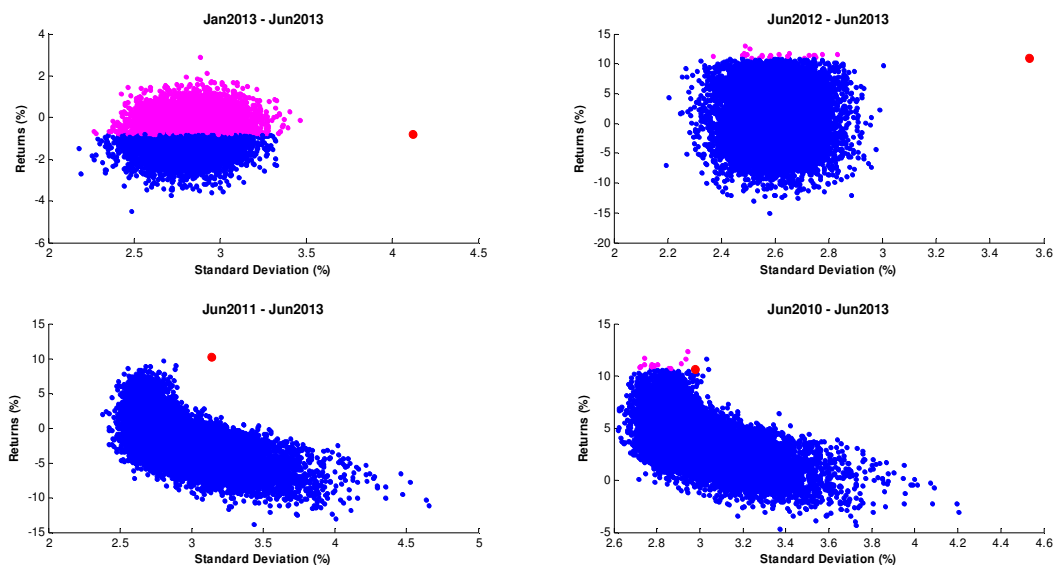


Figure 4.38: Comparing the Market Dynamics of Stanlib Value Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

The fund outperformed only 51.27 per cent of the simulated portfolios during the last six month interval. Over the 36 month interval the fund outperformed 99.84 per cent of the simulated portfolios.

The fund outperformed the simulated portfolios consistently but also took on more risk over the six and 12 month periods. During the 24 and 36 month period the fund had lower risk levels and higher returns.

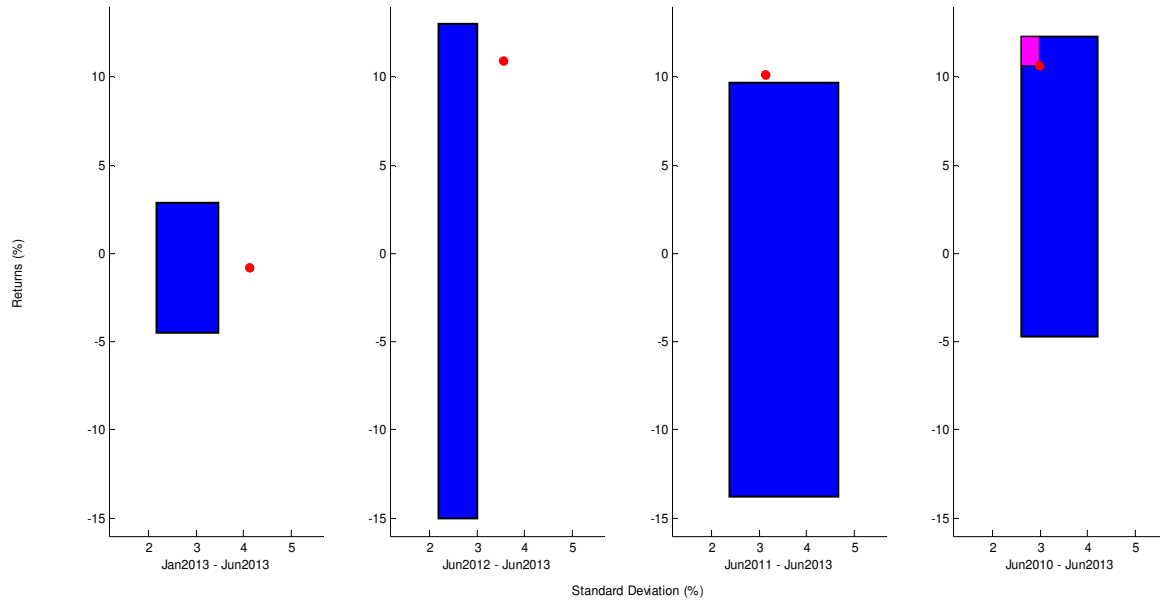


Figure 4.39: PODs - Comparing the Market Dynamics of Stanlib Value Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

The investment manager shows skill in setting up the fund's portfolio. The fund did not perform as well over the last six months, but overall the fund tends to outperform most of the simulated portfolios.

4.2.6 Summary: Value Funds

Table 4.1 contains a summary of the results discussed in Sections 4.2.1 to 4.2.5. It also contains the results of the performance evaluation based on the traditional methods over of the same evaluation period. Each fund is compared against its benchmark and also ranked based on its peers which were also evaluated in this section. The results of the PODs analyses are then summarized in four categories, namely: whether the fund followed its style mandate, the sectors in which the fund manager's show skill, the sectors in which the fund manager's does not show skill and lastly the overall skill of the manager.

Table 4.1: Value Funds - Benchmark, Peer Group and PODs Comparison

| | | Investec Value Fund | Momentum Value Fund | Nedgroup Investments Value Fund | Sanlam Investment Managers (SIM) Value Fund | Stanlib Value Fund |
|----------------------------|--|---|--|--|--|---|
| Traditional Methods | Return (%) | 2.90% | 3.10% | 11.70% | 12.40% | 10.70% |
| | Benchmark | ALSI: 14% | ALSI: 14% | Peer Group Comparison | ALSI: 14% | ALSI: 14% |
| | Benchmark Outperformed / Underperformed | Underperformed | Underperformed | N/A | Underperformed | Underperformed |
| | Peer Group Rank | 5 | 4 | 2 | 1 | 3 |
| PODs | Followed Style Mandate | Mostly value orientated, exposures are not consistent | Followed value mandate, exposures are consistent | Followed value mandate, exposures are consistent | Followed value mandate, exposures are consistent | Followed value mandate, exposures are relatively consistent |
| | Skill Sectors | Large value Small growth | Mid value Small growth | Large value Small core | Large value Small growth Small core Mid value | Large value Mid value |
| | No Skill Sectors | Small growth | Large value Small value | Mid core Small value | Mid growth | Mid core\Mid growth |
| | Overall Skill | No | No | Yes | Yes | Yes |

Note: All quoted returns are annualized returns over the three year evaluation period. The sectors in which the fund manager shows skill (or not) does not include all the sectors that the fund had exposure to. Only those sectors which show a notable skill indication (or lack thereof) are included in the table.

Despite the fact that all the funds underperformed the ALSI, Nedgroup Investments Value Fund, SIM Value Fund and Stanlib Value Fund performed quite well given the fact that the regulation requirements imposed on them were taken into consideration. The ALSI cannot be replicated due to the regulation requirements imposed on South African funds and therefore it is not surprising that the funds underperformed against the ALSI since the ALSI took on more risk due to the concentration of the index. The PODs analyses for these funds also indicated that their managers show skill in selecting the appropriate shares to be included in the portfolios and assigning the correct weights to said shares.

4.3 GROWTH FUNDS

Four growth funds are studied in this section. The funds to be studied are:

- FNB Momentum Growth Fund
- Investec Growth Fund
- Old Mutual Growth Fund

- Stanlib Growth Fund

As was mentioned in the previous section, the fund returns would traditionally be evaluated by comparing fund's return against the returns of the fund's benchmark or against the returns of its peers. Figure 4.40 shows the returns of the five growth funds against the ALSI.

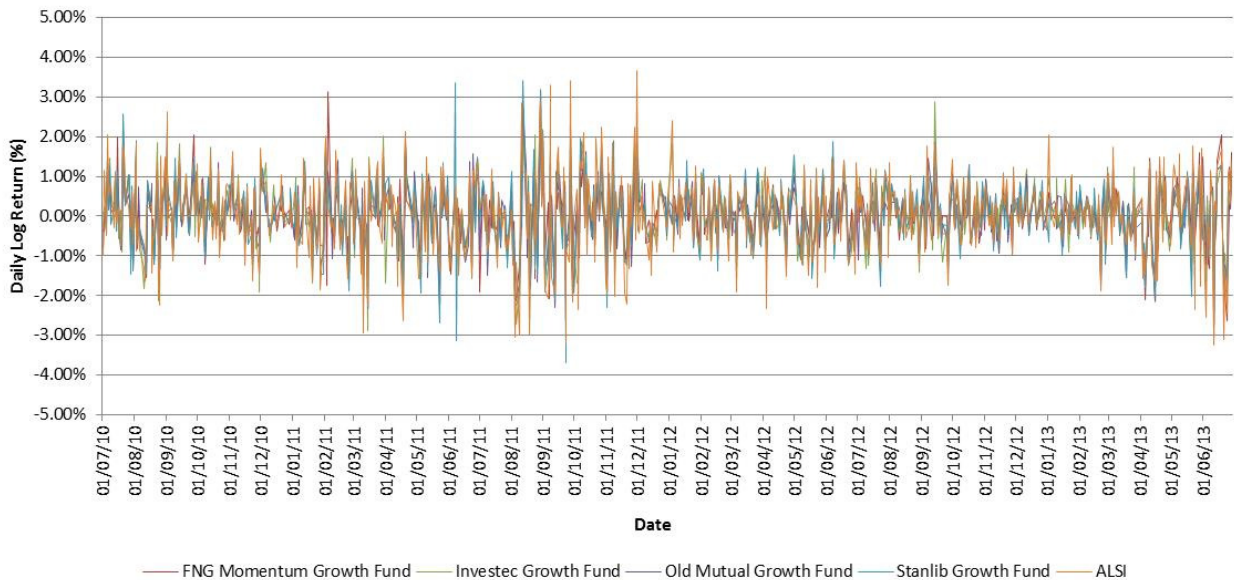


Figure 4.40: The Returns of the ALSI vs. The Growth Funds

The standard deviations of the funds and the ALSI are plotted as well.

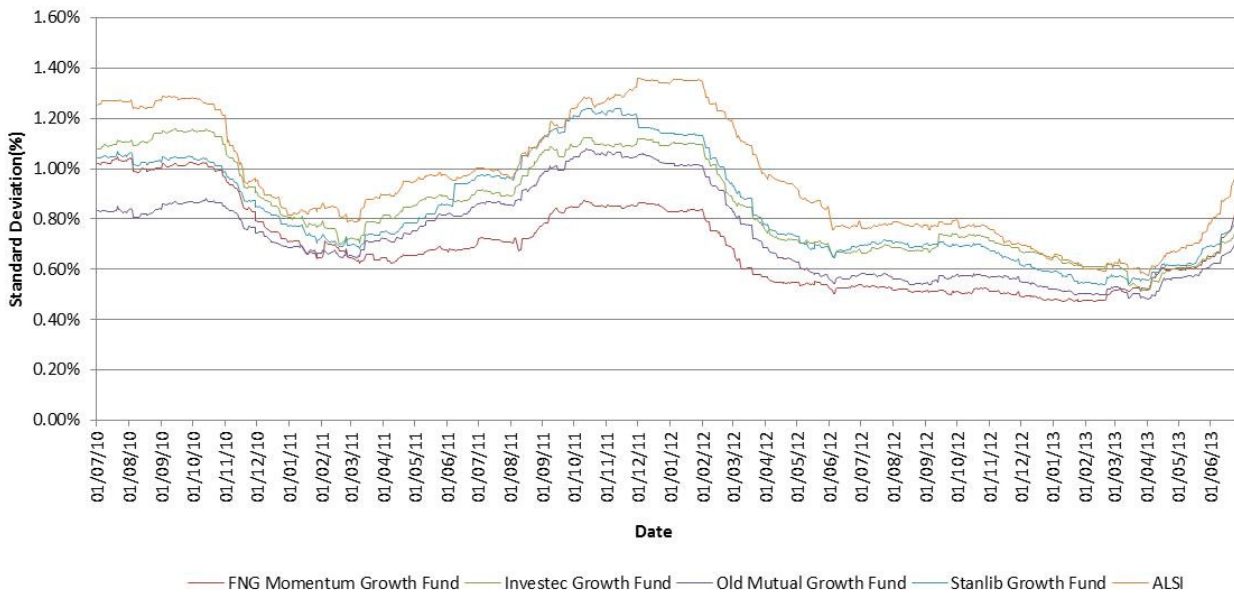


Figure 4.41: The Risk of the ALSI vs. The Growth Funds

The returns and standard deviations seem to move in unison. Once again it is impossible to make a conclusion with regards to the performance of the funds by studying the above graphs. In Figure

4.42 the annualized returns of the funds and the ALSI over the three year evaluation periods are compared against their corresponding standard deviations.

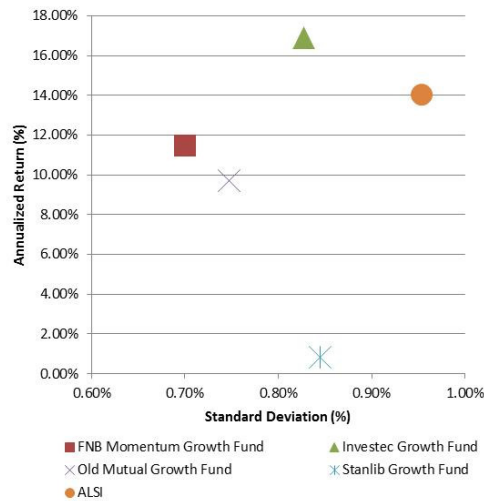


Figure 4.42: Comparing the Market Dynamics of the Growth Funds against that of the ALSI

The ALSI did not compare as well against the growth funds. The ALSI clearly took on more risk but also generated a lower return over the three year period. Coronation Optimum Growth Fund and Investec Value Growth Fund generated higher returns at lower risk levels making them more efficient than the ALSI. As was mentioned before, one possible explanation for the fact that the funds have lower risk levels is that they are less concentrated due to regulation requirements and are therefore less risky. As was done in the previous section, PODs will now be applied to study the above returns in more detail.

4.3.1 FNB Momentum Growth Fund

FNB Momentum Growth Fund is a domestic equity fund which uses the ALSI as a benchmark. On 30 September 2013 the fund had 90.26 per cent of its assets invested in domestic equities. The fund had 9.74 per cent of its assets invested in domestic cash and had no direct foreign investments.

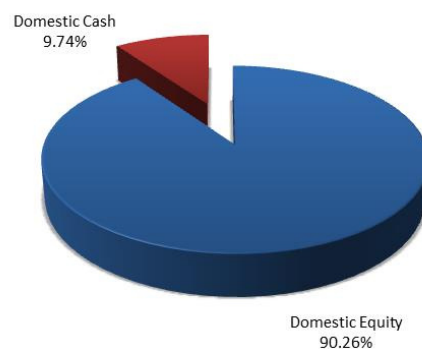


Figure 4.43: FNB Momentum Growth Fund Asset Allocation – 30 September 2013

Source: (Equinox)

The fund exposures remained relatively constant over time. The largest exposure were to the large value, large core, mid core and mid value sectors, which is not consistent with a growth style mandate.

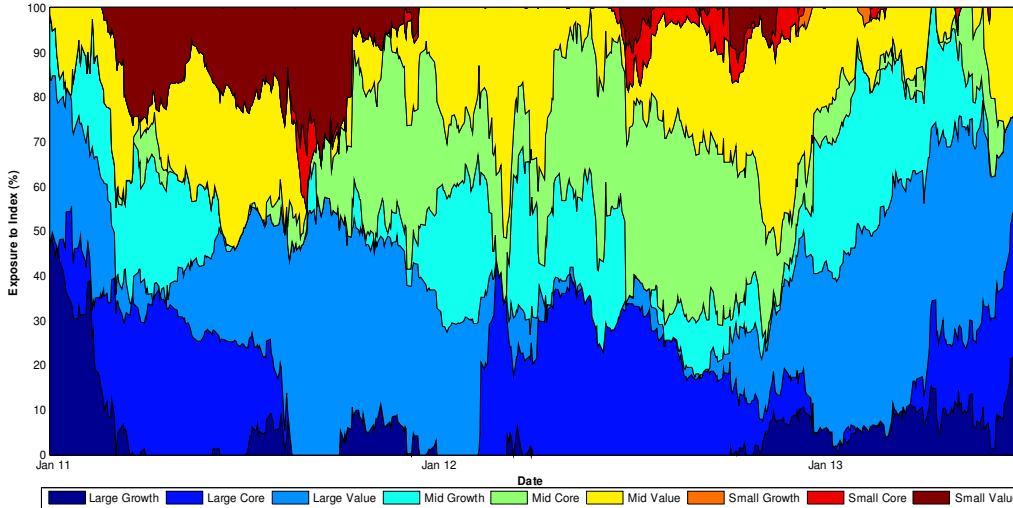


Figure 4.44: Exposure Distribution Area Graph from 1 July 2010 to 30 June 2013 – FNB Momentum Growth Fund

It is clear from the constant six month exposures in Figure 4.45 that the fund predominantly had exposures to the value and core sectors.

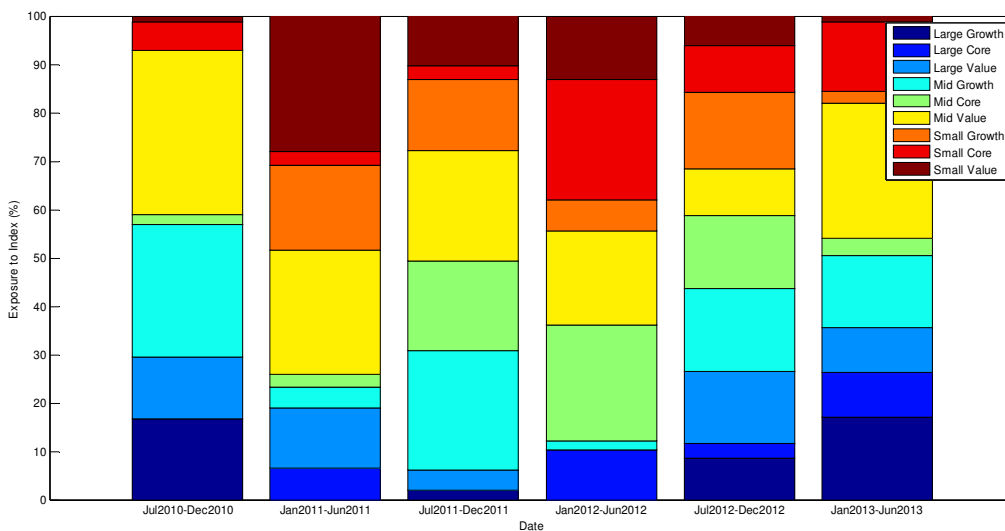


Figure 4.45: FNB Momentum Growth Fund Exposures between 1 July 2010 and 30 June 2013

The fund performed well in the mid value, large value and small core sectors. The fund however, did not perform as well in the large core, mid growth and mid core sectors.

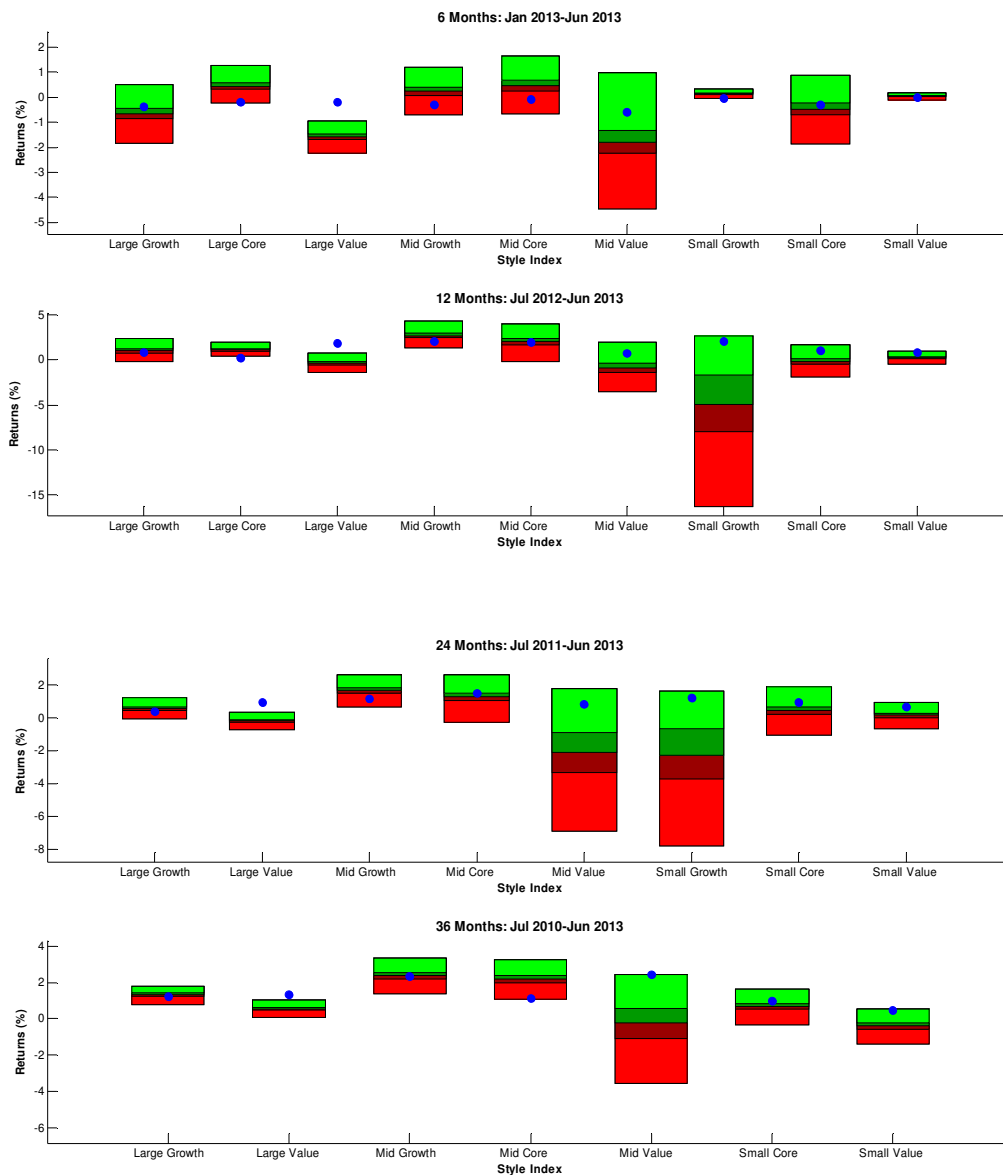


Figure 4.46: Surz Style Index PODs 1 July 2010 and 30 June 2013 - FNB Momentum Growth Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

The fund outperformed most of the simulated portfolios over time as can be seen in Figure 4.46. The fund managed to slightly outperform the simulated portfolios over the 12 and 36 month intervals. Although the fund did not perform as well during the last six months, the fund still managed to outperform most of the simulated portfolios.

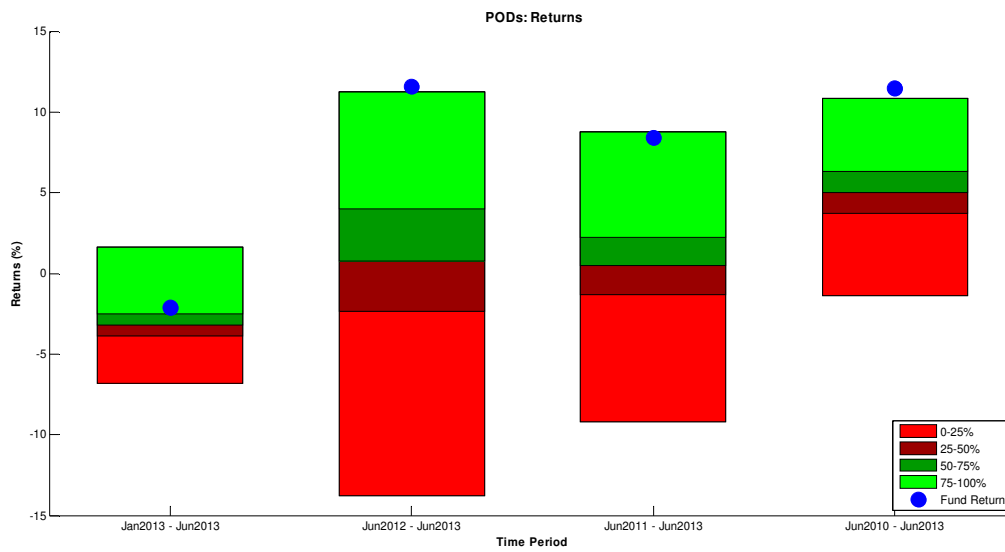


Figure 4.47: Return PODs for the Period 1 July 2010 to 30 June 2013– FNB Momentum Growth Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

Figure 4.47 clearly shows the outperformance. The fund also took on more risk for the periods of 12 months or shorter.

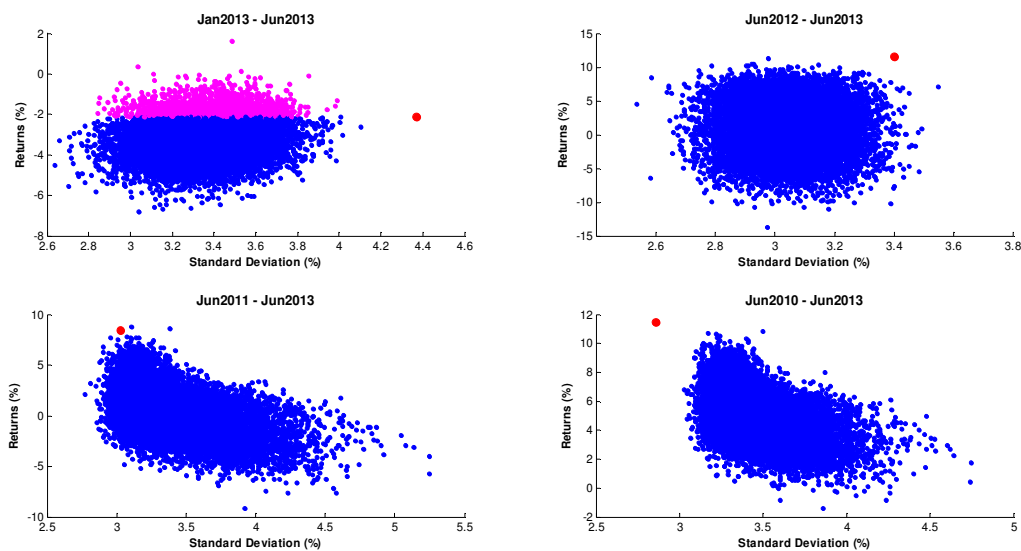


Figure 4.48: Comparing the Market Dynamics of FNB Momentum Growth Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

The fund outperformed 86.39 per cent of the simulated portfolios during the last six month interval and managed to outperform all of the simulated portfolios over the other intervals.

Figure 4.49 indicates that the fund performed very well when incorporating the risk and return in the PODs graph. The fund managed to consistently outperform over the longer time periods. During the last six months the fund generated a lower return at a higher risk level.

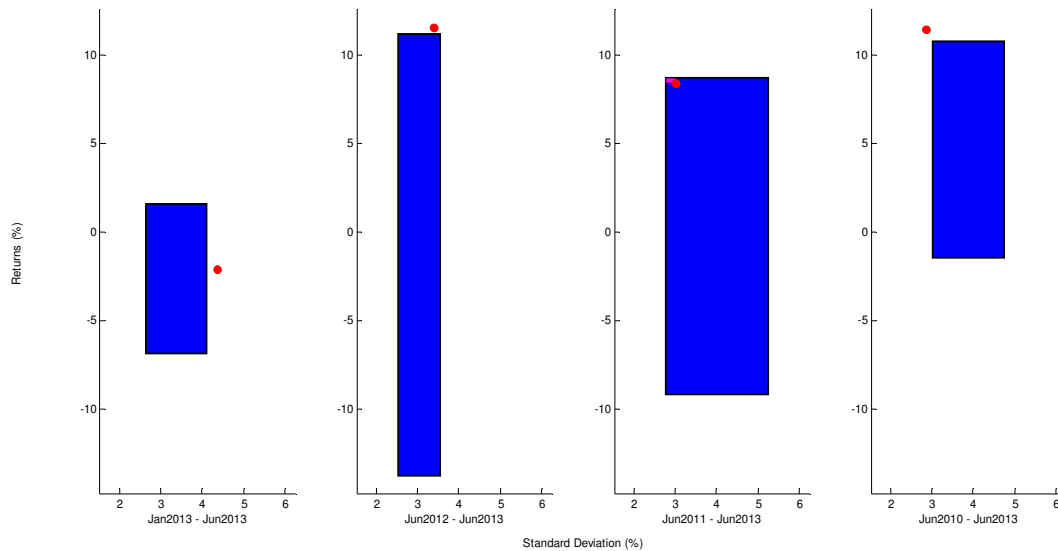


Figure 4.49: PODs - Comparing the Market Dynamics of FNB Momentum Growth Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

The investment manager shows skill in setting up the fund’s portfolio and assigning the appropriate weights to the selected shares. The fund did not perform as well over the last six months, but overall the fund tend to outperform most of the simulated portfolios.

4.3.2 Investec Growth Fund

Investec Growth Fund is a domestic equity fund which uses the ALSI as a benchmark. On 30 September 2013 the fund had 94.29 per cent of its assets invested in domestic equities and 5.71 per cent invested in domestic cash.

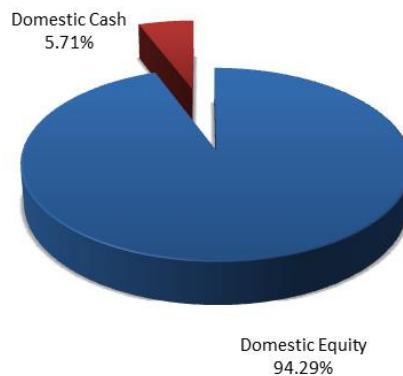


Figure 4.50: Investec Growth Fund Asset Allocation – 30 September 2013

Source: (Equinox)

The fund had quite a large exposure to the large value and large core sectors over the evaluation period.

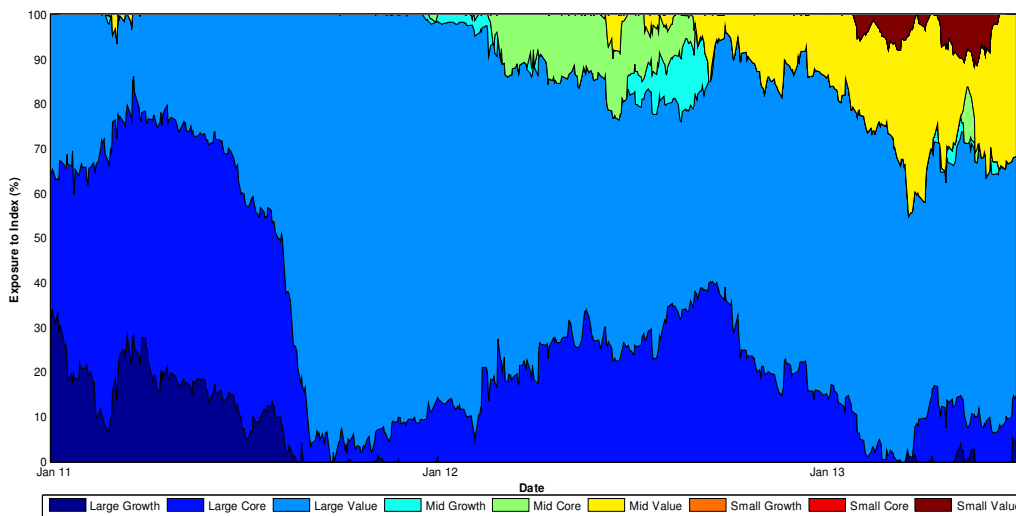


Figure 4.51: Exposure Distribution Area Graph from 1 July 2010 to 30 June 2013 – Investec Growth Fund

It is clear from the constant six month exposures in Figure 4.52 that the fund mostly had exposures to the value and core sectors. This is not consistent with a growth style mandate.

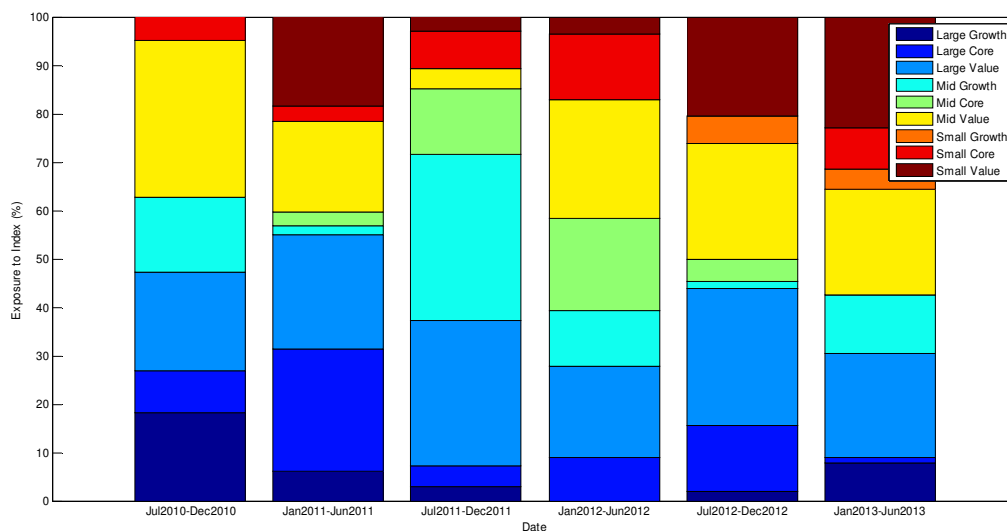


Figure 4.52: Investec Growth Fund Exposures between 1 July 2010 and 30 June 2013

The fund performed well in the large value, mid core and mid value sectors. The fund did not perform well in the large core sector since the returns mostly fell in the bottom quartiles.

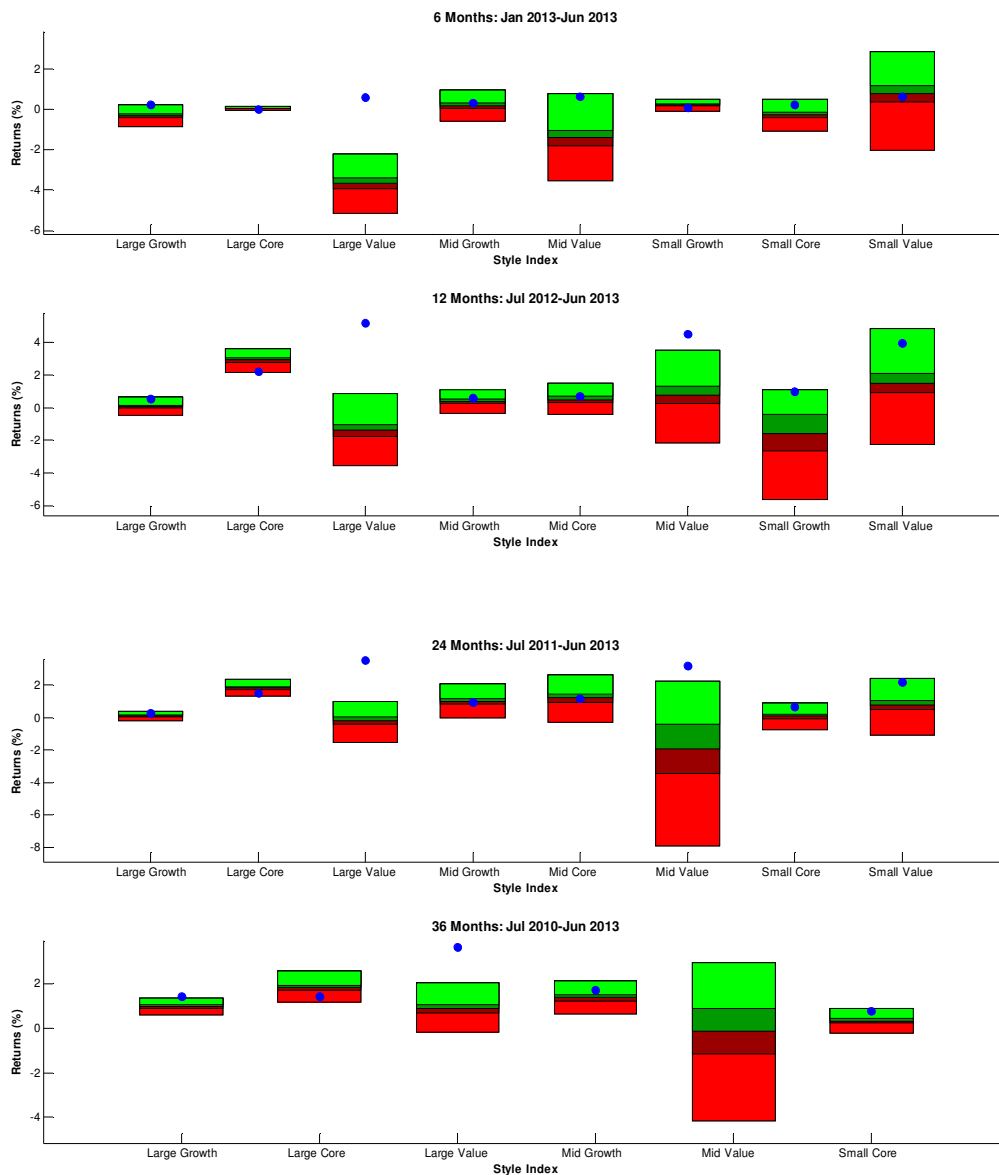


Figure 4.53: Surz Style Index PODs 1 July 2010 and 30 June 2013 - Investec Growth Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

The fund outperformed all of the simulated portfolios over time as can be seen in Figure 4.46. The return over the last six months is lower which can be due to the cash investment on 30 September 2013. The high returns over the longer time periods can be due to investments in other assets.

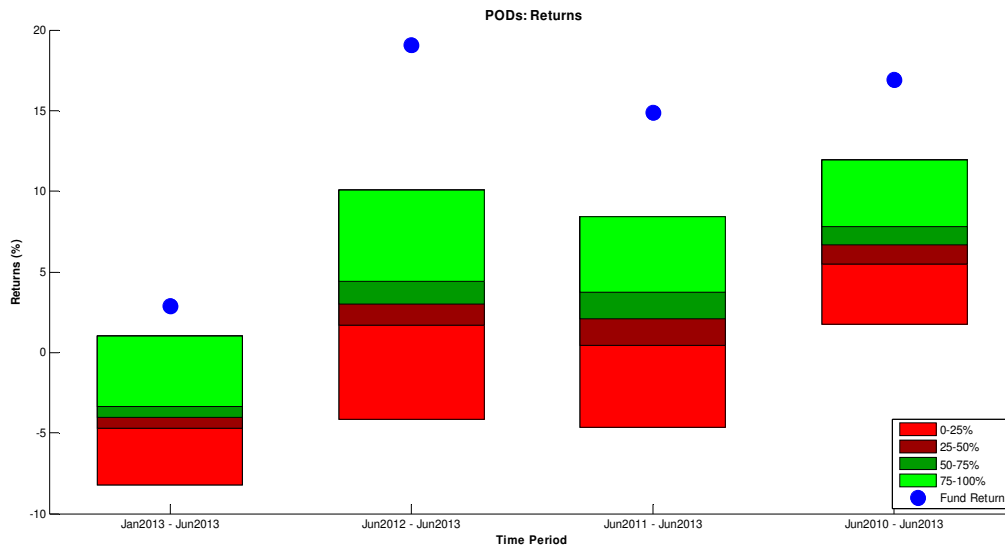


Figure 4.54: Return PODs for the Period 1 July 2010 to 30 June 2013– Investec Growth Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

Figure 4.55 clearly shows the outperformance. Just like the previous funds, the fund took on more risk over the last year.

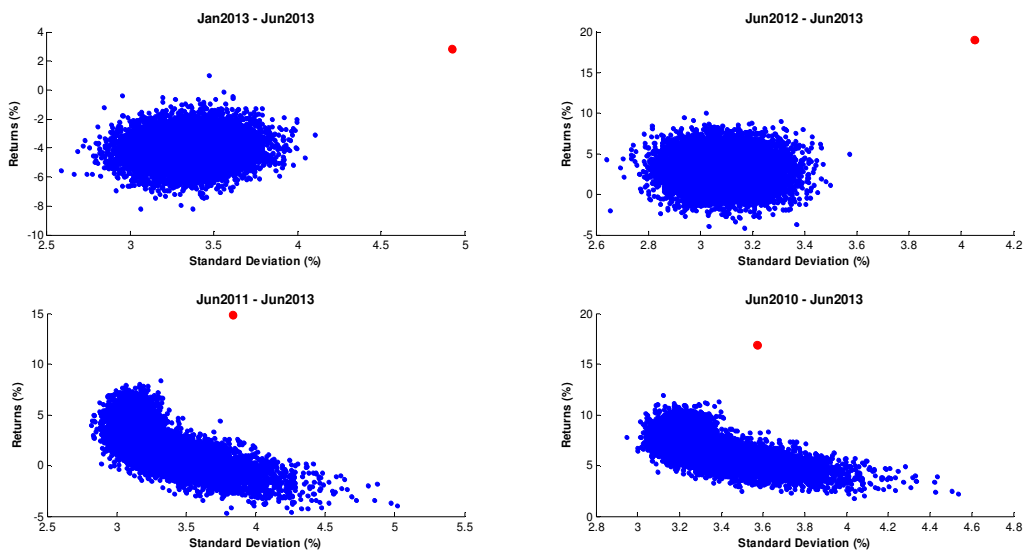


Figure 4.55: Comparing the Market Dynamics of Investec Growth Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

Figure 4.56 indicates that the fund performed very well when incorporating the risk and return in the PODs graph. The fund consistently outperformed all the simulated portfolios. During the last six months the fund generated a lower return in comparison with the previous periods and it was at a higher risk level.

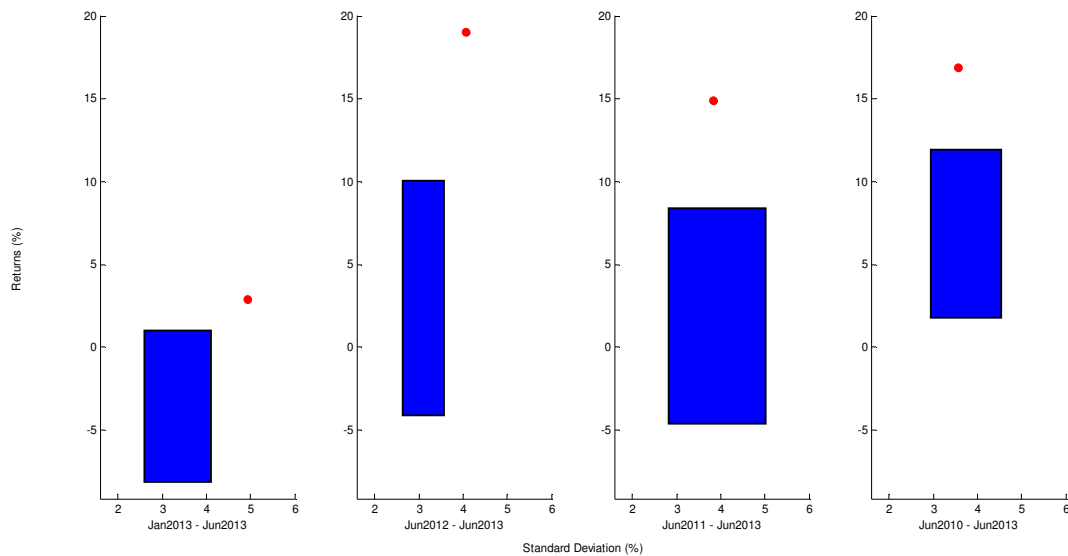


Figure 4.56: PODs - Comparing the Market Dynamics of Investec Growth Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

The results clearly indicates that the fund manager has skill in setting up the fund’s portfolio and assigning the appropriate weights to the selected shares since the fund consistently outperformed the simulated portfolios.

4.3.3 Old Mutual Growth Fund

Old Mutual Growth Fund is a domestic equity fund which uses the ALSI as a benchmark. On 30 September 2013 the fund had 86.66 per cent of its assets invested in domestic equities and 1.22 per cent invested in domestic cash. The fund had a 12.12 per cent exposure to foreign equities and therefore the fund also had exposure to the exchange rate which depreciated over the time period under evaluation.

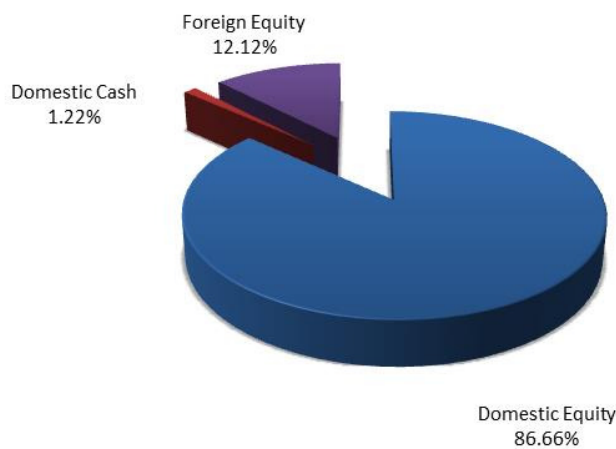


Figure 4.57: Old Mutual Growth Fund Asset Allocation – 30 September 2013

Source: (Old Mutual Growth Fund)

The fund had quite a large exposure to the large value sector over time. The fund also had a large exposure to the large value and small value sectors.

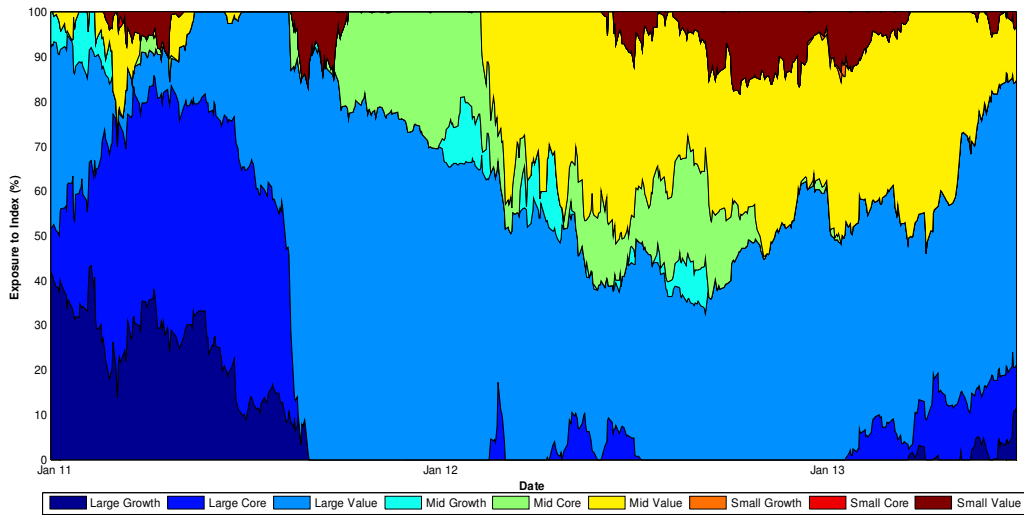


Figure 4.58: Exposure Distribution Area Graph from 1 July 2010 to 30 June 2013 – Old Mutual Growth Fund

It is clear from the constant six month exposures in Figure 4.58 that the fund mostly had exposures to the value sectors. The exposure results are not consistent with a growth style mandate.

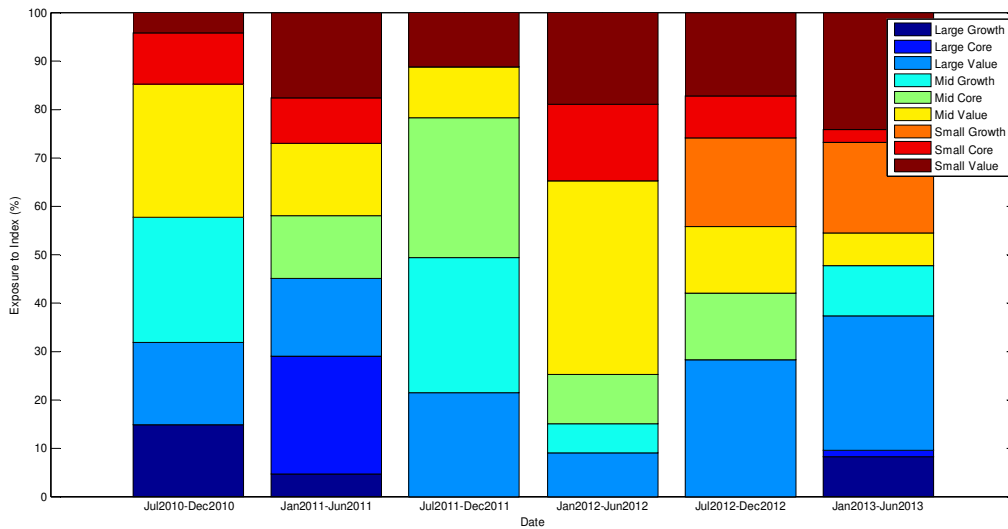


Figure 4.59: Old Mutual Growth Fund Exposures between 1 July 2010 and 30 June 2013

The fund performed well in the large value, mid value and small growth sectors. The fund returns mostly lie within the top quartile which indicates that the fund manager has skill in selecting shares from all sectors.

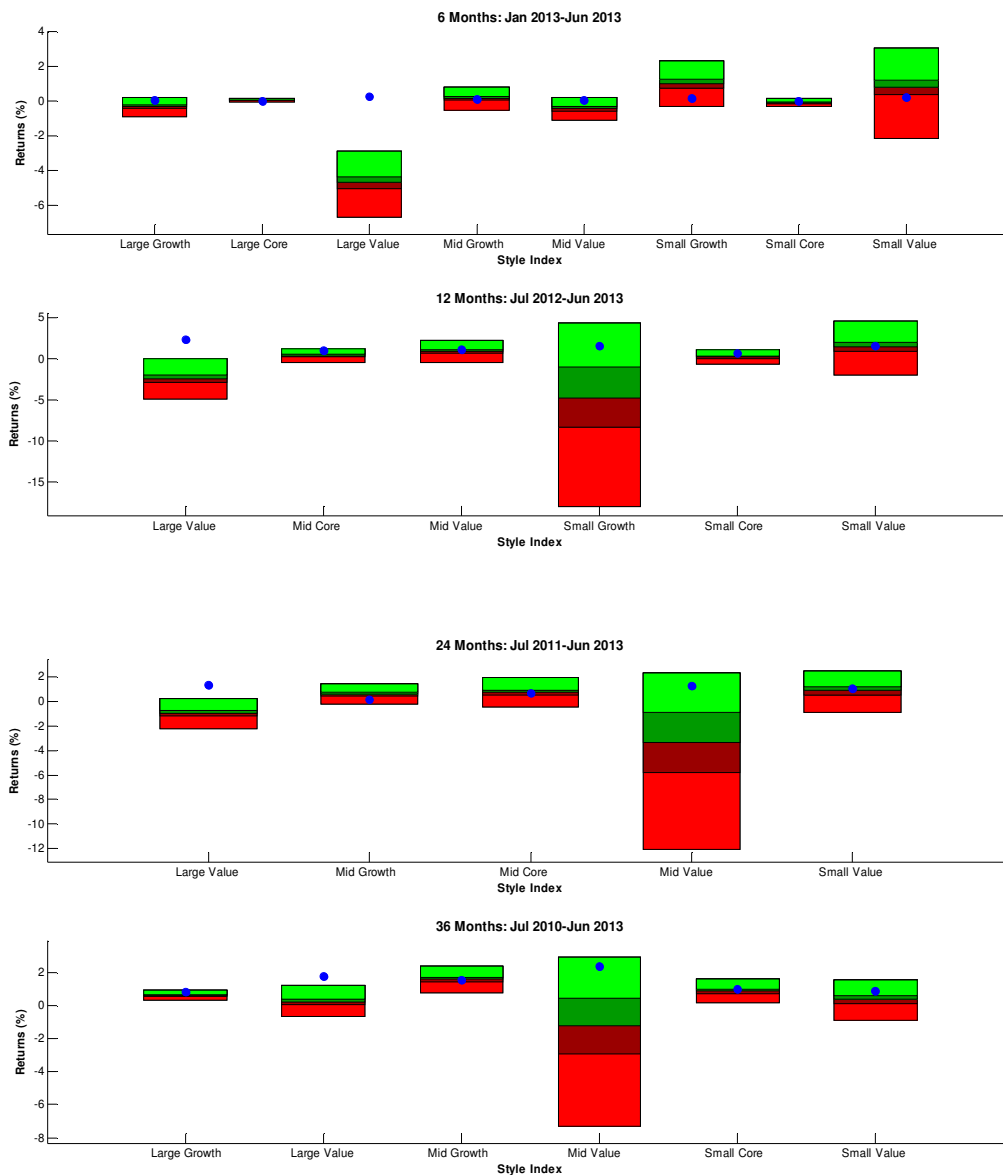


Figure 4.60: Surz Style Index PODs 1 July 2010 and 30 June 2013 - Old Mutual Growth Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

The fund managed to outperform most of the simulated portfolios over time since the returns consistently fell within the top quartile as can be seen in Figure 4.61.

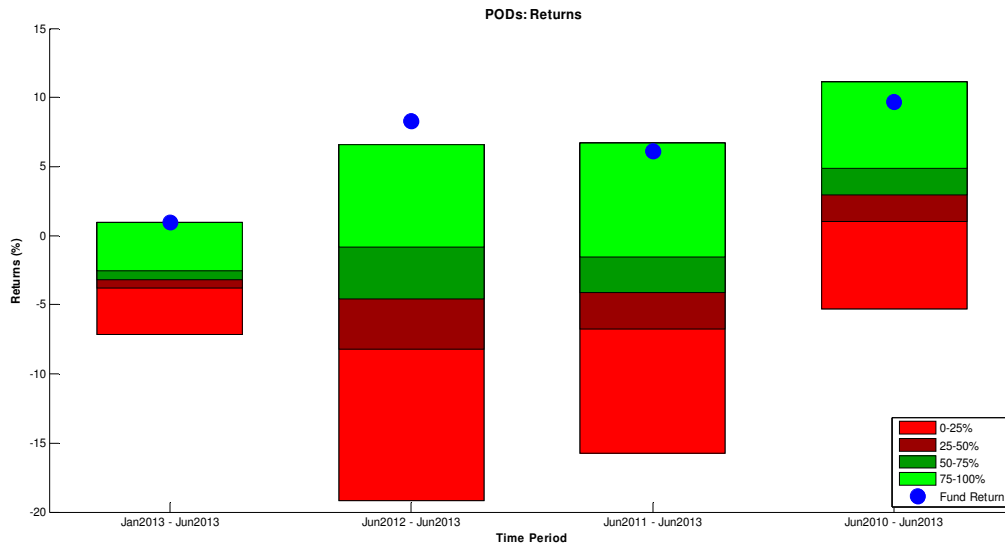


Figure 4.61: Return PODs for the Period 1 July 2010 to 30 June 2013– Old Mutual Growth Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

Figure 4.62 clearly shows the same outperformance as in Figure 4.61. The fund managed to generate higher returns and the risk levels were not as high as some of the simulated portfolios.

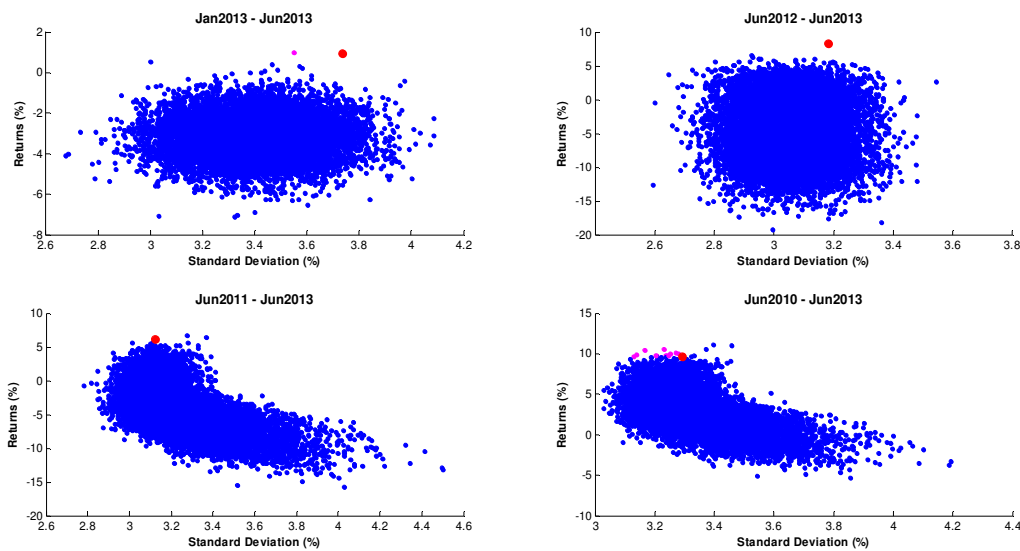


Figure 4.62: Comparing the Market Dynamics of Old Mutual Growth Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

Figure 4.63 indicates that the fund performed very well since the fund consistently outperformed most of the simulated portfolios.

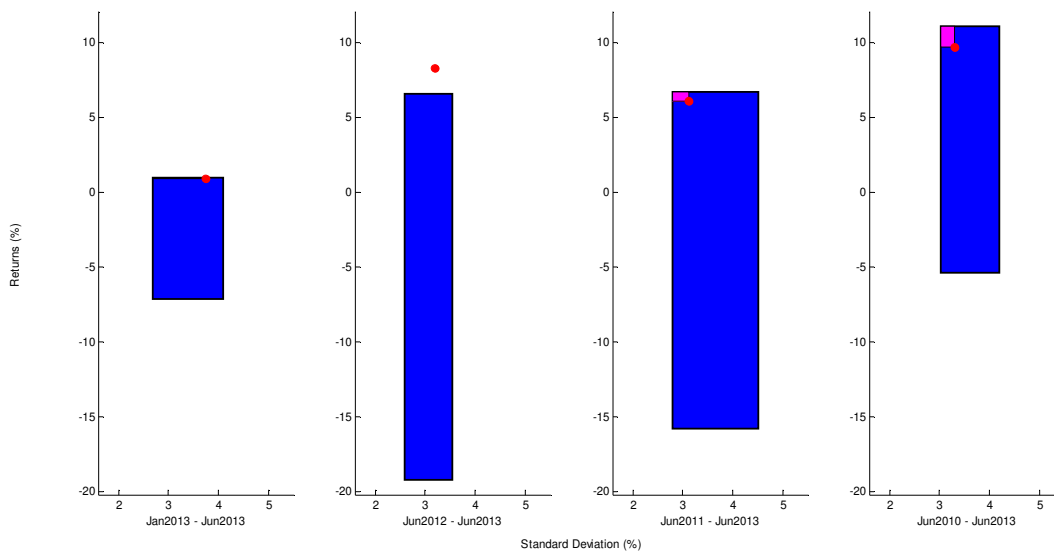


Figure 4.63: PODs - Comparing the Market Dynamics of Old Mutual Growth Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

The results clearly indicates that the fund manager has skill in setting up the fund’s portfolio and assigning the appropriate weights to the selected shares since the fund consistently outperformed most of the simulated portfolios.

4.3.4 Stanlib Growth Fund

Stanlib Growth Fund is a domestic equity fund which uses the ALSI as a benchmark. On 30 September 2013 the fund had 95.06 per cent of its assets invested in domestic equities and 2.38 per cent invested in domestic cash. The remaining 2.56 percent was invested in domestic preference shares.

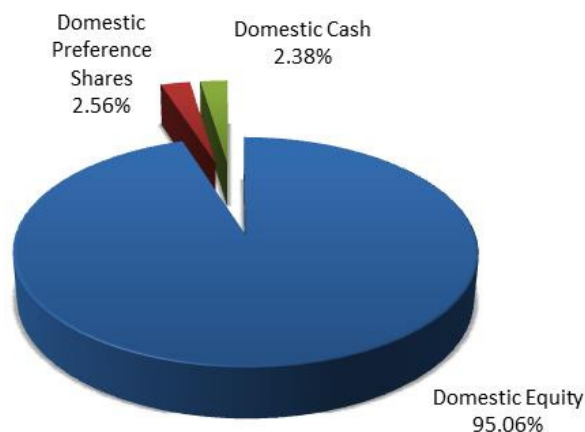


Figure 4.64: Stanlib Growth Fund Asset Allocation – 30 September 2013

Source: (Stanlib Growth Fund)

The fund had quite a large exposure to the large value and large core sectors over the evaluation period. The fund also had a relatively constant exposure to the mid value sector over the last half of the evaluation period.

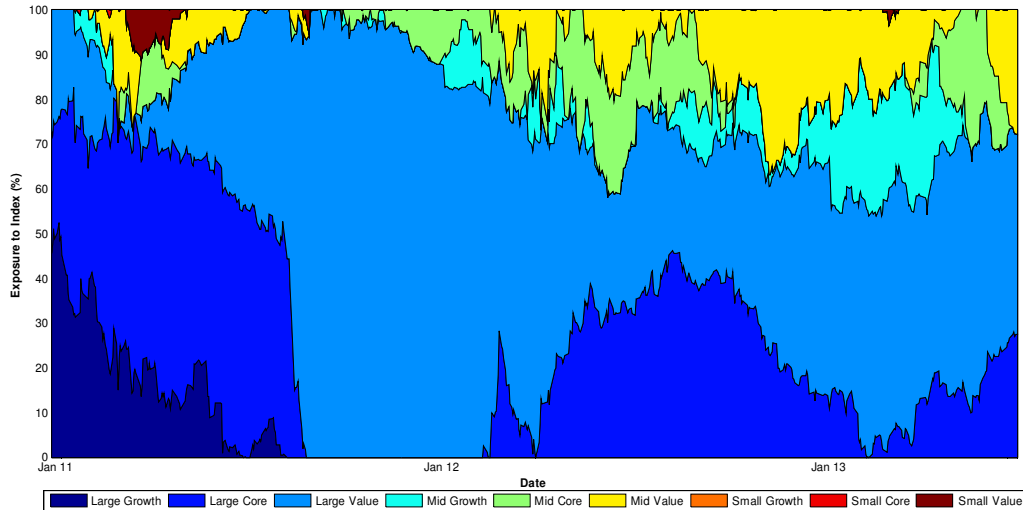


Figure 4.65: Exposure Distribution Area Graph from 1 July 2010 to 30 June 2013 – Stanlib Growth Fund

The constant six month exposures in Figure 4.66 indicate that the fund mostly had exposures to the value and core sectors. This is not consistent with a growth style mandate.

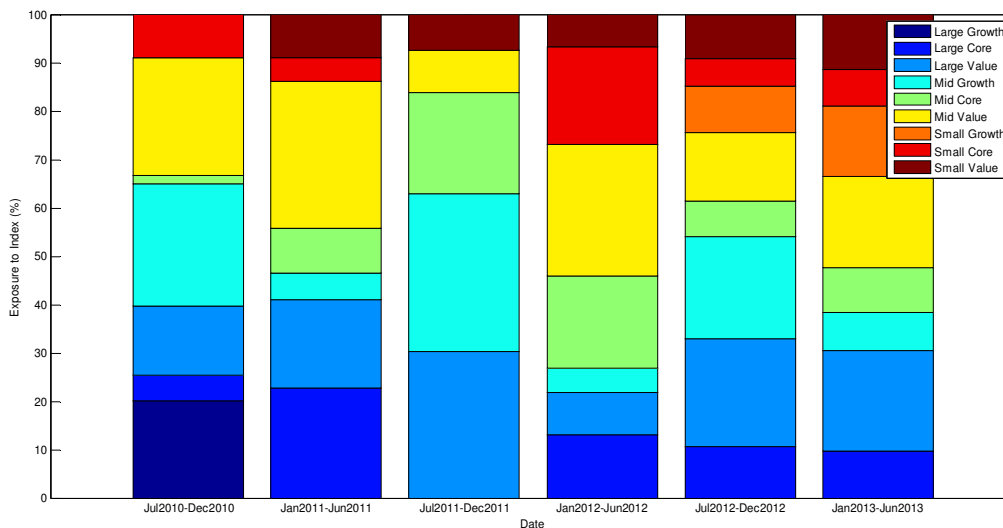


Figure 4.66: Stanlib Growth Fund Exposures between 1 July 2010 and 30 June 2013

The fund performed well in the large value and mid value sectors. The fund did not perform well in the large core sector since the fund underperformed the simulated portfolios. The fund did not perform well in the mid core sector either.

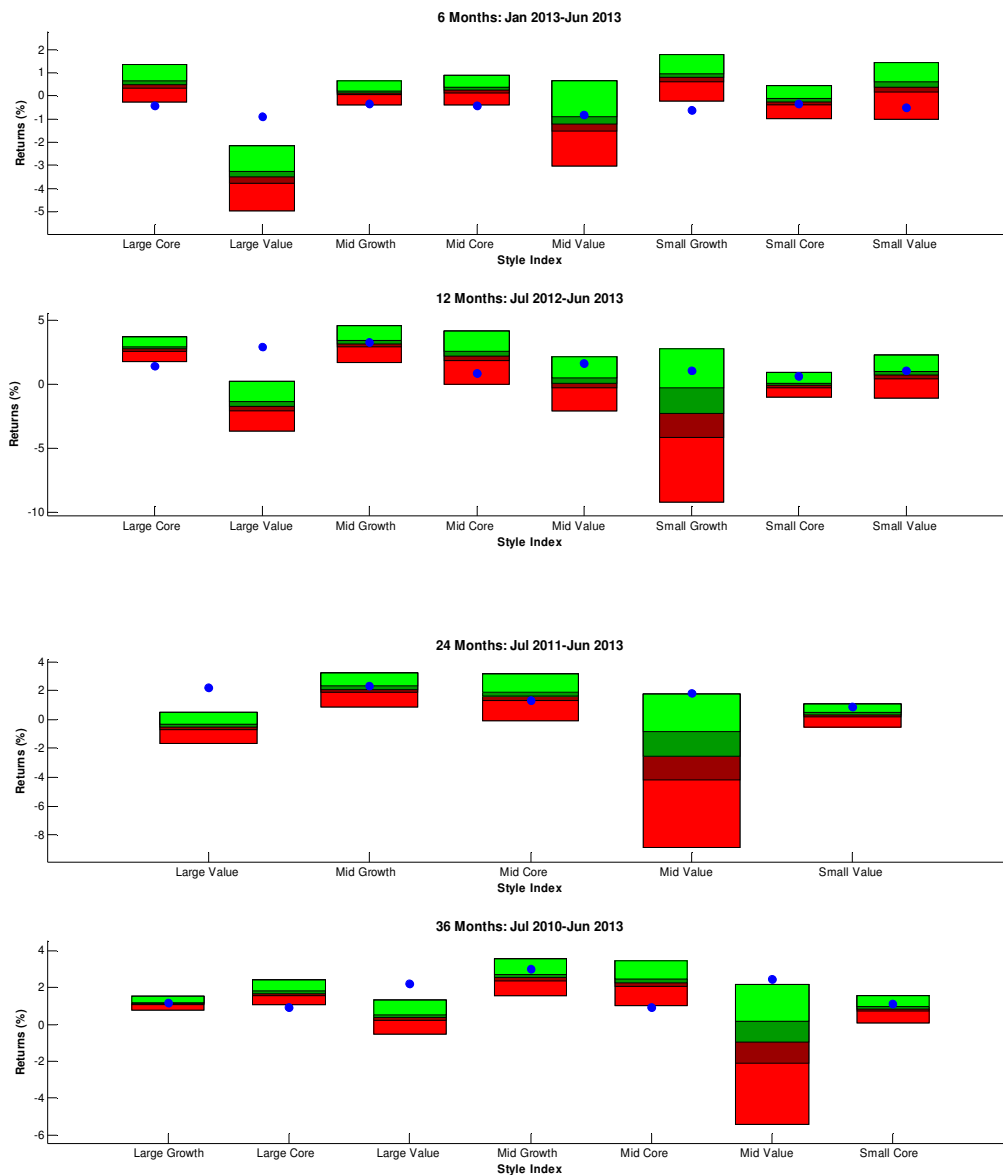


Figure 4.67: Surz Style Index PODs 1 July 2010 and 30 June 2013 - Stanlib Growth Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

The fund outperformed most of the simulated portfolios over the 12, 24 and 36 month periods. The fund however underperformed more than 75 per cent of the simulated portfolios in the last six months.

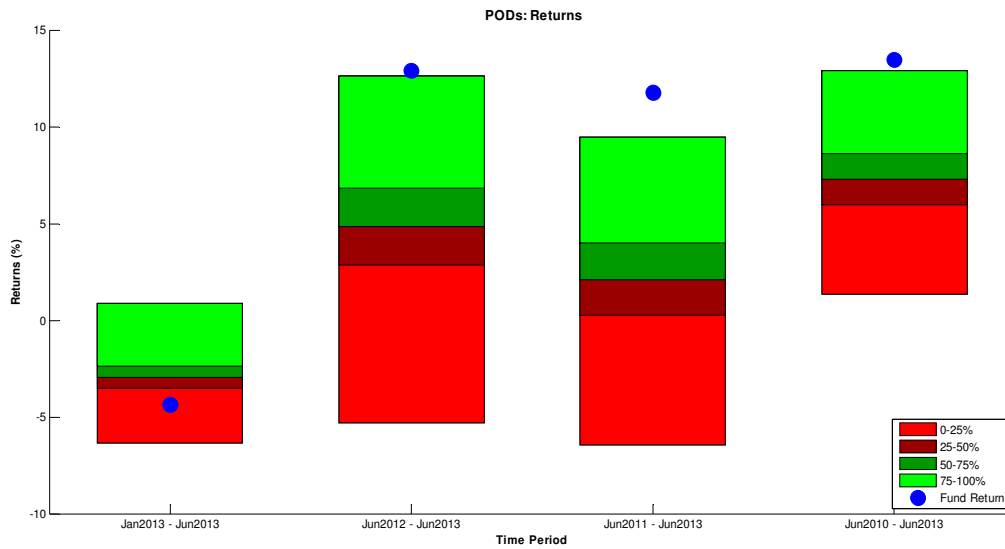


Figure 4.68: Return PODs for the Period 1 July 2010 to 30 June 2013– Stanlib Growth Fund

Note: The POD for the last six months is the effective semi-annual rate. All other rates are annualized.

Figure 4.69 clearly shows the outperformance over the 12, 24 and 36 month time intervals. Just like most of the previous funds, the fund took on more risk over the last year.

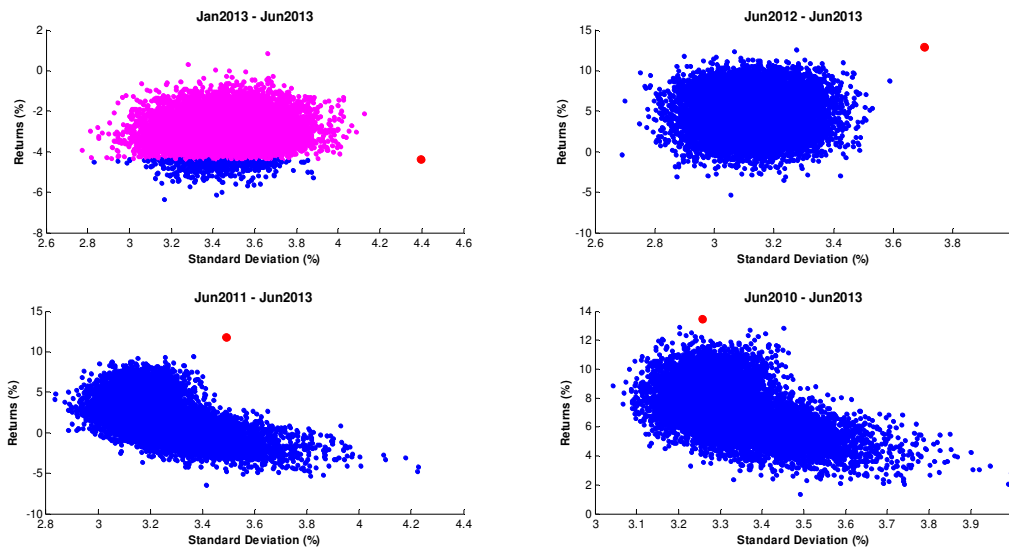


Figure 4.69: Comparing the Market Dynamics of Stanlib Growth Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

Figure 4.70 indicates that the fund performed very well over the 24 and 36 month periods since the fund generated higher returns and had lower risk levels than most of the simulated portfolios. The fund however, took on more risk over the last year and only managed to generate a corresponding high return over the 12 month time period.

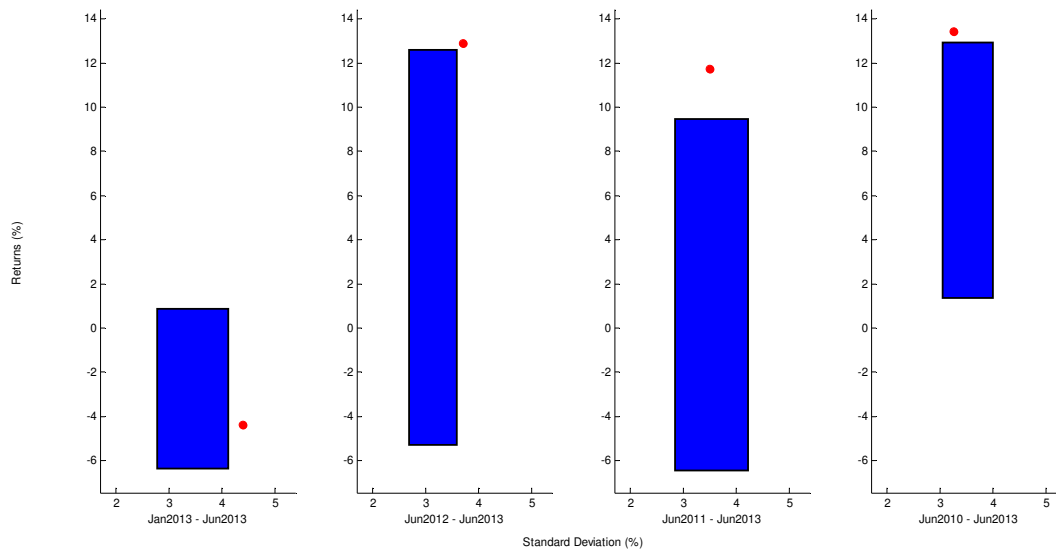


Figure 4.70: PODs - Comparing the Market Dynamics of Stanlib Growth Fund against that of the Simulated Portfolios - 1 July 2010 and 30 June 2013

The results clearly indicate that the fund manager has skill in setting up the fund's portfolio and assigning the appropriate weights to the selected shares since the fund consistently outperformed most of the simulated portfolios over the longer time periods. The fund did not perform as well during the last six months but this could be temporary.

4.3.5 Summary: Growth Funds

Table 4.2 is similar to Table 4.1 in Section 4.2.6. Table 4.2 contains a summary of the results discussed in Sections 4.3.1 to 4.3.4 as well as results of the performance evaluation based on the traditional methods.

Table 4.2: Growth Funds - Benchmark, Peer Group and PODs Comparison

| | | FNB Momentum Growth Fund | Investec Growth Fund | Old Mutual Growth Fund | Stanlib Growth Fund |
|----------------------------|--|--|---|---|---|
| Traditional Methods | Return (%) | 11.46% | 16.89% | 9.70% | 13.45% |
| | Benchmark | ALSI: 14% | ALSI: 14% | ALSI: 14% | ALSI: 14% |
| | Benchmark Outperformed / Underperformed | Underperformed | Outperformed | Underperformed | Underperformed |
| | Peer Group Rank | 3 | 1 | 4 | 2 |
| PODs | Followed Style Mandate | Mostly value orientated, exposures are relatively consistent | Mostly value orientated, exposures are consistent | Mostly value orientated, exposures are consistent | Mostly value orientated, exposures are consistent |
| | Skill Sectors | Mid value Large value Small core | Large value Mid core Mid value | Large value Mid value Small growth | Large value Mid value |
| | No Skill Sectors | Large core Mid growth Mid core | Large Core | N/A | Large core Mid core |
| | Overall Skill | Yes | Yes | Yes | Yes |

Note: All quoted returns are annualized returns over the three year evaluation period. The sectors in which the fund manager shows skill (or not) does not include all the sectors that the fund had exposure to. Only those sectors which show a notable skill indication (or lack thereof) are included in the table.

Investec Growth Fund was the only fund to outperform the ALSI. The other growth funds performed quite well if the regulation requirements imposed on them is taken into account. The PODs analyses indicated that none of the funds in Table 4.2 truly followed a growth mandate. The results could however, be influenced by the returns of the investments that are not domestic equity investments. The managers all showed skill in selecting shares to be included in the portfolios of the funds and assigning weights to these shares.

4.4 SUMMARY

The results were inconclusive in proving that the PODs methodology is superior to the traditional performance evaluation methods since most of the funds had substantial amounts of their assets invested outside the domestic equity market. The results did, however, provide a lot more insight in the performance of the funds than the traditional methods and therefore the possibility that it could be superior should not be excluded.

In order to test the hypotheses with certainty the holdings data of each fund is required in order to calculate each fund's return for its domestic equity investment. By doing so, it is possible to exclude the returns of all other asset classes from the analyses and to only work with the returns of the domestic equities. The MATLAB program written for the PODs analyses proved to be very useful and can easily be adjusted to incorporate the holdings data in the analyses.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

Investors have been using the traditional performance evaluation methods such as peer group comparisons and Broad-Market Indices for years. There are however many biases and other problems (e.g. concentration) related to the use of these methods as was discussed in Section 2.3 of Chapter 2. The biases and problems underlying the traditional evaluation methods could lead to the results of the analyses based on these methods to be incorrect. R.J. Surz therefore proposed the new method called PODs, which aims to eliminate some of the biases and problems that arise when using the traditional methods. This paper compares the traditional performance evaluation methods against Portfolio Opportunity Distributions (PODs) for the South African market. The purpose of the comparison is to determine which method is superior when evaluating a fund.

The PODs of a fund is based on its own unique opportunity set. The opportunity set is set up based on the fund's style mandate, regulation requirements and any other constraints imposed on the fund. The fund's style exposure to the nine Surz Style Indices is determined and then the fund's opportunity set is created based on this style mandate. The style exposure is determined by applying the Returns-Based Style Analysis methodology to the returns of the fund and the Surz Style Indices over various evaluation periods.

PODs create a range of possible returns that the fund could have achieved given its opportunity set by simulating thousands of portfolios based on said opportunity set. The corresponding range of possible standard deviations represents the risk that was taken to achieve the returns. Together, the return and risk of the portfolios create a range of possible investment outcomes. The performance of the fund is compared against the return and risk of the simulated portfolios for each evaluation period. This is done in order to determine how well (or poorly) the fund performed given all the outcomes it could have achieved.

A lot of the information that remains hidden when using the traditional methods is unlocked when PODs are applied. When comparing the performance of a fund against that of a Broad-Market Index, it is only possible to determine how the fund performed against one other possible outcome. In fact, in South Africa the ALSI is used as a Broad-Market Index and it is not even an investable portfolio since the fund cannot replicate it due to various reasons. One such reason is the concentration problem. With peer group comparison it is possible to compare the performance of the fund against the performance of funds with similar mandates. It is however easy to influence the outcome by selecting different funds to be included in the peer group. There are also various other problems related to the use of peer group comparisons and Broad-Market Indices.

When using PODs, the fund is compared against thousands of other portfolios and it is not possible to influence the results as is the case with peer group comparisons. Furthermore, the portfolios are investable since they are based on the fund's own opportunity set and the constraints imposed on the fund are also incorporated. It is therefore possible to determine how the fund compared against thousands of other portfolios that the fund could have actually invested in.

The fund manager's ability to consistently outperform (or underperform) most of the simulated portfolios can also be determined. This is done by dividing the range of possible investment outcomes into quartiles. A fund manager who consistently falls in the top quartile shows skill since the fund is performing well. The opposite is true for a fund manager that consistently falls in the bottom quartile. It is therefore possible to determine the skill of the manager by applying the PODs methodology. This is not possible with the traditional methods.

5.2 SUMMARY OF MAIN FINDINGS

It is impossible to conclude with certainty whether the PODs methodology is truly superior to the traditional methods due to the investment of the funds in foreign and other asset classes. The results do however show that the PODs methodology provides much more insight in the performance of the fund, which part of the fund's return is attributable to the exposure it has to a certain index and the skill of the fund's manager.

The program created in MATLAB to set-up the PODs methodology can, however, still be used to test whether PODs is superior. In order to test the methodology the holdings data of the funds are required. The holdings data can be used to calculate the returns of the funds that specifically relate to their domestic equity investments. These returns can be used together with the program provided in Appendix B to retest the hypotheses stated in Section 1.4.

5.3 PRIORITIES GOING FORWARD

PODs provide investors and fund managers with a different performance evaluation method which eliminates some of the most crucial problems related to the use of the traditional methods. Furthermore, it provides the user with a lot more information regarding the fund's performance and the manager's skill which is not possible when applying the traditional methods.

Firstly, the fund's style mandate is determined over time. This can be compared against the style mandate as set out in the fund's Investment Policy Statement (IPS) in order to determine whether the fund really followed the style mandate as stated in the IPS. Secondly, the fund's performance is compared against a range of possible performance outcomes that it could have achieved given its opportunity set. This provides the user with a good indication of the fund's ability to consistently perform well (or poorly) given the opportunities available to the fund. Thirdly, since the fund's performance is compared against all the possible performance outcomes it could have achieved, it

is possible to determine the skill of the manager in selecting the shares to be included in the fund's portfolio and the manager's ability to consistently outperform (or underperform) most of the portfolio opportunities available in the market.

The priority going forward is to obtain the holdings data of funds and to retest the hypotheses based on the holdings data since the PODs methodology clearly shows potential to be the superior performance evaluation method. If PODs prove to be superior the next step will be to see the implementation of PODs in the portfolio management process in South Africa.

5.4 FURTHER RESEARCH

In this study only five value and five growth funds were compared. There are, however, funds with different mandates such as small cap funds, funds who only invest in financial or industrial stocks, etc. These funds can be studied as discussed in this research paper.

There are also various other constraints applicable to funds, such as tax constraints, risk constraints, special circumstance constraints imposed by the fund managers etc. Further research can be done where these constraints are also included in the analyses.

The evaluation period consists of a 3 year period for which the monthly constituent data is available as provided by the JSE. A longer period can be used as new monthly data becomes available.

The research can also be extended to similar developing countries in the world. By doing so, it will be possible to determine whether the exact same methodology produces similar results for countries with a similar investment industry.

The PODs in this research paper only includes South African equities. The funds however invest in other assets such as equities from other countries, cash, etc. as well. This could have a big effect on the returns. In order to really evaluate the performance of each fund's domestic equity investment the holdings data of each fund is required. Another option is to include the other asset classes and their returns in the study. Such a study would however be extremely large and intricate and should rather be considered on a doctoral level.

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APPENDIX A: Data Analysis

The shares in the following table were not included since the data were unavailable on INet.

Table A.1: Unavailable Information

| Ticker | Company | Time on Index Coinciding with the Evaluation Period |
|---------------|------------------------------------|--|
| CSO | Capital Shopping Centres Group Plc | June 2010 - June 2013 |
| DLT | Delta Property Fund | December 2012 - June 2013 |
| FOS | Foschini | June 2010 - Augustus 2010 |
| GDF | Gold Reef Resorts | June 2010 - February 2011 |
| HVL | Highveld Steel | June 2010 |
| MET | Metropolitan Holdings | June 2010 - October 2010 |
| SGL | Sibanye Gold | February 2013 - June 2013 |

APPENDIX B:

Code

This appendix refers to the MATLAB code used for the analyses. The methodology is implemented with the use of MATLAB via various sub-programs which is grouped together in three sections. The first part is the simulation of all the possible portfolios available in the market given the regulation requirements. The second part of the methodology relates to each specific fund. The exposure of the fund to the nine Surz Style Indices is determined and then these exposures along with the simulation results are used to create the inputs for the PODs graphs. The last part creates the various output graphs.

Table A.1 contains the various functions grouped together in the three sections mentioned above. A short description of what the function does is given as well.

Table B.1: Summary of the MATLAB Functions and its Implementation in the Analyses

| | | Description | Programme | Appendix |
|---------------|--------|--|----------------------|-----------------|
| Part 1 | Step 1 | The first step is to divide the data set into the nine Surz Style Indices. | StyleIndices | B.1.1 |
| | Step 2 | The next step is to simulate a weight for each one of the constituents in the nine Surz Style Indices. | SimPort | B.1.2 |
| | Step 3 | This function repeats the SimPort function for the various periods under evaluation, thus creating nine indices consisting of 10,000 random portfolios, each consisting of 36 monthly returns over a three year period. | SimMatrices | B.1.3 |
| Part 2 | Step 1 | The first function in this section calculates the daily returns for the constituents listed on each of the nine Surz Style Indices based on the market cap weights. | StyleIndicesExposure | B.2.1 |
| | Step 2 | The second function repeats the previous function for all the days in the evaluation period. The “quadprog” function is then implemented to obtain the fund exposures. A matrix containing the semi-annual exposures along with a corresponding graph is returned as output together with a rolling period exposure distribution area graph. | StyleIndexWeights | B.2.2 |
| | Step 3 | Matrices containing the returns and standard deviations of the simulated portfolios based on the fund’s exposure to the Surz Style Indices are created along with the fund’s returns and standard deviations. | FM | B.2.3 |
| Part 3 | Step 1 | This function produces the PODs graph in Figure 2.13. | PODS | B.3.1 |
| | Step 2 | The returns of the fund and the simulated portfolios can be broken down based on the fund’s exposure to the Surz Style Indices. This function produces PODs graphs indicating the breakdown of the returns produced by the previous function. | SurzPODS | B.3.2 |
| | Step 3 | This function compares the standard deviations and returns of the simulated portfolios and the fund in an ‘efficient space’. | RiskReturn | B.3.3 |
| | Step 4 | The PODs graphs and the graph produced by the previous function are combined in this function thus producing PODs that indicate the ‘efficient space’ for each evaluation period. | RiskReturnPODS | B.3.4 |

The following table contains the names of the input data sets along with a short description of what it contains. The code will refer back to these names.

Table B.2: Input Data Sets

| Variable | Description |
|--------------------|---|
| ConstDates | A 39×1 vector containing the monthly dates on which the constituents are available as listed on the ALSI. The monthly dates starts on 24 March 2010 and ends on 28 June 2013. |
| ConstPos | A 266×39 matrix, where each column contains the constituents listed on the ALSI on the dates which correspond with the ConstDates vector. |
| ReturnDates | An 817×1 vector containing the daily dates on which the returns of the constituents are known. |
| MCapDaily | A 266×817 matrix, where each column contains the daily market cap of each constituent which corresponds with the dates in the ReturnDates vector. |
| Aggress | A 266×817 matrix, where each column contains the daily aggressiveness measure of each constituent which corresponds with the dates in the ReturnDates vector. |
| FundRet | An 817×1 vector containing the daily returns of the fund under evaluation. |
| MCap | A 266×39 matrix, where each column contains the market cap of the constituents on the dates which correspond with the dates in the ConstDates vector. |
| NrConst | A 39×1 vector containing the number of constituents listed on the dates in the ConstDates vector. |
| Returns | A 266×817 matrix, where each column contains the returns of the constituents which correspond with the dates in the ReturnDates vector. |

The following functions should be run in MATLAB once the data sets in Table B.2 are created and the functions set out in the rest of the appendix are saved in MATLAB. The functions mentioned in Table B.1 which are not mentioned in Table B.3 are used as well, but they do not have to be run since the functions in Table B.3 uses these functions in their calculations.

Table B.3: Functions to be run in MATLAB

| | Function | Description |
|---------------|--|---|
| Step 1 | <code>[SLG, SLC, SLV, SMG, SMC, SMV, SSG, SSC, SSV] = SimMatrices(MCap, NrConst, ConstPos, Aggress, ConstDates, ReturnDates, Returns);</code> | Simulates the 10,000 random portfolios. |
| Step 2 | <code>[IndexCoeff] = StyleIndexWeights(MCapDaily, NrConst, ConstPos, Aggress, ConstDates, ReturnDates, Returns, FundRet)</code> <code>[LG, LC, LV, MG, MC, MV, SG, SC, SV, FinalRet, StdDev, FRet, FRSurz, FStdDev] = FM(SLG, SLC, SLV, SMG, SMC, SMV, SSG, SSC, SSV, IndexCoeff, FundRet, ConstDates, ReturnDates);</code> | Creates the fund specific data sets. |
| Step 3 | <code>PODS(FinalRet, FRet)</code> <code>SurzPODS(LG, LC, LV, MG, MC, MV, SG, SC, SV, FRSurz, IndexCoeff)</code> <code>[Perc] = RiskReturn(FinalRet, StdDev, FRet, FStdDev)</code> <code>RiskReturnPODS(FinalRet, StdDev, FRet, FStdDev)</code> | Creates the output. |

Step 1 is repeated only once since all the graphs are based on the same simulation set. Steps 2 and 3 are repeated for each fund. The rest of the appendix contains the code sorted as indicated in Table B.1.

B.2 SIMULATION

B.2.1 Surz Style Index Constituents

```
function
[LGP, MGP, SGP, LCP, MCP, SCP, LVP, MVP, SVP, LGM, LCM, LVM, MGM, MCM, MVM, SGM, SCM, SVM] =
StyleIndices(MCap, NrConst, ConstPos, Aggress, ConstDates, ReturnDates, EvalDate)
%Surz Style Indices - Monthly
% This function creates the 9 Surz Style Indices. The position
% of the constituents within each index as well as the market
% capitalization of each constituent is returned as output.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Inputs %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% MCap          = A matrix containing the Market Capitalization on a
%                monthly basis for all the constituents listed on the
%                ALSI over the evaluation period.
% NrConst       = A vector containing the number of constituents for the
%                various days.
% ConstPos      = A matrix containing the constituents for each month as
%                well as the position of each constituent.
```

```

% Aggress      =   A matrix containing the aggressiveness measure for all
%               =   the constituents.
% ConstDates   =   A vector containing the dates of the MCap and
%               =   Aggressiveness matrices.
% ReturnDates  =   A vector containing the dates of the Aggressiveness
%               =   matrix.
% EvalDate     =   The evaluation date.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Outputs %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% LGP          =   The positions of the large growth index constituents.
% LCP          =   The positions of the large core index constituents.
% LVP          =   The positions of the large value index constituents.
% MGP          =   The positions of the mid growth index constituents.
% MCP          =   The positions of the mid core index constituents.
% MVP          =   The positions of the mid value index constituents.
% SGP          =   The positions of the small growth index constituents.
% SCP          =   The positions of the small core index constituents.
% SVP          =   The positions of the small value index constituents.
% LGM          =   The market cap of the large growth index constituents.
% LCM          =   The market cap of the large core index constituents.
% LVM          =   The market cap of the large value index constituents.
% MGM          =   The market cap of the mid growth index constituents.
% MCM          =   The market cap of the mid core index constituents.
% MVM          =   The market cap of the mid value index constituents.
% SGM          =   The market cap the small growth index constituents.
% SCM          =   The market cap of the small core index constituents.
% SVM          =   The market cap of the small value index constituents.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Function Indexes %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The position of the evaluation date in question is found and used as an
% index.
D= find(ConstDates==EvalDate);
% The number of constituents listed on the ALSI on the date in question has
% to be found so that it can be used as an index.
m=NrConst(D,1);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Extracting the Relevant Data %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The relevant Market Cap and Aggressiveness data has to be obtained.
% Firstly the positions of the constituents listed on the index are
% obtained:
CP1=ConstPos(:,D);
CP2=CP1(CP1~=0);
% The Market cap data applicable to the date in question is then extracted:
MCapD=MCap(CP2,D);
% The Aggressiveness data applicable to the date in question is extracted
% as well:
DD= find(ReturnDates==EvalDate);
Agg=Aggress(CP2,DD);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Sort Data Based on Market Cap %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The position of each constituent, the Market Cap and the Aggressiveness
% measure is then combind together.
Combined=[CP2 MCapD Agg];
% The resulting matrix is sorted in descending order based on the Market
% Cap.
[~,d2] = sort(Combined(:,2), 'descend');
MCapS=Combined(d2,:);

```



```

% The second column in each of the created matrices is a vector containing
% the market cap of each constituent.
LGM=GrowthLarge(:,2);
LCM=CoreLarge(:,2);
LVM=ValueLarge(:,2);
MGM=GrowthMid(:,2);
MCM=CoreMid(:,2);
MVM=ValueMid(:,2);
SGM=GrowthSmall(:,2);
SCM=CoreSmall(:,2);
SVM=ValueSmall(:,2);
% Note: The last column in each of the created matrices is a vector
% containing the aggressiveness measure of each constituent.
end

```

B.2.2 Simulation Algorithm

```

function [SimLG, SimLC, SimLV, SimMG, SimMC, SimMV, SimSG, SimSC, SimSV] =
SimPort(MCap, NrConst, ConstPos, Aggress, ReturnDates, ConstDates, Returns, TestPeriod)
% Simulation Algorithm
% This function simulates the random weights for the constituents. The
% random weights are multiplied with the returns of the shares in
% each index to calculate the returns of the 9 Surz Style Indices. The
% function returns the simulated returns.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Inputs %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% MCap          = A matrix containing the Market Capitalization for all
%                the constituents listed on the ALSI over the evaluation
%                period.
% NrConst       = A vector containing the number of constituents for the
%                various evaluation periods.
% ConstPos      = A matrix containing the constituents for each month as
%                well as the position of each constituent.
% Aggress       = A matrix containing the aggressiveness measure for all
%                the constituents, for the days in question.
% ReturnDates   = A vector containing the dates of the Returns matrix.
% ConstDates    = A vector containing the dates of the Market Cap and
%                Aggressiveness matrices.
% Returns       = A vector containing the returns of the constituents
%                over the evaluation period.
% TestPeriod    = The test period refers to the 6 month intervals. These
%                inputs have to be entered in inverted commas (')
%                otherwise a spelling error warning will be returned.
%                * 6Months    = The last 6 months.
%                * 12Months   = The period between 6 and 12 months.
%                * 18Months   = The period between 12 and 18 months.
%                * 24Months   = The period between 18 and 24 months.
%                * 30Months   = The period between 24 and 30 months.
%                * 36Months   = The period between 30 and 36 months.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Outputs %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% SimLG         = A matrix containing the large cap growth continuous
%                returns for the 6 months in the 6 month evaluation
%                period.
% SimLC         = A matrix containing the large cap core continuous
%                returns for the 6 months in the 6 month evaluation
%                period.

```



```

elseif strcmp(TestPeriod, '24Months')
    EvalDates=ConstDates ( (m-23) : (m-18) , 1) ;
    A=[find(ReturnDates==ConstDates (m-23,1)) find(ReturnDates==ConstDates (m-
22,1)) find(ReturnDates==ConstDates (m-21,1)) find(ReturnDates==ConstDates (m-
20,1)) find(ReturnDates==ConstDates (m-19,1)) find(ReturnDates==ConstDates (m-
18,1)) find(ReturnDates==ConstDates (m-17,1))] ;
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
elseif strcmp(TestPeriod, '30Months')
    EvalDates=ConstDates ( (m-29) : (m-24) , 1) ;
    A=[find(ReturnDates==ConstDates (m-29,1)) find(ReturnDates==ConstDates (m-
28,1)) find(ReturnDates==ConstDates (m-27,1)) find(ReturnDates==ConstDates (m-
26,1)) find(ReturnDates==ConstDates (m-25,1)) find(ReturnDates==ConstDates (m-
24,1)) find(ReturnDates==ConstDates (m-23,1))] ;
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
elseif strcmp(TestPeriod, '36Months')
    EvalDates=ConstDates ( (m-35) : (m-30) , 1) ;
    A=[find(ReturnDates==ConstDates (m-35,1)) find(ReturnDates==ConstDates (m-
34,1)) find(ReturnDates==ConstDates (m-33,1)) find(ReturnDates==ConstDates (m-
32,1)) find(ReturnDates==ConstDates (m-31,1)) find(ReturnDates==ConstDates (m-
30,1)) find(ReturnDates==ConstDates (m-29,1))] ;
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
else
    warning('Spelling error, check the spelling. ');
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Simulation Algorithm %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Empty matrices are created in which the returns, based on the simulated
% weights, are stored.
WLGRet=zeros(6,p);
WLCRet=zeros(6,p);
WLVRet=zeros(6,p);
WMGRet=zeros(6,p);
WMCRet=zeros(6,p);
WMVRet=zeros(6,p);
WSGRet=zeros(6,p);
WSCRet=zeros(6,p);
WSVRet=zeros(6,p);
% The returns are calculated on a monthly basis for the 6 month period
% under evaluation.
% A for loop is used to calculate the returns and save it in the created
% empty matrices.
for q=1:length(EvalDates)
    % The positions and market cap of the constituents in the 9 Surz Style
    % Indices have to be obtained first for the evaluation date.
    % This is done via the StyleIndices function.

[LGP, MGP, SGP, LCP, MCP, SCP, LVP, MVP, SVP, LGM, LCM, LVM, MGM, MCM, MVM, SGM, SCM, SVM]=StyleI
ndices(MCap, NrConst, ConstPos, Aggress, ConstDates, ReturnDates, EvalDates(q,1));
    % The positions and market cap of the constituents are combined and
    % then sorted based on the market cap in descending order.
    Position=[LGP; LCP; LVP; MGP; MCP; MVP; SGP; SCP; SVP];
    M_Cap=[LGM; LCM; LVM; MGM; MCM; MVM; SGM; SCM; SVM];
    Comb=[Position M_Cap];
    [~,d2] = sort(Comb(:,2), 'descend');
    % The positions and market cap are extracted and saved in two separate
    % vectors.
    Pos=Comb(d2,1);
    MC=Comb(d2,2);
    % An empty matrix is created in which the simulated weights are
    % stored.

```

```

W=zeros(length(MC),p);
for j=1:p
    % If the market cap is larger than R20 Billion, then the weight
    % falls between 2% and 15%.
    % The top five shares on the index are assigned a weight between 5%
    % and 15%.
    for i=1:5
        W(i,j)=0.05+(0.15-0.05)*rand(1);
    end
    for i=6:length(MC)
        if MC(i,1)>=20000
            W(i,j)=0.02+(0.15-0.02)*rand(1);
            % If the market cap is larger than R2 Billion but smaller
            % than R20 Billion, then a weight between 0% and 10% is
            % assigned to the constituent.
        elseif (MC(i,1)>=2000 && MC(i,1)<20000)
            W(i,j)=0.1*rand(1);
            % If the market cap is smaller than R2 Billion, then the
            % weight falls between 0% and 5%.
        elseif MC(i,1)<2000
            W(i,j)=0.05*rand(1);
        else
            % If the market cap is R0 (the constituent is not listed on
            % the Index) then the weight is 0.
            W(i,j)=0;
        end
    end
end
end
% The returns applicable to the period under evaluation is extracted
% for further calculations.
Ret=sum(transpose>Returns(:,A(1,q):1:(A(1,q+1)-1))));
% The positions of the constituents are once again sorted into the nine
% Surz Style Index categories.
LGPos=zeros(length(LGP),1);
for i=1:length(LGP)
    LGPos(i,1)=find(Pos==LGP(i,1));
end
LCPos=zeros(length(LCP),1);
for i=1:length(LCP)
    LCPos(i,1)=find(Pos==LCP(i,1));
end
LVPos=zeros(length(LVP),1);
for i=1:length(LVP)
    LVPos(i,1)=find(Pos==LVP(i,1));
end
MGPos=zeros(length(MGP),1);
for i=1:length(MGP)
    MGPos(i,1)=find(Pos==MGP(i,1));
end
MCPos=zeros(length(MCP),1);
for i=1:length(MCP)
    MCPos(i,1)=find(Pos==MCP(i,1));
end
MVPos=zeros(length(MVP),1);
for i=1:length(MVP)
    MVPos(i,1)=find(Pos==MVP(i,1));
end
SGPos=zeros(length(SGP),1);
for i=1:length(SGP)
    SGPos(i,1)=find(Pos==SGP(i,1));
end
end

```

```

SCPos=zeros(length(SCP),1);
for i=1:length(SCP)
    SCPos(i,1)=find(Pos==SCP(i,1));
end
SVPos=zeros(length(SVP),1);
for i=1:length(SVP)
    SVPos(i,1)=find(Pos==SVP(i,1));
end
% The weights of the nine Surz Style Indices are then rebased to sum to
% 1.
WLG=W(LGPos,:);
WLGw=zeros(length(LGP),p);
for j=1:p
    WLGw(:,j)=WLG(:,j)./sum(WLG(:,j));
end
WLC=W(LCPos,:);
WLCw=zeros(length(LCP),p);
for j=1:p
    WLCw(:,j)=WLC(:,j)./sum(WLC(:,j));
end
WLV=W(LVPos,:);
WLVw=zeros(length(LVP),p);
for j=1:p
    WLVw(:,j)=WLV(:,j)./sum(WLV(:,j));
end
WMG=W(MGPos,:);
WMGw=zeros(length(MGP),p);
for j=1:p
    WMGw(:,j)=WMG(:,j)./sum(WMG(:,j));
end
WMC=W(MCPos,:);
WMCw=zeros(length(MCP),p);
for j=1:p
    WMCw(:,j)=WMC(:,j)./sum(WMC(:,j));
end
WMV=W(MVPos,:);
WMVw=zeros(length(MVP),p);
for j=1:p
    WMVw(:,j)=WMV(:,j)./sum(WMV(:,j));
end
WSG=W(SGPos,:);
WSGw=zeros(length(SGP),p);
for j=1:p
    WSGw(:,j)=WSG(:,j)./sum(WSG(:,j));
end
WSC=W(SCPos,:);
WSCw=zeros(length(SCP),p);
for j=1:p
    WSCw(:,j)=WSC(:,j)./sum(WSC(:,j));
end
WSV=W(SVPos,:);
WSVw=zeros(length(SVP),p);
for j=1:p
    WSVw(:,j)=WSV(:,j)./sum(WSV(:,j));
end
% the weights are then multiplied with the returns to obtain the
% simulated index returns.
for j=1:p
    WLGRet(q,j)=Ret(:,LGP)*WLGw(:,j);
    WLCRet(q,j)=Ret(:,LCP)*WLCw(:,j);
    WLVRet(q,j)=Ret(:,LVP)*WLVw(:,j);

```

```

        WMGRet(q, j)=Ret(:,MGP)*WMGw(:,j);
        WMCRet(q, j)=Ret(:,MCP)*WMCw(:,j);
        WMVRet(q, j)=Ret(:,MVP)*WMVw(:,j);
        WSGRet(q, j)=Ret(:,SGP)*WSGw(:,j);
        WSCRet(q, j)=Ret(:,SCP)*WSCw(:,j);
        WSVRet(q, j)=Ret(:,SVP)*WSVw(:,j);
    end
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Return Calculations %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The return matrices are then returned as output.
SimLG=transpose(WLGRet);
SimLC=transpose(WLCRet);
SimLV=transpose(WLVRet);
SimMG=transpose(WMGRet);
SimMC=transpose(WMCRet);
SimMV=transpose(WMVRet);
SimSG=transpose(WSGRet);
SimSC=transpose(WSCRet);
SimSV=transpose(WSVRet);
end

```

B.2.3 Simulation Matrices

```

function [SLG,SLC,SLV,SMG,SMC,SMV,SSG,SSC,SSV] =
SimMatrices(MCap,NrConst,ConstPos,Aggress,ConstDates,ReturnDates>Returns)
% Simulation Matrices
% This function repeats the simulation algorithm (SimPort) for the
% 6 month intervals over the three year evaluation period.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Inputs %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% MCap          = A matrix containing the Market Capitalization for all
%                the constituents listed on the ALSI over the evaluation
%                period.
% NrConst       = A vector containing the number of constituents for the
%                various evaluation periods.
% ConstPos      = ` A matrix containing the constituents for each month as
%                well as the position of each constituent.
% Aggress       = A matrix containing the aggressiveness measure for all
%                the constituents, for the days in question.
% ConstDates    = A vector containing the dates of the Market Cap and
%                Aggressiveness matrices.
% ReturnDates   = A vector containing the dates of the Returns matrix.
% Returns       = A vector containing the returns of the constituents
%                over the evaluation period.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Outputs %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% SLG           = A matrix containing the large cap growth continuous
%                returns for the 36 months in the 3 year evaluation
%                period.
% SLC           = A matrix containing the large cap core continuous
%                returns for the 36 months in the 3 year evaluation
%                period.
% SLV           = A matrix containing the large value growth continuous
%                returns for the 36 months in the 3 year evaluation
%                period.

```

```

% SMG      =   A matrix containing the mid cap growth continuous
%            returns for the 36 months in the 3 year evaluation
%            period.
% SMC      =   A matrix containing the mid cap core continuous
%            returns for the 6 months in the 6 month evaluation
%            period.
% SMV      =   A matrix containing the mid value growth continuous
%            returns for the 36 months in the 3 year evaluation
%            period.
% SSG      =   A matrix containing the small cap growth continuous
%            returns for the 36 months in the 3 year evaluation
%            period.
% SSC      =   A matrix containing the small cap core continuous
%            returns for the 36 months in the 3 year evaluation
%            period.
% SSV      =   A matrix containing the small value growth continuous
%            returns for the 36 months in the 3 year evaluation
%            period.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Test Periods %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The 6 month test periods are stored in a vector and then used in
% subsequent analysis.
TestPeriod={'36Months','30Months','24Months','18Months','12Months','6Months'};
% TestPeriod    =   The test period refers to the 6 month intervals. These
%                  inputs have to be entered in inverted commas (')
%                  otherwise a spelling error warning will be returned.
%                  * 6Months    = The last 6 months.
%                  * 12Months   = The period between 6 and 12 months.
%                  * 18Months   = The period between 12 and 18 months.
%                  * 24Months   = The period between 18 and 24 months.
%                  * 30Months   = The period between 24 and 30 months.
%                  * 36Months   = The period between 30 and 36 months.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Simulation Algorithm %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Empty matrices are created in which the simulated values are stored for
% the nine Surz Style Indices.
% Each Surz Style Index has its own matrix with 10000 simulations for each
% month over the 3 year period.
SLG=[];
SLC=[];
SLV=[];
SMG=[];
SMC=[];
SMV=[];
SSG=[];
SSC=[];
SSV=[];
% The SimPort function is now used to simulate the values for the different
% test periods and then the data is stored in the created matrices.
for i=1:6
    [SimLG,SimLC,SimLV,SimMG,SimMC,SimMV,SimSG,SimSC,SimSV] =
SimPort(MCap,NrConst,ConstPos,Aggress,ReturnDates,ConstDates>Returns,TestPeriod(
1,i));
    SLG=[SLG SimLG];
    SLC=[SLC SimLC];
    SLV=[SLV SimLV];
    SMG=[SMG SimMG];
    SMC=[SMC SimMC];
    SMV=[SMV SimMV];

```

```
SSG=[SSG SimSG];
SSC=[SSC SimSC];
SSV=[SSV SimSV];
```

```
end
end
```

B.3 FUND SPECIFICS

B.3.1 Surz Style Index Returns

```
function
[RetOut, LGP, MGP, SGP, LCP, MCP, SCP, LVP, MVP, SVP, LGM, LCM, LVM, MGM, MCM, MVM, SGM, SCM, SVM]
=
StyleIndicesExposure(MCapDaily, NrConst, ConstPos, Aggress, ConstDates, ReturnDates, R
eturns, EvalDate)
%Surz Style Indices - Daily
% This function creates the 9 Surz Style Indices and calculates their
% daily returns for the month ending on the evaluation date. The position
% of the constituents within each index as well as the market
% capitalization of each constituent in each index is returned together
% with the set of daily returns.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Inputs %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% MCapDaily      =   A matrix containing the daily Market Capitalization for
%                   all the constituents listed on the ALSI over the
%                   evaluation period.
% NrConst        =   A vector containing the number of constituents for the
%                   various monthly intervals.
% ConstPos       =   A matrix containing the constituents for each month as
%                   well as the position of each constituent.
% Aggress        =   A matrix containing the aggressiveness measure for all
%                   the constituents, for the days in question.
% ConstDates     =   A vector containing the dates of the Market Cap and
%                   Aggressiveness matrices.
% ReturnDates    =   A vector containing the dates of the Returns matrix.
% Returns        =   A vector containing the returns of the constituents
%                   over the evaluation period.
% EvalDate       =   The evaluation date.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Outputs %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% RetOut         =   A matrix containing the index returns for each of the
%                   nine indices.
% LGP            =   The positions of the large growth index constituents.
% LCP            =   The positions of the large core index constituents.
% LVP            =   The positions of the large value index constituents.
% MGP            =   The positions of the mid growth index constituents.
% MCP            =   The positions of the mid value index constituents.
% SGP            =   The positions of the small growth index constituents.
% SCP            =   The positions of the small core index constituents.
% SVP            =   The positions of the small value index constituents.
% LGM            =   The market cap of the large growth index constituents.
% LCM            =   The market cap of the large core index constituents.
% LVM            =   The market cap of the large value index constituents.
% MGM            =   The market cap of the mid growth index constituents.
% MCM            =   The market cap of the mid core index constituents.
% MVM            =   The market cap of the mid value index constituents.
```

```

% SGM      =   The market cap the small growth index constituents.
% SCM      =   The market cap of the small core index constituents.
% SVM      =   The market cap of the small value index constituents.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Function Indexes %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The position of the evaluation date in question is found and used as an
% index.
D=find(ReturnDates==EvalDate);
% The number of monthly intervals are calculated and used as an index.
n=length(ConstDates);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The number of constituents listed on the ALSI on the date in question has
% to be found so that it can be used as an index.
% This is done by determining the monthly interval in which the evaluation
% date falls.
DVec=zeros(n,1);
for i=1:n
    DVec(i,1)=find(ReturnDates==ConstDates(i,1));
end
NrLarger=zeros(n,1);
for i=1:n
    if EvalDate>=ConstDates(i,1)
        NrLarger(i,1)=1;
    else
        NrLarger(i,1)=0;
    end
end
NrL=sum(NrLarger);
m=NrConst(NrL,1);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Extracting the Relevant Data %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The relevant Market Cap and Aggressiveness data has to be obtained.
% Firstly the positions of the constituents listed on the index are
% obtained:
CP1=ConstPos(:,NrL);
CP2=CP1(CP1~=0);
% The Market cap data applicable to the date in question is then extracted:
MCapD=MCapDaily(CP2,D);
% The Aggressiveness data applicable to the date in question is extracted
% as well:
Agg=Aggress(CP2,D);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Sort Data Based on Market Cap %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The position of each constituent, the Market Cap and the Aggressiveness
% measure is then combined together.
Combined=[CP2 MCapD Agg];
% The resulting matrix is sorted in descending order based on the Market
% Cap.
[~,d2] = sort(Combined(:,2), 'descend');
MCapS=Combined(d2,:);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Split Data Based on Market Cap %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The large cap index consists of the top 40 constituents (based on market
% cap):
LargeCapS=MCapS(1:40,:);
% The mid cap index consists of the next 60 constituents (based on market
% cap):

```

```

MidCapS=MCapS(41:100,:);
% The small cap index consists of the remainder of the constituents (based
% on market cap):
SmallCapS=MCapS(101:m,:);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Sort Data Based on Aggressiveness %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Each of these 3 indices are now sorted based on the Aggressiveness
% measure in descending order.
[~,d4] = sort(LargeCapS(:,3),'descend');
LargeAggressS=LargeCapS(d4,:);
[~,d6] = sort(MidCapS(:,3),'descend');
MidAggressS=MidCapS(d6,:);
[~,d8] = sort(SmallCapS(:,3),'descend');
SmallAggressS=SmallCapS(d8,:);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Split Data Based on Aggressiveness %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The Large, Mid and Small Cap indices are then further broken down into a
% Growth, Core and Value component.
% The Growth indices consists of the top 40% of each of the Large, Mid and
% Small Cap indices respectively.
GrowthLarge=LargeAggressS(1:(0.4*40),:);
GrowthMid=MidAggressS(1:(60*0.4),:);
GrowthSmall=SmallAggressS(1:(round((m-100)*0.4)),:);
% The Core indices consists of the next 20% of each of the Large, Mid and
% Small Cap indices respectively.
CoreLarge=LargeAggressS((0.4*40+1):(0.4*40+0.2*40),:);
CoreMid=MidAggressS((0.4*60+1):(0.4*60+0.2*60),:);
CoreSmall=SmallAggressS((round(0.4*(m-100))+1):(round(0.4*(m-100))+round(0.2*(m-
100))),:);
% The Value indices consists of the last 40% of each of the Large, Mid and
% Small Cap indices respectively.
ValueLarge=LargeAggressS((0.4*40+0.2*40+1):40,:);
ValueMid=MidAggressS((0.4*60+0.2*60+1):60,:);
ValueSmall=SmallAggressS((round(0.4*(m-100))+round(0.2*(m-100))+1):(m-100),:);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Vectors Containing the Positions of the Constituents %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The first column in each of the created matrices is a vector containing the
% number of each constituent.
LGP=GrowthLarge(:,1);
MGP=GrowthMid(:,1);
SGP=GrowthSmall(:,1);
LCP=CoreLarge(:,1);
MCP=CoreMid(:,1);
SCP=CoreSmall(:,1);
LVP=ValueLarge(:,1);
MVP=ValueMid(:,1);
SVP=ValueSmall(:,1);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Vectors Containing the Market Cap of the Constituents %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The second column in each of the created matrices is a vector containg
% the market cap of each constituent.
LGM=GrowthLarge(:,2);
LCM=CoreLarge(:,2);
LVM=ValueLarge(:,2);
MGM=GrowthMid(:,2);
MCM=CoreMid(:,2);
MVM=ValueMid(:,2);

```



```

SGM=GrowthSmall(:,2);
SCM=CoreSmall(:,2);
SVM=ValueSmall(:,2);
% Note: The last column in each of the created matrices is a vector
% containing the aggressiveness measure of each constituent.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Vector Containing the Daily Returns of the Indices %%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The next step is to calculate the daily returns of each of the 9 indices.
% These returns are based on the ALSI information as on the previous
% constituent date.
% The necessary returns are extracted from the Returns matrix.
Ret>Returns(:,D);
% The daily returns are calculated by multiplying the weight of each
% constituent with its corresponding daily return.
LGR=transpose(LGM./sum(LGM))*Ret(LGP,:);
LCR=transpose(LCM./sum(LCM))*Ret(LCP,:);
LVR=transpose(LVM./sum(LVM))*Ret(LVP,:);
MGR=transpose(MGM./sum(MGM))*Ret(MGP,:);
MCR=transpose(MCM./sum(MCM))*Ret(MCP,:);
MVR=transpose(MVM./sum(MVM))*Ret(MVP,:);
SGR=transpose(SGM./sum(SGM))*Ret(SGP,:);
SCR=transpose(SCM./sum(SCM))*Ret(SCP,:);
SVR=transpose(SVM./sum(SVM))*Ret(SVP,:);
% This leads to a daily returns for each of the 9 indices.
% These returns are then combined into a vector.
RetOut=[LGR LCR LVR MGR MCR MVR SGR SCR SVR];
End

```

B.3.2 Fund exposure to the Surz Style Indices

```

function [IndexCoeff] =
StyleIndexWeights(MCapDaily,NrConst,ConstPos,Aggress,ConstDates,ReturnDates,Returns,FundRet)
% Surz Style Index Exposures
% This function calculates the fund's exposure to each of the nine Surz
% Style Indices.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Inputs %%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% MCapDaily      = A matrix containing the daily Market Capitalization for
%                  all the constituents listed on the ALSI over the
%                  evaluation period.
% NrConst        = A vector containing the number of constituents for the
%                  various monthly intervals.
% ConstPos       = A matrix containing the constituents for each month as
%                  well as the position of each constituent.
% Aggress        = A matrix containing the aggressiveness measure for all
%                  the constituents, for the days in question.
% ConstDates     = A vector containing the dates of the Market Cap and
%                  Aggressiveness matrices.
% ReturnDates    = A vector containing the dates of the Returns matrix.
% Returns        = A vector containing the returns of the constituents
%                  over the evaluation period.
% FundRet        = The corresponding daily fund returns for the fund under
%                  evaluation.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Outputs %%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% IndexCoeff     = The matrix containing the exposure to each of the nine

```

```

%                               Surz Style Indices for the 6 month periods.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Function Indexes %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The number of monthly intervals are calculated and used as an index.
m=length(ConstDates);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Date Vectors %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Vectors containing the dates on which the market cap are available for
% the 6 month periods.
Dates6=length(ReturnDates); % The last 6 months.
Dates12=find(ConstDates((m-5),1)==ReturnDates); % The period between 6 and 12
months.
Dates18=find(ConstDates((m-11),1)==ReturnDates); % The period between 12 and 18
months.
Dates24=find(ConstDates((m-17),1)==ReturnDates); % The period between 18 and 24
months.
Dates30=find(ConstDates((m-23),1)==ReturnDates); % The period between 24 and 30
months.
Dates36=find(ConstDates((m-29),1)==ReturnDates); % The period between 30 and 36
months.
DatesB=find(ConstDates((m-35),1)==ReturnDates); % The period between 30 and 36
months.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Return Matrices %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The daily returns of the Surz Style Indices are calculated with the
% StyleIndicesExposure function.
q=length(ReturnDates);
IndVal=[];
for j=1:q
    [RetOut,~,~,~,~,~,~,~,~,~,~,~,~,~,~,~,~] =
StyleIndicesExposure(MCapDaily,NrConst,ConstPos,Aggress,ConstDates,ReturnDates,R
eturns,ReturnDates(j,1));
    IndVal=[IndVal;RetOut];
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Matrices containing the daily returns for the six month intervals are
% created.
IndVal6=IndVal(Dates12:Dates6,:);
IndVal12=IndVal(Dates18:(Dates12-1),:);
IndVal18=IndVal(Dates24:(Dates18-1),:);
IndVal24=IndVal(Dates30:(Dates24-1),:);
IndVal30=IndVal(Dates36:(Dates30-1),:);
IndVal36=IndVal(DatesB:(Dates36-1),:);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The fund returns are also divided into six month intervals.
FR6=FundRet(Dates12:Dates6,:);
FR12=FundRet(Dates18:(Dates12-1),:);
FR18=FundRet(Dates24:(Dates18-1),:);
FR24=FundRet(Dates30:(Dates24-1),:);
FR30=FundRet(Dates36:(Dates30-1),:);
FR36=FundRet(DatesB:(Dates36-1),:);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Index Exposures %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The returns are used to calculate the exposure of the fund to each of the
% 9 indices.
% The first constraint is that the weights must sum to 1.
% This is implemented by the equality constraint matrix Aeq and the vector

```

```

% beq.
Aeq=ones(1,9);
beq=1;
% The next constraint is that each weight must be positive (zero or
% larger).
lb = zeros(9,1);
% The next constraint is that each weight must be less than or equal to
% one.
ub = ones(9,1);
% The index exposures are calculated for each 6 month period.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The matrix H is calculated based on the discussion in Section 3.3.1.2.
H6=2*transpose(IndVal6)*IndVal6;
% The vector f is calculated based on the discussion in Section 3.3.1.2.
f6=transpose(-2*transpose(FR6)*IndVal6);
% Lastly, the "quadprog" function is used to calculate the fund's exposure
% to the various indices for the 6 month period.
IndexCoeff6=quadprog(H6,f6,[],[],Aeq,beq,lb,ub);
% The same process is followed for the other 6 month periods.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
H12=2*transpose(IndVal12)*IndVal12;
f12=transpose(-2*transpose(FR12)*IndVal12);
IndexCoeff12=quadprog(H12,f12,[],[],Aeq,beq,lb,ub);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
H18=2*transpose(IndVal18)*IndVal18;
f18=transpose(-2*transpose(FR18)*IndVal18);
IndexCoeff18=quadprog(H18,f18,[],[],Aeq,beq,lb,ub);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
H24=2*transpose(IndVal24)*IndVal24;
f24=transpose(-2*transpose(FR24)*IndVal24);
IndexCoeff24=quadprog(H24,f24,[],[],Aeq,beq,lb,ub);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
H30=2*transpose(IndVal30)*IndVal30;
f30=transpose(-2*transpose(FR30)*IndVal30);
IndexCoeff30=quadprog(H30,f30,[],[],Aeq,beq,lb,ub);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
H36=2*transpose(IndVal36)*IndVal36;
f36=transpose(-2*transpose(FR36)*IndVal36);
IndexCoeff36=quadprog(H36,f36,[],[],Aeq,beq,lb,ub);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The calculated exposures are then combined together in a matrix.
IndexCoeff=[IndexCoeff36 IndexCoeff30 IndexCoeff24 IndexCoeff18 IndexCoeff12
IndexCoeff6];
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Style Index Weights %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The test periods are 6 month intervals and there are 6 six month
% intervals.
% The returns, weight simulations and other analyses are performed for
% these 6 month intervals.
TestPeriod={'Jul2010-Dec2010','Jan2011-Jun2011','Jul2011-Dec2011','Jan2012-
Jun2012','Jul2012-Dec2012','Jan2013-Jun2013'};
% A new figure window is created.
figure
% A bar graph is constructed indicating the exposure of the fund to the
% various indices.
bar(transpose(100*IndexCoeff),'stack')
% Labels are added to the y- and x-axis.
xlabel('Date');
ylabel('Exposure to Index (%)');
% The x- and y-labels are edited in order to set the limits.

```

```

set(gca,'YTick',[0 10 20 30 40 50 60 70 80 90 100]);
set(gca,'XTickLabel',TestPeriod);
axis([0 7 0 100]);
% A legend is added as well.
legend('Large Growth','Large Core','Large Value','Mid Growth','Mid Core','Mid
Value','Small Growth','Small Core','Small Value','location','NorthEast');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Exposure Distribution Graph %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% A rolling period of 6 month intervals are used to create an exposure
% distribution area graph.
% The exposures are calculated in the same way, the only difference is that
% a rolling period is used.
IC=[];
FRet=FundRet((length(ReturnDates)-750):length(ReturnDates),:);
IndRet=IndVal((length(ReturnDates)-750):length(ReturnDates),:);
for i=125:750
    H=transpose(IndRet((i-124):i,:))*IndRet((i-124):i,:);
    f=transpose(-2*transpose(FRet((i-124):i,:))*IndRet((i-124):i,:));
    Out=quadprog(H,f,[],[],Aeq,beq,lb,ub);
    IC=[IC;transpose(Out)];
end
% The necessary returns are extracted in order to label the x-axis.
RetDat=ReturnDates((length(ReturnDates)-750+125):length(ReturnDates),:);
figure
% An are graph is used to plot the results.
area(RetDat,100.*IC)
xlabel('Date','FontWeight','bold');
ylabel('Exposure to Index (%)','FontWeight','bold');
set(gca,'YTick',[0 10 20 30 40 50 60 70 80 90 100]);
set(gca,'XTick',RetDat);
legend('Large Growth','Large Core','Large Value','Mid Growth','Mid Core','Mid
Value','Small Growth','Small Core','Small
Value','location','BestOutside','Orientation','horizontal');
% The x-axis is edited so that it displays the dates.
datetick('x','mmm yy','keeplimits');
axis([RetDat(1,1) RetDat(length(RetDat),1) 0 100]);
end

```

B.3.3 Fund Specific Matrices

```

function [LG,LC,LV,MG,MC,MV,SG,SC,SV,FinalRet,StdDev,FRet,FRSurz,FStdDev] =
FM(SLG,SLC,SLV,SMG,SMC,SMV,SSG,SSC,SSV,IndexCoeff,FundRet,ConstDates,ReturnDates
)
% Fund Specific Matrices
% This function calculates the data sets relating to each specific fund
% based on the simulations.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Inputs %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% SLG           =   A matrix containing the large cap growth continuous
%                   returns for the 36 months in the 3 year evaluation
%                   period.
% SLC           =   A matrix containing the large cap core continuous
%                   returns for the 36 months in the 3 year evaluation
%                   period.
% SLV           =   A matrix containing the large value growth continuous
%                   returns for the 36 months in the 3 year evaluation
%                   period.

```



```

% The semi-annual returns are calculated first.
LG2=[transpose(sum(transpose(SLG(:,1:6))))
transpose(sum(transpose(SLG(:,7:12)))) transpose(sum(transpose(SLG(:,13:18))))
transpose(sum(transpose(SLG(:,19:24)))) transpose(sum(transpose(SLG(:,25:30))))
transpose(sum(transpose(SLG(:,31:36))))];
LC2=[transpose(sum(transpose(SLC(:,1:6))))
transpose(sum(transpose(SLC(:,7:12)))) transpose(sum(transpose(SLC(:,13:18))))
transpose(sum(transpose(SLC(:,19:24)))) transpose(sum(transpose(SLC(:,25:30))))
transpose(sum(transpose(SLC(:,31:36))))];
LV2=[transpose(sum(transpose(SLV(:,1:6))))
transpose(sum(transpose(SLV(:,7:12)))) transpose(sum(transpose(SLV(:,13:18))))
transpose(sum(transpose(SLV(:,19:24)))) transpose(sum(transpose(SLV(:,25:30))))
transpose(sum(transpose(SLV(:,31:36))))];
MG2=[transpose(sum(transpose(SMG(:,1:6))))
transpose(sum(transpose(SMG(:,7:12)))) transpose(sum(transpose(SMG(:,13:18))))
transpose(sum(transpose(SMG(:,19:24)))) transpose(sum(transpose(SMG(:,25:30))))
transpose(sum(transpose(SMG(:,31:36))))];
MC2=[transpose(sum(transpose(SMC(:,1:6))))
transpose(sum(transpose(SMC(:,7:12)))) transpose(sum(transpose(SMC(:,13:18))))
transpose(sum(transpose(SMC(:,19:24)))) transpose(sum(transpose(SMC(:,25:30))))
transpose(sum(transpose(SMC(:,31:36))))];
MV2=[transpose(sum(transpose(SMV(:,1:6))))
transpose(sum(transpose(SMV(:,7:12)))) transpose(sum(transpose(SMV(:,13:18))))
transpose(sum(transpose(SMV(:,19:24)))) transpose(sum(transpose(SMV(:,25:30))))
transpose(sum(transpose(SMV(:,31:36))))];
SG2=[transpose(sum(transpose(SSG(:,1:6))))
transpose(sum(transpose(SSG(:,7:12)))) transpose(sum(transpose(SSG(:,13:18))))
transpose(sum(transpose(SSG(:,19:24)))) transpose(sum(transpose(SSG(:,25:30))))
transpose(sum(transpose(SSG(:,31:36))))];
SC2=[transpose(sum(transpose(SSC(:,1:6))))
transpose(sum(transpose(SSC(:,7:12)))) transpose(sum(transpose(SSC(:,13:18))))
transpose(sum(transpose(SSC(:,19:24)))) transpose(sum(transpose(SSC(:,25:30))))
transpose(sum(transpose(SSC(:,31:36))))];
SV2=[transpose(sum(transpose(SSV(:,1:6))))
transpose(sum(transpose(SSV(:,7:12)))) transpose(sum(transpose(SSV(:,13:18))))
transpose(sum(transpose(SSV(:,19:24)))) transpose(sum(transpose(SSV(:,25:30))))
transpose(sum(transpose(SSV(:,31:36))))];
% Empty matrices are created in which the weighted returns are stored.
LGW=zeros(p,6);
LCW=zeros(p,6);
LVW=zeros(p,6);
MGW=zeros(p,6);
MCW=zeros(p,6);
MVW=zeros(p,6);
SGW=zeros(p,6);
SCW=zeros(p,6);
SVW=zeros(p,6);
% The semi-annual returns are multiplied with the index coefficients.
for i=1:6
    for j=1:p
        LGW(j,i)=IndexCoeff(1,i)*LG2(j,i);
        LCW(j,i)=IndexCoeff(2,i)*LC2(j,i);
        LVW(j,i)=IndexCoeff(3,i)*LV2(j,i);
        MGW(j,i)=IndexCoeff(4,i)*MG2(j,i);
        MCW(j,i)=IndexCoeff(4,i)*MC2(j,i);
        MVW(j,i)=IndexCoeff(6,i)*MV2(j,i);
        SGW(j,i)=IndexCoeff(7,i)*SG2(j,i);
        SCW(j,i)=IndexCoeff(8,i)*SC2(j,i);
        SVW(j,i)=IndexCoeff(9,i)*SV2(j,i);
    end
end
end

```

```

% The returns for the periods longer than a year is then annualized.
LG=[LGW(:,6) (LGW(:,5)+LGW(:,6))
((exp(LGW(:,3)+LGW(:,4)+LGW(:,5)+LGW(:,6))).^0.5-1)
((exp(LGW(:,1)+LGW(:,2)+LGW(:,3)+LGW(:,4)+LGW(:,5)+LGW(:,6))).^(1/3)-1)];
LC=[LCW(:,6) (LCW(:,5)+LCW(:,6))
((exp(LCW(:,3)+LCW(:,4)+LCW(:,5)+LCW(:,6))).^0.5-1)
((exp(LCW(:,1)+LCW(:,2)+LCW(:,3)+LCW(:,4)+LCW(:,5)+LCW(:,6))).^(1/3)-1)];
LV=[LVW(:,6) (LVW(:,5)+LVW(:,6))
((exp(LVW(:,3)+LVW(:,4)+LVW(:,5)+LVW(:,6))).^0.5-1)
((exp(LVW(:,1)+LVW(:,2)+LVW(:,3)+LVW(:,4)+LVW(:,5)+LVW(:,6))).^(1/3)-1)];
MG=[MGW(:,6) (MGW(:,5)+MGW(:,6))
((exp(MGW(:,3)+MGW(:,4)+MGW(:,5)+MGW(:,6))).^0.5-1)
((exp(MGW(:,1)+MGW(:,2)+MGW(:,3)+MGW(:,4)+MGW(:,5)+MGW(:,6))).^(1/3)-1)];
MC=[MCW(:,6) (MCW(:,5)+MCW(:,6))
((exp(MCW(:,3)+MCW(:,4)+MCW(:,5)+MCW(:,6))).^0.5-1)
((exp(MCW(:,1)+MCW(:,2)+MCW(:,3)+MCW(:,4)+MCW(:,5)+MCW(:,6))).^(1/3)-1)];
MV=[MVW(:,6) (MVW(:,5)+MVW(:,6))
((exp(MVW(:,3)+MVW(:,4)+MVW(:,5)+MVW(:,6))).^0.5-1)
((exp(MVW(:,1)+MVW(:,2)+MVW(:,3)+MVW(:,4)+MVW(:,5)+MVW(:,6))).^(1/3)-1)];
SG=[SGW(:,6) (SGW(:,5)+SGW(:,6))
((exp(SGW(:,3)+SGW(:,4)+SGW(:,5)+SGW(:,6))).^0.5-1)
((exp(SGW(:,1)+SGW(:,2)+SGW(:,3)+SGW(:,4)+SGW(:,5)+SGW(:,6))).^(1/3)-1)];
SC=[SCW(:,6) (SCW(:,5)+SCW(:,6))
((exp(SCW(:,3)+SCW(:,4)+SCW(:,5)+SCW(:,6))).^0.5-1)
((exp(SCW(:,1)+SCW(:,2)+SCW(:,3)+SCW(:,4)+SCW(:,5)+SCW(:,6))).^(1/3)-1)];
SV=[SVW(:,6) (SVW(:,5)+SVW(:,6))
((exp(SVW(:,3)+SVW(:,4)+SVW(:,5)+SVW(:,6))).^0.5-1)
((exp(SVW(:,1)+SVW(:,2)+SVW(:,3)+SVW(:,4)+SVW(:,5)+SVW(:,6))).^(1/3)-1)];
% The final returns is calculated as the weighted returns.
FR=zeros(p,6);
for j=1:p
    for i=1:6
FR(j,i)=LGW(j,i)+LCW(j,i)+LVW(j,i)+MGW(j,i)+MCW(j,i)+MVW(j,i)+SGW(j,i)+SCW(j,i)+
SVW(j,i);
        end
    end
end
% The returns for the periods longer than a year is then annualized.
FinalRet=[FR(:,6) (FR(:,5)+FR(:,6))
((exp(FR(:,3)+FR(:,4)+FR(:,5)+FR(:,6))).^0.5-1)
((exp(FR(:,1)+FR(:,2)+FR(:,3)+FR(:,4)+FR(:,5)+FR(:,6))).^(1/3)-1)];
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Standard Deviation Matrices %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Empty matrices are created to store the returns in.
LGSD=zeros(p,36);
LCSD=zeros(p,36);
LVSD=zeros(p,36);
MGSD=zeros(p,36);
MCSD=zeros(p,36);
MVSD=zeros(p,36);
SGSD=zeros(p,36);
SCSD=zeros(p,36);
SVSD=zeros(p,36);
% The monthly returns are multiplied with the corresponding index
% coefficients.
for i=1:36
    for j=1:p
        if 1<=i<=6
            q=1;
        elseif 7<=i<=12

```

```

        q=2;
    elseif 13<=i<=18
        q=3;
    elseif 19<=i<=24
        q=4;
    elseif 25<=i<=30
        q=5;
    elseif 31<=i<=36
        q=6;
    end
    LGSD(j,i)=IndexCoeff(1,q)*SLG(j,i);
    LCSD(j,i)=IndexCoeff(2,q)*SLC(j,i);
    LVSD(j,i)=IndexCoeff(3,q)*SLV(j,i);
    MGSD(j,i)=IndexCoeff(4,q)*SMG(j,i);
    MCSD(j,i)=IndexCoeff(4,q)*SMC(j,i);
    MVSD(j,i)=IndexCoeff(6,q)*SMV(j,i);
    SGSD(j,i)=IndexCoeff(7,q)*SSG(j,i);
    SCSD(j,i)=IndexCoeff(8,q)*SSC(j,i);
    SVSD(j,i)=IndexCoeff(9,q)*SSV(j,i);
end
% The final monthly returns are then calculated as the weighted sum.
SRet=zeros(p,36);
for j=1:p
    for i=1:36

SRet(j,i)=LGSD(j,i)+LCSD(j,i)+LVSD(j,i)+MGSD(j,i)+MCSD(j,i)+MVSD(j,i)+SGSD(j,i)+
SCSD(j,i)+SVSD(j,i);
        end
    end
% The standard deviations are then calculated and stored in a empty matrix
% created first.
StdDev=zeros(p,4);
for j=1:p
    StdDev(j,1)=(cov(SRet(j,31:36)))^(0.5);
end
for j=1:p
    StdDev(j,2)=(cov(SRet(j,25:36)))^(0.5);
end
for j=1:p
    StdDev(j,3)=(cov(SRet(j,13:36)))^(0.5);
end
for j=1:p
    StdDev(j,4)=(cov(SRet(j,1:36)))^(0.5);
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Fund Return Matrices %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Variables used to index into the existing vectors are created.
m=length(ConstDates);
FR6start=find(ReturnDates==(ConstDates(m-5,1)));
FR6end=length(ReturnDates);
FR12start=find(ReturnDates==(ConstDates(m-11,1)));
FR12end=find(ReturnDates==(ConstDates(m-5,1)))-1;
FR18start=find(ReturnDates==(ConstDates(m-17,1)));
FR18end=find(ReturnDates==(ConstDates(m-11,1)))-1;
FR24start=find(ReturnDates==(ConstDates(m-23,1)));
FR24end=find(ReturnDates==(ConstDates(m-17,1)))-1;
FR30start=find(ReturnDates==(ConstDates(m-29,1)));
FR30end=find(ReturnDates==(ConstDates(m-23,1)))-1;
FR36start=find(ReturnDates==(ConstDates(m-35,1)));
FR36end=find(ReturnDates==(ConstDates(m-29,1)))-1;

```



```

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Output: PODS %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% A new figure is created.
figure
% The a-axis is divided into 5 regions.
set(gca,'XTick',0:1:5);
% The hold on option is activated so that the figure can be changed.
hold on
% For each period a POD is now created.
for j=1:4
    % A rectangle is created representing the range of returns.
    % The rectangle is then divided into 4 percentiles.
    rectangle('Position',[j-
0.3,100*min(FinalRet(:,j)),0.6,100*(max(FinalRet(:,j))-
min(FinalRet(:,j)))],'LineWidth',1);
    fill([(j-0.3) (j-0.3) (j+0.3) (j+0.3)], [100*min(FinalRet(:,j))
100*max(FinalRet(:,j)) 100*max(FinalRet(:,j)) 100*min(FinalRet(:,j))], [1 0 0]);
    fill([(j-0.3) (j-0.3) (j+0.3) (j+0.3)], [100*prctile(FinalRet(:,j),25)
100*max(FinalRet(:,j)) 100*max(FinalRet(:,j)) 100*prctile(FinalRet(:,j),25)],
[0.6 0 0]);
    fill([(j-0.3) (j-0.3) (j+0.3) (j+0.3)], [100*prctile(FinalRet(:,j),50)
100*max(FinalRet(:,j)) 100*max(FinalRet(:,j)) 100*prctile(FinalRet(:,j),50)], [0
0.6 0]);
    fill([(j-0.3) (j-0.3) (j+0.3) (j+0.3)], [100*prctile(FinalRet(:,j),75)
100*max(FinalRet(:,j)) 100*max(FinalRet(:,j)) 100*prctile(FinalRet(:,j),75)], [0
1 0]);
    % The returns of the fund is added next.

plot(j,100*FRet(j,1),'o','MarkerFaceColor','blue','MarkerEdgeColor','blue','Mark
erSize',12);
end
%Labels are added to the axes, as well as a title:
xlabel('Time Period','FontWeight','bold');
ylabel('Returns (%)','FontWeight','bold');
title('\bf PODs: Returns','FontSize',11,'FontWeight','bold');
% A legend indicating the fund returns are added to the graph.
legend('0-25%','25-50%','50-75%','75-100%','Fund
Return','location','SouthEast');
% Labels are added to the x-axis.
Lab={'','Jan2013 - Jun2013','Jun2012 - Jun2013','Jun2011 - Jun2013','Jun2010 -
Jun2013',''};
set(gca,'XTickLabel',Lab);
% The "hold of" option is disactivated so that the figure can not be edited
% anymore.
hold off
end

```

B.3.2 Surz Style PODs Graphs

```

function [] = SurzPODS(LG,LC,LV,MG,MC,MV,SG,SC,SV,FRSurz,IndexCoeff)
%Surz Style PODs
% This function creates PODs graphd for each evaluation period for each
% Surz Style Index.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Inputs %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% LG          = The returns for the large cap growth index for the
%              6,12, 24 and 36 month intervals.
% LC          = The returns for the large cap core index for the
%              6,12, 24 and 36 month intervals.

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% LV      = The returns for the large cap value index for the
%          6,12, 24 and 36 month intervals.
% MG      = The returns for the mid cap growth index for the
%          6,12, 24 and 36 month intervals.
% MC      = The returns for the mid cap core index for the
%          6,12, 24 and 36 month intervals.
% MV      = The returns for the mid cap value index for the
%          6,12, 24 and 36 month intervals.
% SG      = The returns for the small cap growth index for the
%          6,12, 24 and 36 month intervals.
% SC      = The returns for the small cap core index for the
%          6,12, 24 and 36 month intervals.
% SV      = The returns for the small cap value index for the
%          6,12, 24 and 36 month intervals.
% FRSurz  = The fund returns for the Surz Style Indices based on
%          the index coefficients.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Function Inputs %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The index coefficients is first sorted from newest to oldest.
IndexCoeff=[IndexCoeff(:,6) IndexCoeff(:,5) IndexCoeff(:,4) IndexCoeff(:,3)
IndexCoeff(:,2) IndexCoeff(:,1)];
% Labels are also created for the x-axis.
PODLabels=strvcat('Large Growth','Large Core','Large Value','Mid Growth','Mid
Core','Mid Value','Small Growth','Small Core','Small Value');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Output: Surz Style Index PODS %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% A set of PODs is now created for each period.
for j=1:4
    if j==1
        % A new figure is created which is divided into subplots.
        figure
        subplot(2,1,1);
        % The index coefficients equal to zero is excluded from the plot.
        % A vector is created containing the position of the non-zero index
        % coefficients.
        IC=IndexCoeff(:,1);
        nPos=abs(IC(:,1))>=0.00001;
        PosValues=IC(nPos);
        n=length(PosValues);
        Pos=zeros(n,1);
        for i=1:n
            Pos(i,1)=find(IC(:,1)==PosValues(i,1));
        end
        %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
        if any(Pos==1)~=0
            % The first PODs is then created for the first non-zero
            % position.
            nn=find(Pos==1);
            % A rectangle is created representing the range of returns.
            rectangle('Position',[nn-
0.3),100*min(LG(:,j)),0.6,100*(max(LG(:,j))-min(LG(:,j))),'LineWidth',1);
            % The "hold on" option is activated so that the figure can be
            % changed.
            hold on
            % The rectangle is then divided into 4 percentiles.
            fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(LG(:,j))
100*max(LG(:,j)) 100*max(LG(:,j)) 100*min(LG(:,j))], [1 0 0]);
            fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LG(:,j),25)
100*max(LG(:,j)) 100*max(LG(:,j)) 100*prctile(LG(:,j),25)], [0.6 0 0]);

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fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LG(:,j),50)
100*max(LG(:,j)) 100*max(LG(:,j)) 100*prctile(LG(:,j),50)], [0 0.6 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LG(:,j),75)
100*max(LG(:,j)) 100*max(LG(:,j)) 100*prctile(LG(:,j),75)], [0 1 0]);
% The returns of the fund is added next.
plot(nn,100*FRSurz(1,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
% The "hold off" option is disactivated so that the figure can
% not be edited anymore.
hold off
end
% The same process is followed for the other Surz Style Indices for
% the various periods.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==2)~=0
nn=find(Pos==2);
rectangle('Position',[(nn-
0.3),100*min(LC(:,j)),0.6,100*(max(LC(:,j))-min(LC(:,j)))],'LineWidth',1);
hold on
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(LC(:,j))
100*max(LC(:,j)) 100*max(LC(:,j)) 100*min(LC(:,j))], [1 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LC(:,j),25)
100*max(LC(:,j)) 100*max(LC(:,j)) 100*prctile(LC(:,j),25)], [0.6 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LC(:,j),50)
100*max(LC(:,j)) 100*max(LC(:,j)) 100*prctile(LC(:,j),50)], [0 0.6 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LC(:,j),75)
100*max(LC(:,j)) 100*max(LC(:,j)) 100*prctile(LC(:,j),75)], [0 1 0]);
plot(nn,100*FRSurz(2,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
hold off
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==3)~=0
nn=find(Pos==3);
rectangle('Position',[(nn-
0.3),100*min(LV(:,j)),0.6,100*(max(LV(:,j))-min(LV(:,j)))],'LineWidth',1);
hold on
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(LV(:,j))
100*max(LV(:,j)) 100*max(LV(:,j)) 100*min(LV(:,j))], [1 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LV(:,j),25)
100*max(LV(:,j)) 100*max(LV(:,j)) 100*prctile(LV(:,j),25)], [0.6 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LV(:,j),50)
100*max(LV(:,j)) 100*max(LV(:,j)) 100*prctile(LV(:,j),50)], [0 0.6 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LV(:,j),75)
100*max(LV(:,j)) 100*max(LV(:,j)) 100*prctile(LV(:,j),75)], [0 1 0]);
plot(nn,100*FRSurz(3,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
hold off
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==4)~=0
nn=find(Pos==4);
rectangle('Position',[(nn-
0.3),100*min(MG(:,j)),0.6,100*(max(MG(:,j))-min(MG(:,j)))],'LineWidth',1);
hold on
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(MG(:,j))
100*max(MG(:,j)) 100*max(MG(:,j)) 100*min(MG(:,j))], [1 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MG(:,j),25)
100*max(MG(:,j)) 100*max(MG(:,j)) 100*prctile(MG(:,j),25)], [0.6 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MG(:,j),50)
100*max(MG(:,j)) 100*max(MG(:,j)) 100*prctile(MG(:,j),50)], [0 0.6 0]);

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    if any(Pos==8)~=0
        nn=find(Pos==8);
        rectangle('Position',[nn-
0.3),100*min(SC(:,j)),0.6,100*(max(SC(:,j))-min(SC(:,j)))], 'LineWidth',1);
        hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(SC(:,j))
100*max(SC(:,j)) 100*max(SC(:,j)) 100*min(SC(:,j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SC(:,j),25)
100*max(SC(:,j)) 100*max(SC(:,j)) 100*prctile(SC(:,j),25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SC(:,j),50)
100*max(SC(:,j)) 100*max(SC(:,j)) 100*prctile(SC(:,j),50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SC(:,j),75)
100*max(SC(:,j)) 100*max(SC(:,j)) 100*prctile(SC(:,j),75)], [0 1 0]);
        plot(nn,100*FRSurz(8,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
        hold off
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    if any(Pos==9)~=0
        nn=find(Pos==9);
        rectangle('Position',[nn-
0.3),100*min(SV(:,j)),0.6,100*(max(SV(:,j))-min(SV(:,j)))], 'LineWidth',1);
        hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(SV(:,j))
100*max(SV(:,j)) 100*max(SV(:,j)) 100*min(SV(:,j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SV(:,j),25)
100*max(SV(:,j)) 100*max(SV(:,j)) 100*prctile(SV(:,j),25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SV(:,j),50)
100*max(SV(:,j)) 100*max(SV(:,j)) 100*prctile(SV(:,j),50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SV(:,j),75)
100*max(SV(:,j)) 100*max(SV(:,j)) 100*prctile(SV(:,j),75)], [0 1 0]);
        plot(nn,100*FRSurz(9,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
        hold off
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    % Minimum and maximum values are created to edit the axis.

min6=min([min(LG(:,j)),min(LC(:,j)),min(LV(:,j)),min(MG(:,j)),min(MC(:,j)),min(M
V(:,j)),min(SG(:,j)),min(SC(:,j)),min(SV(:,j))])-0.01;

max6=max([max(LG(:,j)),max(LC(:,j)),max(LV(:,j)),max(MG(:,j)),max(MC(:,j)),max(M
V(:,j)),max(SG(:,j)),max(SC(:,j)),max(SV(:,j))])+0.01;
    % The axis is then edited using these values.
    axis([0 (n+1) 100*min6 100*max6]);
    % Labels are extracted for the non-zero index coefficients and then
    % added to the x-axis.
    PODLab=strvcat(' ',PODLabels(Pos,:), '');
    set(gca,'XTickLabel',PODLab);
    set(gca,'XTick', 1:1:n);
    % A title is added to label the boxplot.
    title('6 Months: Jan 2013-Jun 2013','FontSize',11,'FontWeight','bold');
    % Labels are also added to the y- and x-axis.
    ylabel('Returns (%)','FontWeight','bold')
    xlabel('Style Index','FontWeight','bold')
elseif j==2
    subplot(2,1,2);
    IC=IndexCoeff(:,2);
    nPos=abs(IC(:,1))>=0.00001;
    PosValues=IC(nPos);
    n=length(PosValues);

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Pos=zeros(n,1);
for i=1:n
    Pos(i,1)=find(IC(:,1)==PosValues(i,1));
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==1)~=0
    nn=find(Pos==1);
    rectangle('Position',[nn-
0.3),100*min(LG(:,j)),0.6,100*(max(LG(:,j))-min(LG(:,j))),'LineWidth',1);
    hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(LG(:,j))
100*max(LG(:,j)) 100*max(LG(:,j)) 100*min(LG(:,j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LG(:,j),25)
100*max(LG(:,j)) 100*max(LG(:,j)) 100*prctile(LG(:,j),25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LG(:,j),50)
100*max(LG(:,j)) 100*max(LG(:,j)) 100*prctile(LG(:,j),50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LG(:,j),75)
100*max(LG(:,j)) 100*max(LG(:,j)) 100*prctile(LG(:,j),75)], [0 1 0]);
        plot(nn,100*FRSurz(1,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
    hold off
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==2)~=0
    nn=find(Pos==2);
    rectangle('Position',[nn-
0.3),100*min(LC(:,j)),0.6,100*(max(LC(:,j))-min(LC(:,j))),'LineWidth',1);
    hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(LC(:,j))
100*max(LC(:,j)) 100*max(LC(:,j)) 100*min(LC(:,j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LC(:,j),25)
100*max(LC(:,j)) 100*max(LC(:,j)) 100*prctile(LC(:,j),25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LC(:,j),50)
100*max(LC(:,j)) 100*max(LC(:,j)) 100*prctile(LC(:,j),50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LC(:,j),75)
100*max(LC(:,j)) 100*max(LC(:,j)) 100*prctile(LC(:,j),75)], [0 1 0]);
        plot(nn,100*FRSurz(2,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
    hold off
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==3)~=0
    nn=find(Pos==3);
    rectangle('Position',[nn-
0.3),100*min(LV(:,j)),0.6,100*(max(LV(:,j))-min(LV(:,j))),'LineWidth',1);
    hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(LV(:,j))
100*max(LV(:,j)) 100*max(LV(:,j)) 100*min(LV(:,j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LV(:,j),25)
100*max(LV(:,j)) 100*max(LV(:,j)) 100*prctile(LV(:,j),25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LV(:,j),50)
100*max(LV(:,j)) 100*max(LV(:,j)) 100*prctile(LV(:,j),50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LV(:,j),75)
100*max(LV(:,j)) 100*max(LV(:,j)) 100*prctile(LV(:,j),75)], [0 1 0]);
        plot(nn,100*FRSurz(3,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
    hold off
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==4)~=0
    nn=find(Pos==4);

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        rectangle('Position', [(nn-
0.3), 100*min(MG(:, j)), 0.6, 100*(max(MG(:, j))-min(MG(:, j)))]), 'LineWidth', 1);
        hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(MG(:, j))
100*max(MG(:, j)) 100*max(MG(:, j)) 100*min(MG(:, j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MG(:, j), 25)
100*max(MG(:, j)) 100*max(MG(:, j)) 100*prctile(MG(:, j), 25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MG(:, j), 50)
100*max(MG(:, j)) 100*max(MG(:, j)) 100*prctile(MG(:, j), 50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MG(:, j), 75)
100*max(MG(:, j)) 100*max(MG(:, j)) 100*prctile(MG(:, j), 75)], [0 1 0]);
        plot(nn, 100*FRSurz(4, j), 'o', 'MarkerFaceColor', 'blue',
'MarkerEdgeColor', 'blue', 'MarkerSize', 6);
        hold off
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    if any(Pos==5)~=0
        nn=find(Pos==5);
        rectangle('Position', [(nn-
0.3), 100*min(MC(:, j)), 0.6, 100*(max(MC(:, j))-min(MC(:, j)))]), 'LineWidth', 1);
        hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(MC(:, j))
100*max(MC(:, j)) 100*max(MC(:, j)) 100*min(MC(:, j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MC(:, j), 25)
100*max(MC(:, j)) 100*max(MC(:, j)) 100*prctile(MC(:, j), 25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MC(:, j), 50)
100*max(MC(:, j)) 100*max(MC(:, j)) 100*prctile(MC(:, j), 50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MC(:, j), 75)
100*max(MC(:, j)) 100*max(MC(:, j)) 100*prctile(MC(:, j), 75)], [0 1 0]);
        plot(nn, 100*FRSurz(5, j), 'o', 'MarkerFaceColor', 'blue',
'MarkerEdgeColor', 'blue', 'MarkerSize', 6);
        hold off
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    if any(Pos==6)~=0
        nn=find(Pos==6);
        rectangle('Position', [(nn-
0.3), 100*min(MV(:, j)), 0.6, 100*(max(MV(:, j))-min(MV(:, j)))]), 'LineWidth', 1);
        hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(MV(:, j))
100*max(MV(:, j)) 100*max(MV(:, j)) 100*min(MV(:, j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MV(:, j), 25)
100*max(MV(:, j)) 100*max(MV(:, j)) 100*prctile(MV(:, j), 25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MV(:, j), 50)
100*max(MV(:, j)) 100*max(MV(:, j)) 100*prctile(MV(:, j), 50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MV(:, j), 75)
100*max(MV(:, j)) 100*max(MV(:, j)) 100*prctile(MV(:, j), 75)], [0 1 0]);
        plot(nn, 100*FRSurz(6, j), 'o', 'MarkerFaceColor', 'blue',
'MarkerEdgeColor', 'blue', 'MarkerSize', 6);
        hold off
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    if any(Pos==7)~=0
        nn=find(Pos==7);
        rectangle('Position', [(nn-
0.3), 100*min(SG(:, j)), 0.6, 100*(max(SG(:, j))-min(SG(:, j)))]), 'LineWidth', 1);
        hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(SG(:, j))
100*max(SG(:, j)) 100*max(SG(:, j)) 100*min(SG(:, j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SG(:, j), 25)
100*max(SG(:, j)) 100*max(SG(:, j)) 100*prctile(SG(:, j), 25)], [0.6 0 0]);

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        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SG(:,j),50)
100*max(SG(:,j)) 100*max(SG(:,j)) 100*prctile(SG(:,j),50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SG(:,j),75)
100*max(SG(:,j)) 100*max(SG(:,j)) 100*prctile(SG(:,j),75)], [0 1 0]);
        plot(nn,100*FRSurz(7,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
        hold off
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    if any(Pos==8)~=0
        nn=find(Pos==8);
        rectangle('Position',[(nn-
0.3),100*min(SC(:,j)),0.6,100*(max(SC(:,j))-min(SC(:,j)))], 'LineWidth',1);
        hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(SC(:,j))
100*max(SC(:,j)) 100*max(SC(:,j)) 100*min(SC(:,j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SC(:,j),25)
100*max(SC(:,j)) 100*max(SC(:,j)) 100*prctile(SC(:,j),25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SC(:,j),50)
100*max(SC(:,j)) 100*max(SC(:,j)) 100*prctile(SC(:,j),50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SC(:,j),75)
100*max(SC(:,j)) 100*max(SC(:,j)) 100*prctile(SC(:,j),75)], [0 1 0]);
        plot(nn,100*FRSurz(8,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
        hold off
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    if any(Pos==9)~=0
        nn=find(Pos==9);
        rectangle('Position',[(nn-
0.3),100*min(SV(:,j)),0.6,100*(max(SV(:,j))-min(SV(:,j)))], 'LineWidth',1);
        hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(SV(:,j))
100*max(SV(:,j)) 100*max(SV(:,j)) 100*min(SV(:,j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SV(:,j),25)
100*max(SV(:,j)) 100*max(SV(:,j)) 100*prctile(SV(:,j),25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SV(:,j),50)
100*max(SV(:,j)) 100*max(SV(:,j)) 100*prctile(SV(:,j),50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SV(:,j),75)
100*max(SV(:,j)) 100*max(SV(:,j)) 100*prctile(SV(:,j),75)], [0 1 0]);
        plot(nn,100*FRSurz(9,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
        hold off
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

min6=min([min(LG(:,j)),min(LC(:,j)),min(LV(:,j)),min(MG(:,j)),min(MC(:,j)),min(M
V(:,j)),min(SG(:,j)),min(SC(:,j)),min(SV(:,j))])-0.01;

max6=max([max(LG(:,j)),max(LC(:,j)),max(LV(:,j)),max(MG(:,j)),max(MC(:,j)),max(M
V(:,j)),max(SG(:,j)),max(SC(:,j)),max(SV(:,j))])+0.01;
axis([0 (n+1) 100*min6 100*max6]);
PODLab=strvcat(' ',PODLLabels(Pos,:),' ');
set(gca,'XTickLabel',PODLab);
set(gca,'XTick', 1:1:n);
% A title is added to label the boxplot.
title('12 Months: Jul 2012-Jun 2013','FontSize',11,'FontWeight','bold');
% Labels are also added to the y- and x-axis.
ylabel('Returns (%)','FontWeight','bold')
xlabel('Style Index','FontWeight','bold')
elseif j==3

```

```

figure
subplot(2,1,1);
IC=IndexCoeff(:,4);
nPos=abs(IC(:,1))>=0.00001;
PosValues=IC(nPos);
n=length(PosValues);
Pos=zeros(n,1);
for i=1:n
    Pos(i,1)=find(IC(:,1)==PosValues(i,1));
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==1)~=0
    nn=find(Pos==1);
    rectangle('Position',[nn-
0.3),100*min(LG(:,j)),0.6,100*(max(LG(:,j))-min(LG(:,j)))], 'LineWidth',1);
    hold on
    fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(LG(:,j))
100*max(LG(:,j)) 100*max(LG(:,j)) 100*min(LG(:,j))], [1 0 0]);
    fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LG(:,j),25)
100*max(LG(:,j)) 100*max(LG(:,j)) 100*prctile(LG(:,j),25)], [0.6 0 0]);
    fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LG(:,j),50)
100*max(LG(:,j)) 100*max(LG(:,j)) 100*prctile(LG(:,j),50)], [0 0.6 0]);
    fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LG(:,j),75)
100*max(LG(:,j)) 100*max(LG(:,j)) 100*prctile(LG(:,j),75)], [0 1 0]);
    plot(nn,100*FRSurz(1,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
    hold off
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==2)~=0
    nn=find(Pos==2);
    rectangle('Position',[nn-
0.3),100*min(LC(:,j)),0.6,100*(max(LC(:,j))-min(LC(:,j)))], 'LineWidth',1);
    hold on
    fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(LC(:,j))
100*max(LC(:,j)) 100*max(LC(:,j)) 100*min(LC(:,j))], [1 0 0]);
    fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LC(:,j),25)
100*max(LC(:,j)) 100*max(LC(:,j)) 100*prctile(LC(:,j),25)], [0.6 0 0]);
    fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LC(:,j),50)
100*max(LC(:,j)) 100*max(LC(:,j)) 100*prctile(LC(:,j),50)], [0 0.6 0]);
    fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LC(:,j),75)
100*max(LC(:,j)) 100*max(LC(:,j)) 100*prctile(LC(:,j),75)], [0 1 0]);
    plot(nn,100*FRSurz(2,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
    hold off
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==3)~=0
    nn=find(Pos==3);
    rectangle('Position',[nn-
0.3),100*min(LV(:,j)),0.6,100*(max(LV(:,j))-min(LV(:,j)))], 'LineWidth',1);
    hold on
    fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(LV(:,j))
100*max(LV(:,j)) 100*max(LV(:,j)) 100*min(LV(:,j))], [1 0 0]);
    fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LV(:,j),25)
100*max(LV(:,j)) 100*max(LV(:,j)) 100*prctile(LV(:,j),25)], [0.6 0 0]);
    fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LV(:,j),50)
100*max(LV(:,j)) 100*max(LV(:,j)) 100*prctile(LV(:,j),50)], [0 0.6 0]);
    fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LV(:,j),75)
100*max(LV(:,j)) 100*max(LV(:,j)) 100*prctile(LV(:,j),75)], [0 1 0]);

```

```

        plot(nn,100*FRSurz(3,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
        hold off
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    if any(Pos==4)~=0
        nn=find(Pos==4);
        rectangle('Position',[nn-
0.3),100*min(MG(:,j)),0.6,100*(max(MG(:,j))-min(MG(:,j)))],'LineWidth',1);
        hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(MG(:,j))
100*max(MG(:,j)) 100*max(MG(:,j)) 100*min(MG(:,j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MG(:,j),25)
100*max(MG(:,j)) 100*max(MG(:,j)) 100*prctile(MG(:,j),25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MG(:,j),50)
100*max(MG(:,j)) 100*max(MG(:,j)) 100*prctile(MG(:,j),50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MG(:,j),75)
100*max(MG(:,j)) 100*max(MG(:,j)) 100*prctile(MG(:,j),75)], [0 1 0]);
        plot(nn,100*FRSurz(4,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
        hold off
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    if any(Pos==5)~=0
        nn=find(Pos==5);
        rectangle('Position',[nn-
0.3),100*min(MC(:,j)),0.6,100*(max(MC(:,j))-min(MC(:,j)))],'LineWidth',1);
        hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(MC(:,j))
100*max(MC(:,j)) 100*max(MC(:,j)) 100*min(MC(:,j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MC(:,j),25)
100*max(MC(:,j)) 100*max(MC(:,j)) 100*prctile(MC(:,j),25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MC(:,j),50)
100*max(MC(:,j)) 100*max(MC(:,j)) 100*prctile(MC(:,j),50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MC(:,j),75)
100*max(MC(:,j)) 100*max(MC(:,j)) 100*prctile(MC(:,j),75)], [0 1 0]);
        plot(nn,100*FRSurz(5,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
        hold off
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    if any(Pos==6)~=0
        nn=find(Pos==6);
        rectangle('Position',[nn-
0.3),100*min(MV(:,j)),0.6,100*(max(MV(:,j))-min(MV(:,j)))],'LineWidth',1);
        hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(MV(:,j))
100*max(MV(:,j)) 100*max(MV(:,j)) 100*min(MV(:,j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MV(:,j),25)
100*max(MV(:,j)) 100*max(MV(:,j)) 100*prctile(MV(:,j),25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MV(:,j),50)
100*max(MV(:,j)) 100*max(MV(:,j)) 100*prctile(MV(:,j),50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MV(:,j),75)
100*max(MV(:,j)) 100*max(MV(:,j)) 100*prctile(MV(:,j),75)], [0 1 0]);
        plot(nn,100*FRSurz(6,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
        hold off
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    if any(Pos==7)~=0
        nn=find(Pos==7);

```

```

        rectangle('Position',[nn-
0.3),100*min(SG(:,j)),0.6,100*(max(SG(:,j))-min(SG(:,j)))], 'LineWidth',1);
        hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(SG(:,j))
100*max(SG(:,j)) 100*max(SG(:,j)) 100*min(SG(:,j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SG(:,j),25)
100*max(SG(:,j)) 100*max(SG(:,j)) 100*prctile(SG(:,j),25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SG(:,j),50)
100*max(SG(:,j)) 100*max(SG(:,j)) 100*prctile(SG(:,j),50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SG(:,j),75)
100*max(SG(:,j)) 100*max(SG(:,j)) 100*prctile(SG(:,j),75)], [0 1 0]);
        plot(nn,100*FRSurz(7,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
        hold off
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    if any(Pos==8)~=0
        nn=find(Pos==8);
        rectangle('Position',[nn-
0.3),100*min(SC(:,j)),0.6,100*(max(SC(:,j))-min(SC(:,j)))], 'LineWidth',1);
        hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(SC(:,j))
100*max(SC(:,j)) 100*max(SC(:,j)) 100*min(SC(:,j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SC(:,j),25)
100*max(SC(:,j)) 100*max(SC(:,j)) 100*prctile(SC(:,j),25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SC(:,j),50)
100*max(SC(:,j)) 100*max(SC(:,j)) 100*prctile(SC(:,j),50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SC(:,j),75)
100*max(SC(:,j)) 100*max(SC(:,j)) 100*prctile(SC(:,j),75)], [0 1 0]);
        plot(nn,100*FRSurz(8,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
        hold off
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    if any(Pos==9)~=0
        nn=find(Pos==9);
        rectangle('Position',[nn-
0.3),100*min(SV(:,j)),0.6,100*(max(SV(:,j))-min(SV(:,j)))], 'LineWidth',1);
        hold on
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(SV(:,j))
100*max(SV(:,j)) 100*max(SV(:,j)) 100*min(SV(:,j))], [1 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SV(:,j),25)
100*max(SV(:,j)) 100*max(SV(:,j)) 100*prctile(SV(:,j),25)], [0.6 0 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SV(:,j),50)
100*max(SV(:,j)) 100*max(SV(:,j)) 100*prctile(SV(:,j),50)], [0 0.6 0]);
        fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(SV(:,j),75)
100*max(SV(:,j)) 100*max(SV(:,j)) 100*prctile(SV(:,j),75)], [0 1 0]);
        plot(nn,100*FRSurz(9,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
        hold off
    end
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

min6=min([min(LG(:,j)),min(LC(:,j)),min(LV(:,j)),min(MG(:,j)),min(MC(:,j)),min(M
V(:,j)),min(SG(:,j)),min(SC(:,j)),min(SV(:,j))])-0.01;

max6=max([max(LG(:,j)),max(LC(:,j)),max(LV(:,j)),max(MG(:,j)),max(MC(:,j)),max(M
V(:,j)),max(SG(:,j)),max(SC(:,j)),max(SV(:,j))])+0.01;
    axis([0 (n+1) 100*min6 100*max6]);
    PODLab=strvcat(' ',PODLabels(Pos,:), '');
    set(gca,'XTickLabel',PODLab);

```

```

set(gca,'XTick', 1:1:n);
% A title is added to label the boxplot.
title('24 Months: Jul 2011-Jun 2013','FontSize',11,'FontWeight','bold');
% Labels are also added to the y- and x-axis.
ylabel('Returns (%)','FontWeight','bold')
xlabel('Style Index','FontWeight','bold')
elseif j==4
subplot(2,1,2);
IC=IndexCoeff(:,6);
nPos=abs(IC(:,1))>=0.00001;
PosValues=IC(nPos);
n=length(PosValues);
Pos=zeros(n,1);
for i=1:n
Pos(i,1)=find(IC(:,1)==PosValues(i,1));
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==1)~=0
nn=find(Pos==1);
rectangle('Position',[nn-
0.3),100*min(LG(:,j)),0.6,100*(max(LG(:,j))-min(LG(:,j))),'LineWidth',1);
hold on
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(LG(:,j))
100*max(LG(:,j)) 100*max(LG(:,j)) 100*min(LG(:,j))], [1 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LG(:,j),25)
100*max(LG(:,j)) 100*max(LG(:,j)) 100*prctile(LG(:,j),25)], [0.6 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LG(:,j),50)
100*max(LG(:,j)) 100*max(LG(:,j)) 100*prctile(LG(:,j),50)], [0 0.6 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LG(:,j),75)
100*max(LG(:,j)) 100*max(LG(:,j)) 100*prctile(LG(:,j),75)], [0 1 0]);
plot(nn,100*FRSurz(1,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
hold off
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==2)~=0
nn=find(Pos==2);
rectangle('Position',[nn-
0.3),100*min(LC(:,j)),0.6,100*(max(LC(:,j))-min(LC(:,j))),'LineWidth',1);
hold on
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(LC(:,j))
100*max(LC(:,j)) 100*max(LC(:,j)) 100*min(LC(:,j))], [1 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LC(:,j),25)
100*max(LC(:,j)) 100*max(LC(:,j)) 100*prctile(LC(:,j),25)], [0.6 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LC(:,j),50)
100*max(LC(:,j)) 100*max(LC(:,j)) 100*prctile(LC(:,j),50)], [0 0.6 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LC(:,j),75)
100*max(LC(:,j)) 100*max(LC(:,j)) 100*prctile(LC(:,j),75)], [0 1 0]);
plot(nn,100*FRSurz(2,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
hold off
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==3)~=0
nn=find(Pos==3);
rectangle('Position',[nn-
0.3),100*min(LV(:,j)),0.6,100*(max(LV(:,j))-min(LV(:,j))),'LineWidth',1);
hold on
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(LV(:,j))
100*max(LV(:,j)) 100*max(LV(:,j)) 100*min(LV(:,j))], [1 0 0]);

```

```

fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LV(:,j),25)
100*max(LV(:,j)) 100*max(LV(:,j)) 100*prctile(LV(:,j),25)], [0.6 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LV(:,j),50)
100*max(LV(:,j)) 100*max(LV(:,j)) 100*prctile(LV(:,j),50)], [0 0.6 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(LV(:,j),75)
100*max(LV(:,j)) 100*max(LV(:,j)) 100*prctile(LV(:,j),75)], [0 1 0]);
plot(nn,100*FRSurz(3,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
hold off
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==4)~=0
nn=find(Pos==4);
rectangle('Position',[(nn-
0.3),100*min(MG(:,j)),0.6,100*(max(MG(:,j))-min(MG(:,j)))], 'LineWidth',1);
hold on
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(MG(:,j))
100*max(MG(:,j)) 100*max(MG(:,j)) 100*min(MG(:,j))], [1 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MG(:,j),25)
100*max(MG(:,j)) 100*max(MG(:,j)) 100*prctile(MG(:,j),25)], [0.6 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MG(:,j),50)
100*max(MG(:,j)) 100*max(MG(:,j)) 100*prctile(MG(:,j),50)], [0 0.6 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MG(:,j),75)
100*max(MG(:,j)) 100*max(MG(:,j)) 100*prctile(MG(:,j),75)], [0 1 0]);
plot(nn,100*FRSurz(4,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
hold off
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==5)~=0
nn=find(Pos==5);
rectangle('Position',[(nn-
0.3),100*min(MC(:,j)),0.6,100*(max(MC(:,j))-min(MC(:,j)))], 'LineWidth',1);
hold on
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(MC(:,j))
100*max(MC(:,j)) 100*max(MC(:,j)) 100*min(MC(:,j))], [1 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MC(:,j),25)
100*max(MC(:,j)) 100*max(MC(:,j)) 100*prctile(MC(:,j),25)], [0.6 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MC(:,j),50)
100*max(MC(:,j)) 100*max(MC(:,j)) 100*prctile(MC(:,j),50)], [0 0.6 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MC(:,j),75)
100*max(MC(:,j)) 100*max(MC(:,j)) 100*prctile(MC(:,j),75)], [0 1 0]);
plot(nn,100*FRSurz(5,j),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',6);
hold off
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if any(Pos==6)~=0
nn=find(Pos==6);
rectangle('Position',[(nn-
0.3),100*min(MV(:,j)),0.6,100*(max(MV(:,j))-min(MV(:,j)))], 'LineWidth',1);
hold on
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*min(MV(:,j))
100*max(MV(:,j)) 100*max(MV(:,j)) 100*min(MV(:,j))], [1 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MV(:,j),25)
100*max(MV(:,j)) 100*max(MV(:,j)) 100*prctile(MV(:,j),25)], [0.6 0 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MV(:,j),50)
100*max(MV(:,j)) 100*max(MV(:,j)) 100*prctile(MV(:,j),50)], [0 0.6 0]);
fill([(nn-0.3) (nn-0.3) (nn+0.3) (nn+0.3)], [100*prctile(MV(:,j),75)
100*max(MV(:,j)) 100*max(MV(:,j)) 100*prctile(MV(:,j),75)], [0 1 0]);

```



```

min6=min([min(LG(:,j)),min(LC(:,j)),min(LV(:,j)),min(MG(:,j)),min(MC(:,j)),min(M
V(:,j)),min(SG(:,j)),min(SC(:,j)),min(SV(:,j))])-0.01;

max6=max([max(LG(:,j)),max(LC(:,j)),max(LV(:,j)),max(MG(:,j)),max(MC(:,j)),max(M
V(:,j)),max(SG(:,j)),max(SC(:,j)),max(SV(:,j))]+0.01;
axis([0 (n+1) 100*min6 100*max6]);
PODLab=strvcat(' ',PODLabels(Pos,:), '');
set(gca,'XTickLabel',PODLab);
set(gca,'XTick', 1:1:n);
% A title is added to label the boxplot.
title('36 Months: Jul 2010-Jun 2013','FontSize',11,'FontWeight','bold');
% Labels are also added to the y- and x-axis.
ylabel('Returns (%)','FontWeight','bold')
xlabel('Style Index','FontWeight','bold')
end
end
end

```

B.3.3 Risk versus Return Plots

```

function [Perc] = RiskReturn(FinalRet, StdDev, FRet, FStdDev)
%Risk versus Return Plots
% This function creates risk versus return plots for the various
% evaluation periods.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Inputs %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% LG = The returns for the large cap growth index for the
% 6,12, 24 and 36 month intervals.
% LC = The returns for the large cap core index for the
% 6,12, 24 and 36 month intervals.
% LV = The returns for the large cap value index for the
% 6,12, 24 and 36 month intervals.
% MG = The returns for the mid cap growth index for the
% 6,12, 24 and 36 month intervals.
% MC = The returns for the mid cap core index for the
% 6,12, 24 and 36 month intervals.
% MV = The returns for the mid cap value index for the
% 6,12, 24 and 36 month intervals.
% SG = The returns for the small cap growth index for the
% 6,12, 24 and 36 month intervals.
% SC = The returns for the small cap core index for the
% 6,12, 24 and 36 month intervals.
% SV = The returns for the small cap value index for the
% 6,12, 24 and 36 month intervals.
% FinalRet = The final returns of the simulated portfolios based on
% the index coefficients.
% StdDev = The standard deviations of the simulated portfolios.
% FRet = The fund returns for the 6, 12, 24 and 36 month
% periods.
% FRSurz = The fund returns for the Surz Style Indices based on
% the index coefficients.
% FStdDev = The standard deviations of the fund.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Function Inputs %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% p = The number of simulations.
p=10000;
% The time periods for the PODs graphs are:

```



```

PODsD={'Jan2013 - Jun2013','Jun2012 - Jun2013','Jun2011 - Jun2013','Jun2010 - Jun2013'};
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Output: Risk vs. Return %%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% A new figure window is created.
figure
% A risk vs. return plot is created for each evaluation period.
% The figure therefore contains 4 subplots.
for i=1:4
    % Each subplot contains a risk vs. return plot.
    subplot(2,2,i);
    % The "hold on" option is activated so that the figure can be
    % edited.
    hold on
    % Each return and its corresponding standard deviation is compared
    % against that of the fund to determine whether it is more efficient
    % than that of the fund.
    for j=1:p
        % Each return/standard deviation pair is tested against the
        % return/standard deviation of the fund.
        % If the fund's return is higher and the fund's standard deviation
        % is lower then a purple dot is made for the specific scenario.
        if (FinalRet(j,i)>FRet(i,1))&&(StdDev(j,i)<FStdDev(i,1))
            plot(100.*StdDev(j,i),100.*FinalRet(j,i),'o','MarkerFaceColor','m',
'MarkerEdgeColor','m','MarkerSize',4)
        else
            % If not, the scenario is marked with a blue dot.
            plot(100.*StdDev(j,i),100.*FinalRet(j,i),'o','MarkerFaceColor','blue',
'MarkerEdgeColor','blue','MarkerSize',4)
        end
    end
    % The fund's return/standard deviation is marked with a red dot.
    plot(100.*FStdDev(i,1),100.*FRet(i,1),'o','MarkerFaceColor','red',
'MarkerEdgeColor','red','MarkerSize',6)
    % Each plot is marked with an x- and y-label as well as a title.
    xlabel('Standard Deviation (%)','FontWeight','bold');
    ylabel('Returns (%)','FontWeight','bold');
    title(PODsD(1,i),'FontSize',11,'FontWeight','bold');
% The "hold of" option is disactivated so that the figure can not be edited
% anymore.
hold off
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% The percentage of portfolio that the fund over- and underperformed is
% calculated as well.
PercOver=zeros(p,4);
PercUnder=zeros(p,4);
Perc=zeros(2,4);
for i=1:4
    for j=1:p
        % Each return/standard deviation pair is tested against the
        % return/standard deviation of the fund.
        if (FinalRet(j,i)>FRet(i,1))
            if (StdDev(j,i)<FStdDev(i,1))
                PercOver(j,i)=1;
            else
                PercUnder(j,i)=1;
            end
        else
    
```

```

        PercUnder(j,i)=1;
    end
end
end
Perc(1,1:4)=sum(PercOver) ./p;
Perc(2,1:4)=sum(PercUnder) ./p;
end

```

B.3.4 Risk versus Return PODs

```

function [] = RiskReturnPODs(FinalRet,StdDev,FRet,FStdDev)
%Risk versus Return Plots
% Risk versus return plots are created for the evaluation periods.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Inputs %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% FinalRet      =   The final returns of the simulated portfolios based on
%                the index coefficients.
% StdDev        =   The standard deviations of the simulated portfolios.
% FRet          =   The fund returns for the 6, 12, 24 and 36 month
%                periods.
% FStdDev       =   The standard deviations of the fund.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Function Inputs %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Labels are also created for the x-axis.
PODsD={'Jan2013 - Jun2013','Jun2012 - Jun2013','Jun2011 - Jun2013','Jun2010 -
Jun2013'};
% Minimum and maximum values are calculated in order to edit the axis.
MinStd=zeros(1,4);
MaxStd=zeros(1,4);
MinRet=zeros(1,4);
MaxRet=zeros(1,4);
for i=1:4
    MinStd(1,i)=min(StdDev(:,i));
    MaxStd(1,i)=max(StdDev(:,i));
    MinRet(1,i)=min(FinalRet(:,i));
    MaxRet(1,i)=max(FinalRet(:,i));
end
TStdMin=min(min(MinStd),min(FStdDev));
TStdMax=max(max(MaxStd),max(FStdDev));
TRetMin=min(min(MinRet),min(FRet));
TRetMax=max(max(MaxRet),max(FRet));
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Output: PODs, Risk vs. Return %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% A new figure window is created.
figure
% The figure is divided into 4 plots, one for each evaluation period.
subplot(1,4,1);
for i=1:4
    subplot(1,4,i);
    % The "hold on" option is activated so that the figure can be edited.
    hold on
    if ((FStdDev(i,1)>=MaxStd(1,i)) || (FStdDev(i,1)<=MinStd(1,i)) ||
(FRet(i,1)>=MaxRet(1,i)) || (FRet(i,1)<=MinRet(1,i)))
        % A rectangle is created which represents the fund's risk and
        % return opportunity set.
        rectangle('Position',[100*MinStd(1,i),100*MinRet(1,i),100*(MaxStd(1,i)-
MinStd(1,i)),100*(MaxRet(1,i)-MinRet(1,i))],'LineWidth',2,'FaceColor','blue');
    end
end
end

```

```
else
    rectangle('Position',[100*MinStd(1,i),100*MinRet(1,i),100*(MaxStd(1,i)-
MinStd(1,i)),100*(MaxRet(1,i)-MinRet(1,i))],'LineWidth',2,'FaceColor','blue');
    % Another rectangle is added to the plot which represents the
    % more efficient portfolios.
    rectangle('Position',[100*MinStd(1,i),100*FRet(i,1),100*(FStdDev(i,1)-
MinStd(1,i)),100*(MaxRet(1,i)-FRet(i,1))],'FaceColor','magenta')
end
% The fund's return/standard deviation point is marked in red.
plot(100*FStdDev(i,1),100*FRet(i,1),'o','MarkerFaceColor','red',
'MarkerEdgeColor','red','MarkerSize',6)
% An x-label is added to mark each plot based on the evaluation period.
xlabel(PODsD(1,i));
% The axis of each plot is set to be the same.
axis([(100*TStdMin-1) (100*TStdMax+1) (100*TRetMin-1) (100*TRetMax+1)]);
% The "hold of" option is disactivated so that the figure can not be
% edited anymore.
hold off
end
% Labels are added to each sub-plot.
suplabel('Standard Deviation (%)','x');
suplabel('Returns (%)','y');
end
```