An empirical investigation of the conditional risk-return trade-off in South Africa

A research report submitted by

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ABSTRACT

One of the fundamental tenets of finance is the relationship between risk and return. This research report contributes to the debate by testing the conditional risk-return relationship of shares on the Johannesburg Stock Exchange (JSE) for the period 2001 to 2011. More specifically, the extent to which beta, standard deviation, semi-deviation and value-at-risk (VaR) are individually able to explain total share return, taking into account the conditional framework of up and down markets and sub-periods, is investigated. Portfolios based on these risk measures have been tracked and regressed. The robustness of the relationships are tested by using value and equal weighted portfolios.

The study indicates that standard deviation was able to explain the risk-return relationship across all scenarios (overall, up/down markets and sub-periods), while beta proved to be an ineffective measure of risk under all scenarios. The testing of downside risk measures revealed that semi-deviation produced weak results under all scenarios, while value-at-risk proved to be an effective measure of risk both during poor market conditions and on an overall basis.

DECLARATION

I, Andrew Scott Limberis, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Commerce (Accounting) in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

ANDREW SCOTT LIMBERIS

Signed at …………………………………………………

On the ………….. day of …………………… 2012

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CHAPTER 1: INTRODUCTION

1.1 Purpose of the study

The purpose of this research report is to examine the conditional risk-return relationship of shares on the Johannesburg Stock Exchange (JSE) from 2001 to 2011. More specifically, this research report will attempt to determine to what extent beta, standard deviation, semi-deviation and value-at-risk (VaR) are individually able to explain total share return, taking into account the conditional framework of up and down markets and sub-periods.

1.2 Context of the study

One of the fundamental tenets of finance is the relationship between risk and return. Theory dictates that the greater the risk, the greater the expected return. This trade-off between risk and return is also logical: one would demand a greater return for bearing a greater level of risk. This trade-off can be closely linked to the theory behind many asset pricing models. The capital asset pricing model (CAPM) of Sharpe (1964), Lintner (1965) and Black (1972) has been widely used to value risky assets (So and Tang, 2010). Two important principles of the CAPM model are that: the expected return of a risky asset has a positive, linear relationship to its systematic risk (beta), and that no other variable other than market beta can explain the cross-sectional variation of expected returns (So and Tang, 2010).

A large body of research has applied the CAPM as well as other asset pricing models, using a range of explanatory factors, in an attempt to explain share returns. A seminal study by Fama and MacBeth (1973) found support for the CAPM. Since then, the validity of the CAPM has come under much scrutiny. Basu (1977) found support for the explanatory power of price-to-earnings ratios, while Fama and French (1992) did not find any support for the CAPM and proposed that book-to-market and size factors better explained returns. Locally, van Rensburg and Robertson (2003) found support for size and price-to-earnings ratios as explanatory factors on the JSE. These explanatory factors can be understood to be proxies for “unnamed sources of risk” (Fama and French (1992, p. 428)).

Pettengill, Sundaram and Mathur (1995) extended the understanding of the risk-return relationship by considering specific circumstances only. They introduced the idea of considering a conditional criterion when attempting to assess the reliability of beta as an explanatory factor. They argued that the relationship between beta and returns differed during both up and down markets.

Recently, more emphasis has been placed on using other statistical proxies for risk as determinants of share returns (as in Tang and Shum (2004) and Amenc, Martellini, Goltz and Sahoo (2011)). Different statistical measures of risk, including value-at-risk, kurtosis, skewness and semi-deviation were used in these papers.

The understanding of the trade-off between risk and return, and even how to quantify risk, is of diverse opinion. A greater understanding of risk may have significant theoretical and practical applications in the never-ending attempt to balance risk and return.

1.3 Problem statement

1.3.1 *Main problem*

The main problem is to analyse the relationship between risk and return for shares listed on the Johannesburg Stock Exchange from 1 December 2001 to 30 November 2011.

1.3.2 *Sub-problems*

The first sub-problem is to calculate the effectiveness, of the individual risk measures: beta, standard deviation, semi-deviation and value-at-risk, in explaining and producing share returns.

The second sub-problem is to assess to what extent, if any, a relationship between risk and return can be identified in accordance with the conditional framework (both in an increasing and declining local market).

The third sub-problem is to determine and understand which of the risk measures outperform or underperform one another during each of the four defined sub-periods.

1.4 Significance of the study

The study fills a gap in that it attempts to identify to what extent, if any, a range of statistical measures for risk can explain and produce share returns on the JSE. The range of risk measures go beyond the standard use of beta and is in line with the international trend of using risk measures other than beta to explain share returns. Similar research on the JSE has been limited in terms of the scope of using different statistical measures for risk. Other explanatory factors, capturing some extent of risk, such as size and book-to-market ratios have however been quite well documented both on the JSE (van Rensburg and Robertson, 2003; Auret and Sinclaire, 2006) as well as internationally (Fama and French, 1992 and Gaunt, 2004).

This study intends to provide guidance to both academics and practitioners as it will help to provide insight into the role of risk in the determination of share returns, and thus how better to measure risk. The theoretical relevance of this research is that it will assist academics' understanding of the trade-off between risk and return. It will help in the consideration of risk under a conditional framework of up and down markets or during defined periods of sustained upwards, downwards or sideways movement.

The results of this research report may benefit practitioners, who might be able to further understand risk in an emerging market context, specifically of that in South Africa. An investment strategy may be developed based on the possible predictive power of the different risk measures, evidenced in this report. Practitioners may obtain a better understanding of how risk fits in to asset pricing models and investment strategies. Insight into possible effects of up and down markets on investment strategies may also be enhanced. Finally, this study is important as it attempts to highlight whether or not investors have actually been compensated by higher returns for any additional risk taken.

1.5 Delimitations of the study

- This research report is not testing the validity of the CAPM on the JSE. The results may however provide important inferences about the usefulness of beta. These inferences may or may not be able to be extrapolated to the applicability of the CAPM.

- The explanatory power of other statistical and non-statistical proxies for risk, including size and book-to-market ratios, will not be specifically considered.

- An exclusively long-term risk-reward relationship will not be analysed.

- A multivariate analysis will not be performed. Due to the nature and understanding of the risk measures (beta, standard deviation, semi-deviation and value-at-risk), it is expected that a multivariate analysis will not provide a material, additional benefit.

1.6 Definition of terms

Return spread – the difference in average monthly returns between the most risky portfolio (named ‘1’) and the least risky portfolio (named ‘10’).

Risk spread – the difference in average monthly risk measures between the most risky portfolio (named ‘1’) and the least risky portfolio (named ‘10’).

Up market – if during the month in question, the JSE All Share Index (J203) rose in value.

Down market – if during the month in question, the JSE All Share Index (J203) did not rise in value.

The definition and understanding of risk will be discussed in the literature review due to its wide interpretation and the variety of ways in which one is able to quantify risk.

1.7 Assumptions

All adjustments made by BFA McGregor are accurate and complete with respect to the effects of share splits, share consolidations, mergers and acquisitions, unbundlings, name changes and other corporate action. This assumption is fairly reasonable due to the standing of BFA McGregor. Any errors made by BFA McGregor should not greatly influence results as it is expected that only a minority of all companies may be affected. As portfolios are created, it is expected that any errors in a single specific share should only have a minor effect on the overall result. Data validity and reliability tests are performed as a precautionary measure.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This literature review provides support to the popular concept of a risk-return relationship. More detailed aspects of this relationship are discussed.

The structure of this chapter is as follows. The definition and general understanding of risk is discussed. Different interpretations and types of risk are then considered. From this, a number of proxies for risk, and how they form part of the framework of a risk-return relationship, is discussed.

With a general understanding in place, literature relating to each of the three sub-problems is then discussed. Initially the four chosen risk measures (as identified in sub-problem 1) are discussed. This is followed by sub-problem 2 where the up and down market criteria is considered. Finally literature relating to sub-problem 3 (the four defined sub-periods) is presented.

2.2 Understanding risk

2.2.1 *Total, systematic and unsystematic risk*

Total risk, as the words imply, encapsulates all possible risk. Markowitz (1952) stated that one could replace the word ‘risk’ with ‘variance of return’ without any real change in meaning. It therefore stands that variance or (standard deviation) can almost be representative of total risk. However, by the purest interpretation of the word ‘total’, it posits that no single factor could possibly encapsulate all risk. Furthermore any combination of unknown factors that capture the risk of a single security may and probably will change over time. Such factors may not even be consistent amongst other entities within the same industry.

Systematic risk is a pervasive and wide-spread risk (Chen, Roll and Ross, 1986). Chen et al (1986) proposed a number of macro-economic variables to explain share return. Strong support was found for industrial production amongst other factors, whilst the oil price had no explanatory power on returns. Beta is however widely accepted as a proxy for systematic risk.

Unsystematic risk (also known as idiosyncratic or specific risk) is more difficult to encapsulate. A combination of company specific factors makes up this risk. These factors will often largely differ amongst companies, and could be numerous in number and vary from significant to insignificant in influence. Montgomery and Singh (1984) stated that specific risk forms a larger component of total risk than systematic risk does.

Amenc et al (2011) used the word ‘total’ to describe their chosen risk measures (their chosen risk measures were value-at-risk, volatility, semi-deviation, skewness and kurtosis). The use of this word was solely for the purpose of differentiation from idiosyncratic risk and systematic risk. Amenc et al (2011) is therefore not saying that these measures represent total risk, but rather that these measures are more aptly captured by the word ‘total’ as opposed to the words ‘systematic’ or ‘unsystematic’. A similar interpretation has been followed in this research report. Standard deviation, semi-deviation and value-at-risk are considered ‘total’ risk measures, while beta is considered a systematic risk measure.

Lakonishok and Shapiro (1984) found that systematic risk explained very little, if any, variation in returns from 1962 to 1980. On the other hand, total risk appeared to have some explanatory power. Later, Lakonishok and Shapiro (1986) tested whether unsystematic risk was priced in addition to systematic risk. Their results rejected the premise that beta matters and in addition, they found that total risk (as measured by variance and residual standard deviation) is no more important than systematic risk, for small firms.

Merton (1987) and Malkiel and Xu (2002) asserted that specific risk, in addition to systematic risk, should be positively rewarded as undiversified investors will demand compensation for bearing specific risk. Investors may not be diversified, as they are unable to identify the true market portfolio, or as they may be unable for some reason to hold all shares in that market portfolio (Malkiel and Xu, 2002; Amenc et al, 2011). Amenc et al (2011) further argued that the market portfolio is, by definition, made up of the combined holdings of constrained and unconstrained investors. It therefore follows that both types of investors would be affected by specific risk. Tang and Shum (2004) found that investors in Singapore securities were not only compensated for bearing systematic risk but were compensated for also bearing unsystematic risk.

One of the important principles of the CAPM is that investors are only compensated for systematic risk as unsystematic risk can be eliminated through diversification. Beta should therefore alone be able to explain share return.

2.2.2 *Statistical and other proxies for risk*

Asset pricing models (such as, the arbitrage pricing model (APM) and Fama and French's three factor model) attempt to explain share returns using one or more factors. These factors include statistical proxies (such as the four measures used in this report). They also include other factors which proxy for risk (such as size and book-to-market ratios).

van Rensburg and Robertson (2003) dealt with a number of these factors. They tested 24 different factors to ascertain which, if any, had notable explanatory power over returns. These factors ranged from price-to-earnings ratios to financial distress and trading volume.

2.3 Statistical measures of risk

As discussed earlier, beta, standard deviation, semi-deviation and value-at-risk have been tested in an attempt to explain share returns. Each of these chosen measures has yielded strong results in one or multiple studies (Pettengill et al, 1995; Liang and Park, 2007; Amenc et al, 2011).

2.3.1 *Beta*

Pettengill et al (1995) asserted that testing the effectiveness of beta does not necessarily imply that one is testing the suitability of the CAPM, although some consideration should be given to the relationship between beta and the CAPM. The testing of beta and the CAPM is often closely intertwined and conclusions about CAPM can often be extended to that of beta.

Lakonishok and Shapiro (1984) reflected that the popularity of the CAPM was due to its intuitive appeal and ease to compute. They stated that an assumption of the CAPM is that rational risk-averse investors diversify their risk and as such only require compensation for bearing systematic risk (which cannot be diversified away).

Lakonishok and Shapiro (1984) considered that some investors may not hold diversified portfolios due to a number of reasons, including the effect of transaction costs and due to stock picking in an attempt to outperform the market. They then considered the possibility that risk, as measured by variance or standard deviation may be priced in addition to systematic risk. They stated that the question of whether beta captures all of an assets' risk was the major issue with using beta. Lakonishok and Shapiro (1986) provided further evidence against the CAPM. This evidence was that institutional investors tend to under-invest in small firms. They did however put forward the possibility that fully diversified investors may timely restore the market to equilibrium by arbitraging between shares, thereby restoring the equilibrium criteria required for the support of the CAPM.

In more international evidence, Fama and French (1992) also rejected their being a positive relationship between return and betas. Daniel and Titman (1997) found no support for beta once size and book-to-market ratios had been taken into account.

Estrada (2007, p. 169) asserted that CAPM was "a questionable and restrictive measure of risk". His results found in favour of downside beta as opposed to the traditional beta and CAPM.

Based on the weak support for beta and the CAPM, Auret and Sinclaire (2006) excluded beta from their analysis on the JSE.

2.3.2 *Standard deviation*

Since the seminal work of Markowitz (1952), standard deviation of returns has been one of the best-known measures for risk (Liang and Park, 2007). Markowitz (1952) further used variance to create his theory of portfolio diversification (an attempted maximisation of returns whilst minimizing of risk). Markowitz (1952, p. 79) labelled this his “expected returns – variance of returns rule”. Here again is evidence of the inseparable risk-return relationship.

Lakonishok and Shapiro (1984) found a significant relationship between variance and returns. This relationship, however, disappeared when size was included as an explanatory factor.

Estrada (2007) argued that standard deviation could only be accurate and meaningful when the underlying stock returns are symmetrical and normal. Mangani (2007) found evidence in favour of the normality and the stationary state of share returns on the JSE. Standard deviation could therefore be a viable option to capture risk on the JSE. Its widespread popularity has demanded its inclusion as a measure of risk in this report.

2.3.3 ***Semi-deviation***

Estrada (2007) stated that investors do not mind upside volatility but they do mind downside volatility. He went on to say that semi-deviation is also useful if the underlying data is both symmetric and asymmetric, unlike standard deviation. Semi-deviation also combines standard deviation and skewness into a single risk measure. Finally he found support for downside risk measures over standard risk measures both in an emerging and developed market context.

Liang and Park (2007) considered semi-deviation to be of interest as investors dislike downside volatility. The paper also commented that semi-deviation is a measure which considers standard deviation only over negative outcomes. By examining the equation to calculate semi-deviation, this observation becomes apparent. Only if a return is less than the average return, will a value for semi-deviation be returned. It therefore stands to reason that this measure may capture more total risk during poor market conditions than other non-downside risk measures. Liang and Park (2007) however found little support for semi-deviation as an effective measure of risk in the hedge fund industry in the US from 1995 to 2004.

2.3.4 *Value-at-risk*

Value-at-risk is the maximum loss which investors may incur during a specific time horizon and at a specific confidence level. The weakness, however, of value-at-risk is that it does not indicate the scale of possible losses, should any losses exceed the maximum loss at the certain confidence interval (Liang and Park, 2007). According to Liang and Park (2007), value-at-risk is a widely used measure of risk. When testing the measure they found only some support for the use of value-at-risk in the hedge fund industry.

Bali and Cakici (2004) found strong support in favour of value-at-risk in explaining average returns. This relationship was robust even in light of different time horizons, loss probabilities, and after controlling for size, liquidity and other factors. Their data was NYSE, Amex and Nasdaq companies listed between 1958 to 2001.

Amenc et al (2011) found similar results for semi-deviation, volatility and value-at-risk. When looking at a short-term (1 month) risk-return relationship, the results were not that strong. The relationship became considerably stronger over the longer term (the holding period of which was two years in that report). Semi-deviation, volatility and value-at-risk had a much greater return spread than the risk measures kurtosis and skewness. The r-squared values were also higher for these three risk measures. Their results were based on US equities from 1963 to 2009.

2.4 A conditional risk-return relationship

2.4.1 *Up and down markets*

Lakonishok and Shapiro (1984) first introduced the idea of dividing the market into up and down periods. They found that high-beta and high-variance shares outperformed low-beta and low-variance shares in up markets, and vice versa in down markets.

Pettengill et al (1995) furthered this idea and argued that when realized market returns fell below the risk-free rate, an inverse relationship between realised returns and beta should exist. They added that investors must perceive that there is a possibility that actual return could be less than the risk free rate; otherwise no investor would hold a risk free asset. Their results found that beta was a useful measure of risk once this conditional relationship was taken into account. Tang and Shum (2004) found that the explanatory power of beta increased 100 fold upon the introduction of a conditional up and down market.

Lakonishok and Shapiro (1984) acknowledged that investors cannot predict whether the market will go up or down, and therefore accepted that their results would not be relevant for investors who are unable to forecast whether the market is going to move up or down. Although forecasting is and always will be an uncertain action, the forecasting of market movements may be more practical in certain circumstances.

This research report uses data for the ten year period spanning 1 December 2001 to 30 November 2011; this period consists of 120 months. During these months the JSE All Share Index (J203) increased in value for 69 months and decreased in value for the other 51 months.

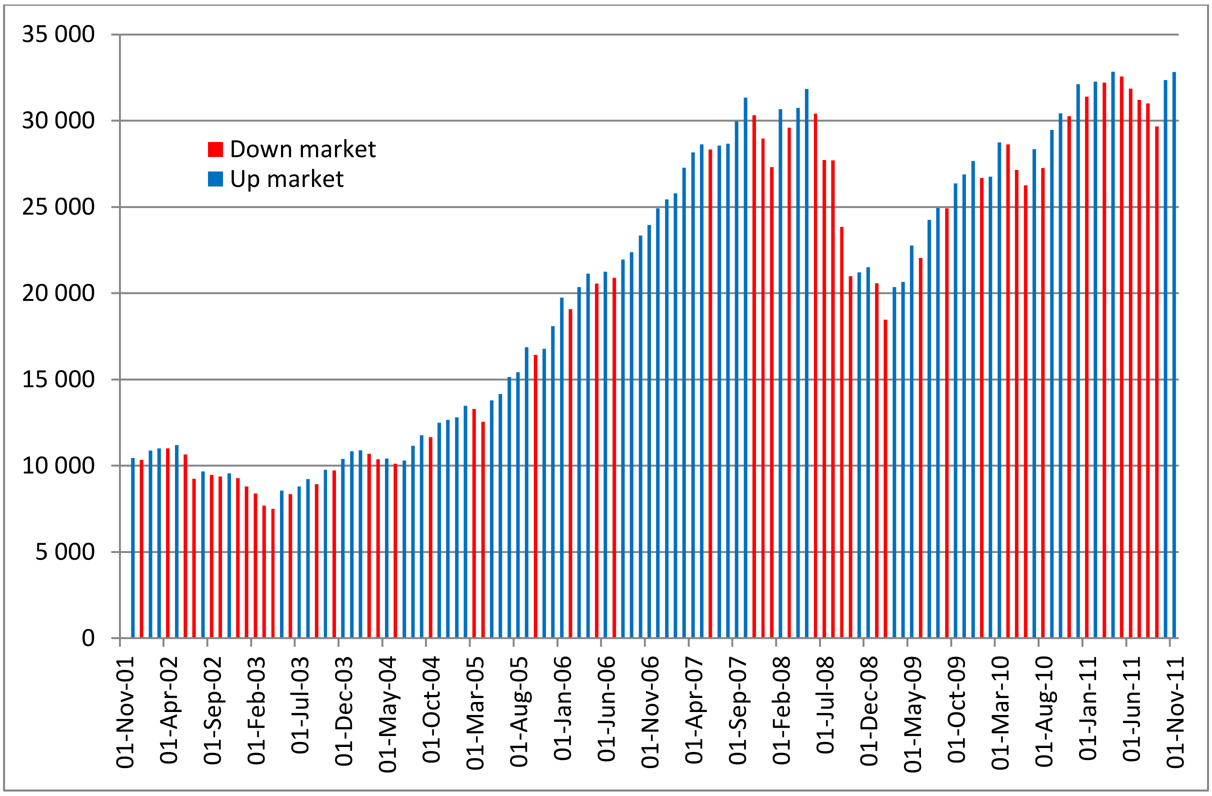

Figure 1: Up and down months for the JSE All Share Index

The longest consecutive period of an increase in value in the J203 spanned ten months. This occurred from August 2006 to May 2007 while there was a strong bull market in play.

The longest consecutive period of a decrease in value in the J203 spanned five months. This occurred on three occasions. The first occurred from December 2002 to April 2003. This was during the early stages of sub-period one, just prior to a strong bull market which succeeded these five months. The second instance stretched from June 2008 to October 2008. This was during the market crash of 2008/2009. The final instance was from May 2011 to October 2011. This was during the fourth sub-period where there was much uncertainty in the world markets.

2.4.2 *Sub-periods*

The use of sub-periods in similar studies is quite popular. Fama and French (1992), van Rensburg and Robertson (2003) and Auret and Cline (2011) all used sub-periods as robustness tests in an attempt to support their results over shorter time periods. The use of sub-periods in this report goes one step further than this. Each sub-period has a different economic characteristic. The sub-periods were not randomly split as done in other studies but rather carefully chosen. The results from each sub-period are therefore not expected to provide support to the overall results, but rather to yield additional, useful information about the concept of risk under different market conditions. Mutooni and Muller (2007) found that at times the market was better suited towards a growth style and at other times, a value style. Based on this expectation, the choice of sub-periods may highlight conclusions similar to that in Mutooni and Muller (2007).

2.5 Conclusion

This chapter has presented the relevant literature and evidence illustrating that Ohlson’s (1995) valuation model provides a rigorous conceptual foundation for regressions of equity values using earnings and book values of assets. The literature reveals that the Ohlson’s (1995) model is continually being revised and re-specified for specific purposes and environments, and has been empirically, extensively tested.

Empirical works generally find significant relationships between share prices and both book value and accounting earnings, although some of the works find a decreasing trend in the value relevance. Specification issues arising from the other information variable are, however, highlighted as being key to the successful use of the model, and will be borne in mind in developing the equation for this study. The next chapter presents the research hypothesis, framework, and data that underpin the hypothesis for this study.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Methodology

This research report will follow a purely quantitative approach, following the guidelines in the seminal studies of Fama and MacBeth (1973), and Fama and French (1992). The continued use of these methodological approaches (as seen in van Rensburg and Robertson (2003), Liang and Park (2007) and Amenc et al (2011)) is testament to the appropriateness of this methodology.

3.2 Research Design

Two designs are appropriate based on the two methodologies employed.

Firstly, portfolios based on the different measures of risk have been created and their performance tracked. Tracking is based on the investment of R1 at the inception of each portfolio. The average monthly portfolio return has been noted.

An ordinary least squares (OLS) regression analysis using constructed portfolios, with return as the dependant variable and a single measure of risk (beta, standard deviation, semi-deviation or value-at-risk) as the independent variable has been performed.

3.3 Population and sampling

3.3.1 *Population*

The population consists of all companies listed and delisted during the period from 30 November 1998 to 30 November 2011 (inclusive), on the JSE. Delisted companies have been included, as delisting is *ex post* information and was therefore not considered. This is consistent with the approach of Liang and Park (2007).

3.3.2 *Sample*

For a company to be included in the sample, more than three years of daily data, is required. The inclusion and treatment of companies does, to a small extent, differ upon listing and delisting (if either are applicable during the sample period). This is consistent with the approaches of Liang and Park (2007) and Basiewicz and Auret (2009). Both of these studies required between two to five years of data for shares to be included in their samples.

Portfolios have been rebalanced monthly, therefore shares listed part-way through the month were not available for inclusion at the beginning of the month. As such, these shares are only included in the sample from when they were available for purchase at the beginning of that month (a full month of daily shares prices is available). Therefore, for listed shares, thirteen months of daily share prices is required for a share to be included in the sample.

Shares that delisted during the period were still included in the portfolios, provided that twelve months of daily data was available by the end of the month preceding the month in which the share delisted.

3.3.3 *Treatment upon delisting*

Due to data limitations, the ideal treatment of shares upon delisting has not been possible. Ideally, the loss upon delisting should equal the last traded share price, less any compensation received (in cash, other shares or kind).

This research has however assumed a full loss of value upon delisting. The reasonability of this is however questionable. Some shares may be delisted and liquidated with no compensation for shareholders. Shareholders may pre-empt this and the share price may be insignificant just prior to delisting. Other shares may form part of a buyout or merger, and as a result there will be compensation received upon delisting, perhaps even an increase in share price. The share price just prior to delisting would be expected to approximate the compensation to be received.

The reasonability and effect of the above assumption on the overall results has been tested by assuming a 50% or 0% loss of value upon delisting. Upon computing these results, it was noted that the assumptions upon delisting had no material impact on the overall results. The only point of note is that the share return results under the 100% case are slightly lower than under the 50% and 0% cases (which was expected). When benchmarking the results against the JSE All Share Index, one should bear the impact of this assumption in mind. The results based on the 50% and 0% assumption have therefore not been included in this report.

In line with this approach, Strugnell, Gilbert and Kruger (2011) also made the assumption of a 100% loss of value upon delisting. They accepted that this was not a perfect approach; however it did not materially impact their results when they re-performed their tests with the assumption of a 50% loss of value.

3.3.4 *Thin trading*

The effects of thin trading on the JSE are a concern. Basiewicz and Auret (2009) asserted that the JSE is an illiquid market. Although liquidity has improved over the years, a number of shares are still thinly traded. In an effort to minimize the effects of thin trading on the results presented in this research, a relatively simplistic approach has been followed. As the extent of thin trading is likely to be market specific, only the precedent set by research on the JSE has been considered.

van Rensburg and Robertson (2003) only included shares whose turnover ratio was greater than 0.01%. They defined the turnover ratio as the average number of shares traded daily for the month divided by the number of ordinary shares outstanding at the beginning of the month. Basiewicz and Auret (2009) had a similar yet stricter liquidity criterion. Auret and Sinclaire (2006) required only that shares be traded at least once every month.

Although these measures take into account the effects of thin trading, they do have one downfall. Shares with a small market capitalization, that may trade frequently, may only have a small value traded. Institutional or even private investors may not be able to invest in these shares to a desired extent due to scale issues. It can be argued that these shares should therefore be excluded from the sample. The criteria used in this research is an attempt to take into account this weakness. Admittedly, by doing so, some thinly traded shares will still be included in the sample. As discussed, this is not expected to materially affect results.

Basiewicz and Auret (2009) also excluded shares below 100 cents. Lower priced shares often fall outside the scope of many investors on the JSE (Basiewicz and Auret, 2009). It follows that companies with a small market capitalisation may also therefore fall out of the ambit of my investors, most notably larger institutional investors.

The exact criteria used in this research report to exclude shares from the sample are therefore: any share with an average share price of less than R1 and an average market capitalisation of less than R100 million will be excluded. The list of these shares was reviewed for reasonability and it was adjudged that no significant shares were excluded from the sample. This process reduced the total sample of shares by 688 to 457.

3.4 Procedure for data collection

The raw data of daily closing share prices, monthly dividend yields and daily market capitalisations were sourced from the BFA McGregor database.

3.5 Data analysis and interpretation

3.5.1 *Portfolio formation*

The formation of portfolios is very popular in asset pricing literature. The reason for this is that portfolios have distinct benefits over the use of single shares. These include more accurate risk measure calculations as any noise in a single share will be offset against noise in each of the other shares. One downfall is that the results may however depend on how the portfolio formation process is defined (Amenc et al, 2011).

The portfolio creation process has been described by using beta as the risk measure. This procedure has been repeated for each of the other risk measures (standard deviation, semi-deviation and value-at-risk).

Using the closing prices on 30 November 2001, ten portfolios have been created in line with the approach followed by Amenc et al (2011). Fama and MacBeth (1973) created twenty portfolios; however, they had 435 to 845 companies available with which to make their 20 portfolios. Approximately 250 companies are available with which to create the 10 portfolios. In determining which shares to place into each portfolio, the previous twelve full months of daily data have been used to calculate the beta for each share, the shares were then ranked according to their betas, and portfolio's formed.

The precise formation of the portfolios is similar to that as described in detail by Fama and MacBeth (1973). The detail is as follows: let *n* be the total number of shares allocated to the portfolios each month. Each of the middle eight portfolios will consist of the integer *n*/10 shares. If *n* is even, the first and last portfolio each has [integer *n*/10 + integer (0.5(*n* – 10 x integer *n*/10))] shares. If *n* is odd then the first (highest beta) portfolio receives the additional share.

The equally weighted, and value weighted, return for each portfolio was calculated. This process was repeated to ensure that portfolios are rebalanced monthly in line with the approach by van Rensburg and Robertson (2003), and betas are always based on the preceding twelve full years of daily data. There are therefore 120 time series observations for each of the 10 portfolios. The total return spread between the highest and lowest beta portfolios has been recorded.

3.5.2 ***Portfolio tracking***

Fama and French (1992) applied a similar methodology; however their results were presented in a tabular format showing average monthly returns as opposed to cumulative Rand value graphs. So and Tang (2010) also employed a similar methodology. Amenc et al (2011) used a similar methodology to determine whether different statistical proxies for risk could effectively encapsulate a risk-return relationship.

The use of graphs showing the value of R1 invested at the inception of the portfolio, followed by the tracking of the portfolio, is the same as that seen in Mutooni and Muller (2007). Mutooni and Muller (2007) tracked the performance of portfolios based on size and value characteristics, with the additional consideration of switching between the strategies to produce greater returns. A summary table, in Appendix D, shows the future value of the R1 invested in each portfolio. A more meaningful table, and consistent with other research including Fama and French (1992), can be found in the summary section of presentation of results, showing the average monthly performance of each portfolio.

The benefit of this portfolio tracking approach is that it does not assume a linear relationship between risk and return, unlike the linear regression methodology. Furthermore, the graphical methodology can be useful in terms of strategy timing and can enable one to make a multitude of time series and cross-sectional observations.

3.5.3 ***Regression model***

To provide additional support to the portfolio tracking methodology, a regression model, based on the overall and up/down market level data only, was created. The regression on sub-period data only serves as a robustness test for the overall results. Individual stock level regressions, as evidenced in Amenc et al (2011), yielded less significant results than the portfolio level regressions. Therefore only portfolio level regressions are applied.

The regression takes the form of the univariate, time-series, OLS regression. As the purpose of this report is not to create a multivariate model, the multivariate regressions and resulting multicollinearity concerns of Auret and Sinclaire (2006) are therefore not relevant.

The equation for regressions is similar those used by Tang and Shum (2004, p. 185) and Auret and Sinclaire (2006, p. 33).

$$R_{j,t+1} = \tilde{y}_{0,t+1} + \tilde{y}_{1,t+1} Variable_{j,t} + \epsilon_{j,t+1} \qquad (1)$$

Where: $R_{j,t+1}$ is the return for portfolio j at time $t+1$. $\tilde{y}_{0,t+1}$ is the constant term. $\tilde{y}_{1,t+1}$ is the factor coefficient of the variable. $Variable_{j,t}$ is the beta, standard deviation, semi-deviation or value-at-risk for portfolio j at time t. ϵ_{jt} is the error term.

Auret and Sinclaire (2006) discussed two ways in which the element of risk can be incorporated into a returns model. The first method is an indirect method of using the risk and return spread. This involves finding the difference between the risk and return of portfolios 1 and 10, and then performing a time-series regression from this data. The second, direct method uses a share's risk measure to explain its return. A cross sectional regression is run based on the 10 portfolios. This is repeated for each of the months. The time-series values of the cross sectional coefficients are then used. Auret and Sinclaire (2006) discussed that the choice between these two options was debatable. This report has followed the approach of the former of these two methods (the indirect method).

Like van Rensburg and Robertson (2003) and Auret and Sinclaire (2006), a student's t-test is used to test the significance of the slope coefficient being statistically different from zero.

3.5.4 *Return calculations*

The monthly return has been calculated by taking the percentage movement from the closing share price of the last day of the previous month to the closing share price one month later. Added to this percentage return will be the dividend return for the same share. Due to the limitation of the availability of precise information regarding actual dividend amounts and dates paid or accrued, a monthly dividend return has been calculated. To calculate this, the annual dividend return has been converted into a monthly effective return. This treatment of dividends is consistent with Fama and French (1998) and later Mutooni and Muller (2007).

3.5.5 *Risk measure calculations*

All measures are calculated using the preceding twelve full months of daily share returns (that is excluding dividend returns) in line with Amenc et al (2011).

The calculation of the different risk measures is as follows:

a. ***Beta***

It is the slope resulting from the OLS regression of a single company's share prices to the value of the JSE All Share Index (J203). The J203 will proxy for the market portfolio. This method of calculating beta is consistent with that used by Auret and Cline (2011).

b. ***Standard deviation***

The standard method of calculating the standard deviation of a sample has been used.

$$Standard\ deviation = \sqrt{E\{(R - \mu)^2\}}$$

c. ***Semi-deviation***

This measure has been calculated using the formula used by Liang and Park (2007, p. 341). This is also the same formula used by Amenc et al (2011).

$$Semi - deviation = \sqrt{E\{Min[(R - \mu), 0]^2\}}$$

R represents a single day's share return. μ represents the average share return for a twelve month period. Semi-deviation is similar to standard deviation. Semi-deviation does however only take into account returns that are less than the average return. This can clearly be evidenced in this formula, whereby if the return is greater than the average, the minimum of that number and zero is used. In this case that must be zero.

d. ***Value-at-risk***

$$\boldsymbol{VaR} = -\ (\boldsymbol{\mu} + \boldsymbol{Z}(\boldsymbol{\alpha})\boldsymbol{x}\ \boldsymbol{\sigma})$$

$$= -\ (\mu - 1.645\ x\ \sigma)$$

α represents 5%. This represents a confidence interval of 95%.This is the same formula as used by Liang and Park (2007, p. 342). Liang and Park (2007) also used a confidence interval of 95%. They however used a time horizon of 1 month as this was the frequency of their return data. The frequency of return data in this report is daily, and for this reason a daily time horizon was used. The formula assumes that the returns are normally distributed. This assumption is considered to be reasonable in line with Mangani (2007).

The value-at-risk measure that is calculated has been multiplied by -1 as value-at-risk is usually a negative number, while beta, standard deviation and semi-deviation are all positive numbers. In order to be consistent and to be able to observe a positive relationship between risk and return. This adjustment is consistent with Bali and Cakici (2004) and Liang and Park (2007).

Amenc et al (2011) and Bali and Cakici (2004) also used the 95% confidence interval.

3.6 Limitations of the study

- Transaction costs were not considered. These may be significant due to the monthly rebalancing of portfolios. It is nevertheless believed, that the results present a fair and reasonable conclusion to the purpose of this report.

3.7 Robustness and validity tests

3.7.1 ***Portfolio weightings***

The base case scenario will be to use equal-weighted portfolios. Consistent with Pettengill et al (1995) and Amenc et al (2011), value weighted portfolios will also be used to test the robustness of the relationship.

3.7.2 ***Sub-periods***

The ten year period that has been chosen for this research report has been split into four pre-defined sub-periods. During each of these sub-periods, the market has been categorized in terms of the general movement in the overall value of the market. Figure 2, below, is a graphical representation of the four sub-periods that were chosen, in light of the movement of the JSE All Share Index.

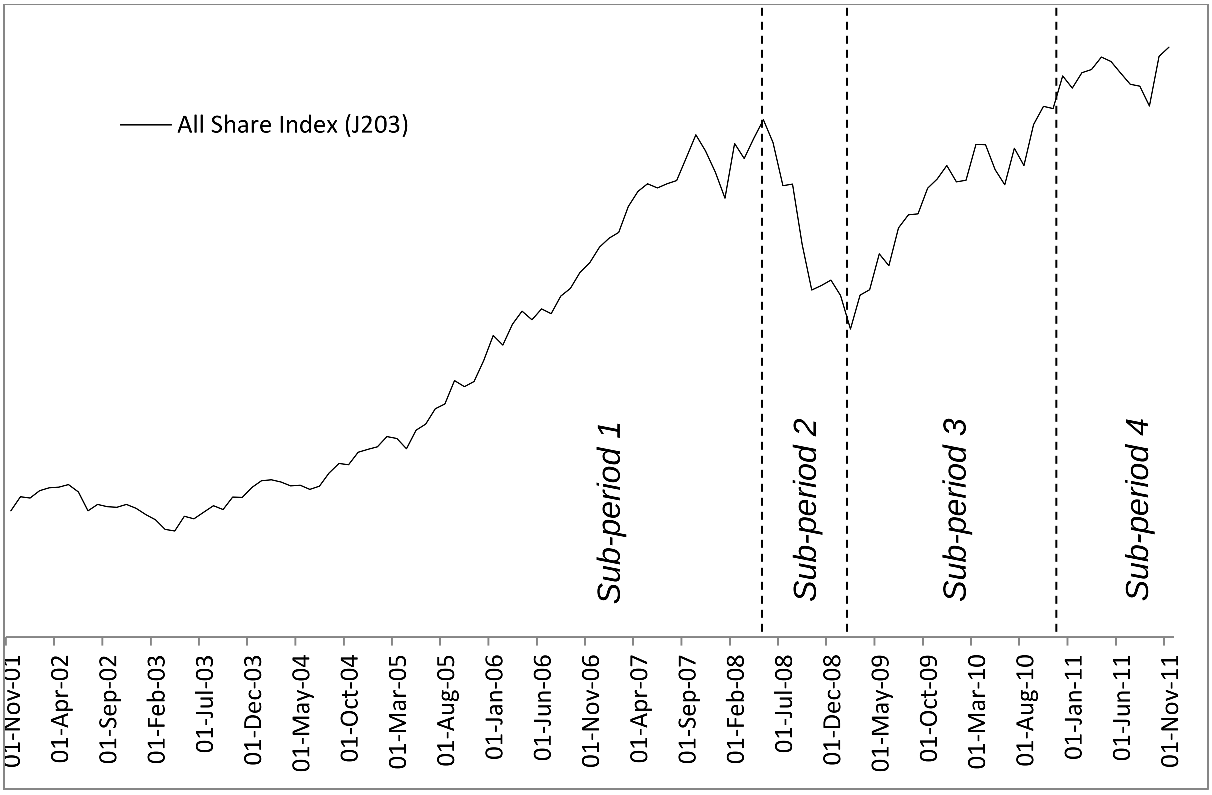

Figure 2: Graphical representation of sub-periods

The four sub-periods are:

a. ***Period 1 (1 December 2001 to 31 May 2008)***

During the first 18 months of this period, the All Share Index dropped to a month-end low of 7510.4 on 30 April 2003. This period thereafter is characterised by a strong bull market. The All Share Index returned an average of 14.31% per annum over the full six and a half year sub-period. The All Share Index reached a month-ending high of 31841.27, prior to the market crash in 2008/2009.

b. ***Period 2 (1 June 2008 to 28 February 2009)***

This period was characterised by the global sub-prime market crash. During these nine months the All Share Index crashed 42.01% to a month-ending low of 18465.33.

c. *Period 3 (1 March 2009 to 30 November 2010)*

This twenty one month period was characterised by the recovery of the JSE. The All Share Index returned to a month-end level of 30266.4, an average return of 32.63% per annum.

d. *Period 4 (1 December 2010 to 30 November 2011)*

This final sub-period has been characterised by a general sideways movement, albeit a gradual increase in the All Share Index. During this period there was much uncertainty within the market as the US and Europe grappled with a liquidity crisis. The All Share Index rose 8.41% during this twelve month period.

3.7.3 *Data validity and reliability*

Large, unusual movements in the share prices extracted from the BFA McGregor database were further examined for their reasonableness. A number of adjustments were not made by the BFA McGregor database in respect of share splits and consolidations. An appropriate adjustment was made to these share prices to correct the raw data.

CHAPTER 4: PRESENTATION OF RESULTS

4.1 Introduction

Charts specifically relating to each of the three defined sub-problems are presented in an effort to provide specific detail to answer each of the sub-problems.

A summary table and chart then summarizes the results obtained. These results add some context to the main purpose of this report.

The basis of preparation of the charts is the assumption of the investment of R1 in each of the portfolios. For example investing R1 in the most risky beta portfolio (with the equal weighting of each share within the portfolio) will mean that after 10 years of such a strategy, one would have assets worth R2.59. That equates to a return of 259% or 9.98% per annum compounded annually.

Returns based on the equal weighting and value weighting of shares within the portfolios are presented. Only pertinent, equal weighted graphs have been included in the main part of this report. Additional and value weighted graphs can be found in Appendix A, B, C and D. Appendix A relates to sub-problem 1; Appendix B to sub-problem 2; Appendix C to sub-problem 3; and Appendix D to the overall results.

Returns from equal weighted portfolios are graphically presented with a log scale of 2 so as to allow a better graphical comparison between portfolios. Value weighted graphs can be found in the appendix. Equal weighted results have been preferred as individual firm affects can less likely influence results (Basiewicz and Auret, 2009)).

4.2 Sample of shares

A total of 354 shares have been included in the sample. Of the 354 shares, 102 delisted at some stage during the 10 year period. 88 shares listed at some stage during the 10 year period. 164 shares were continuously listed throughout the 10 year period.

The timing of the 102 delistings is as follows: 78 occurred in sub-period 1, 6 in sub-period 2, 12 in sub-period 3 and 6 in sub-period 4.

On average, 248 shares per month were sorted into the ten defined portfolios. In June 2009, the maximum number of shares for a single month (266 shares), were sorted into the ten defined portfolios. In September 2007, a low of 224 shares were sorted into the ten defined portfolios.

Considering the defined criteria for the inclusion of shares in the sample, Figure 3 illustrates the number of shares which were used each month to create the portfolios. Due to overall market conditions and various other factors, the number of shares per month was not a static figure.

In the figure below, the red lines indicate the 164 shares which formed part of the sample for every single month of the entire 10 year period. The blue lines represent the number of shares which were included in the sample but were not continuously listed throughout the 10 year period. These shares represent approximately one third of the monthly sample.

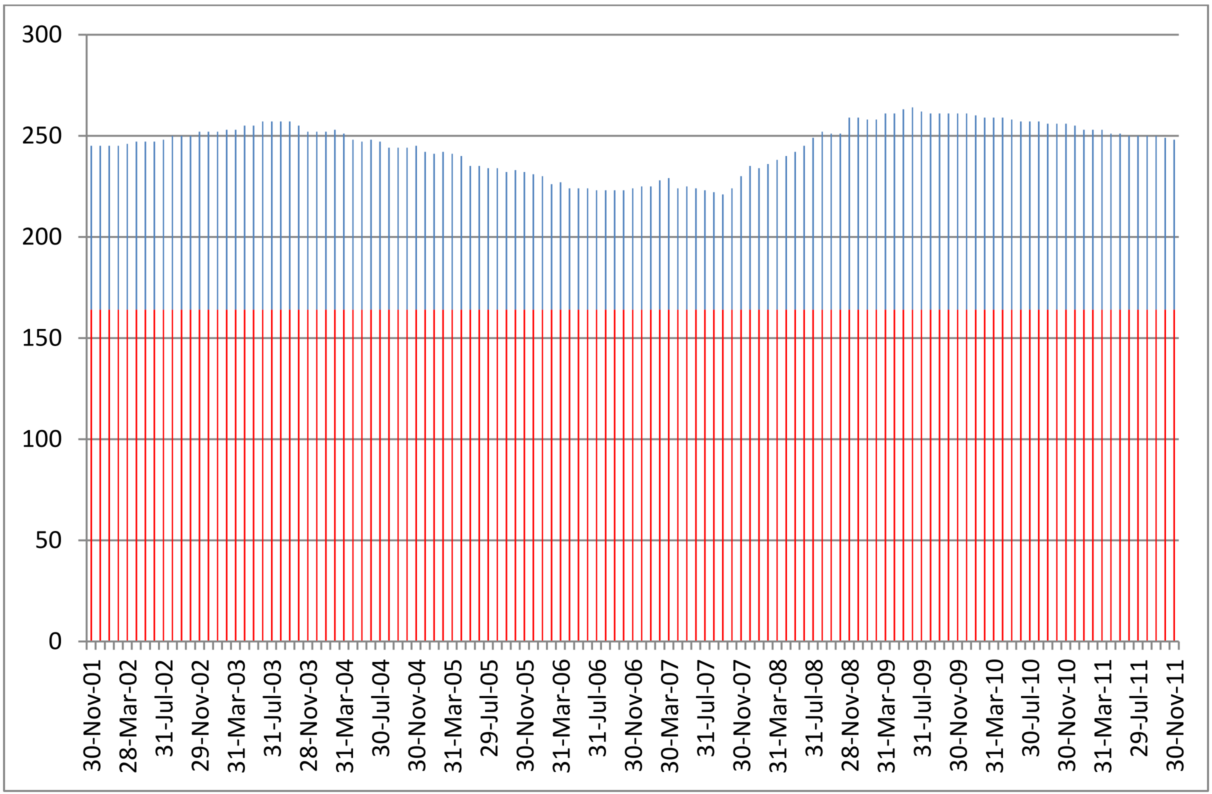

Figure 3: Number of shares per month included in the sample

Bearing in mind these statistics, the constant need for adaption and oversight of portfolios is apparent. The possibility of survivorship bias being a concern is also apparent.

The average number of shares used per month is fairly consistent with Auret and Cline (2011). Auret and Cline (2011) did however use different selection criteria. Their number of shares averaged approximately 250 from 2001 to 2006. Basiewicz and Auret (2009) had on average 190 shares based on similar selection criteria but they controlled for liquidity. van Rensburg and Robertson (2003) had on average 336 shares per month for the 10 year period up to 2000. They also controlled for liquidity. Bearing this in mind, the sample selected may include a small number of illiquid shares, or might be missing some liquid shares. The effect of this is not expected to be significant due to the fact that portfolios are constructed and approximately 25 shares form part of each portfolio. Therefore any irregularity, of any nature for that matter, should not have a major effect on the overall results.

4.3 Results pertaining to Sub-problem 1

In this first sub-problem, the effectiveness, of the individual risk measures: beta, standard deviation, semi-deviation and value-at-risk, in explaining and producing share returns is examined.

Each risk measure is considered separately so as to be able to properly examine the performance of the most risky and least risky portfolios within each risk measure. The outperformance, or underperformance, by the most risky portfolio (portfolio 1) over the least risky (portfolio 10) is also shown. This allows a time series observation, of the relative difference between the most risk and least risky portfolios, to indicate if or when it is preferable to hold more or less risky assets. The importance of timing may thus be highlighted.

Appendix A contains one additional graph and one additional table. This graph is the value weighted equivalent of Figure 7 (which looks at semi-deviation). The value weighted graphs for each of the other three risk measures have not been shown. The reason for this is that all three value weighted graphs show similar results to the equal weighted graphs, which are already shown. Semi-deviation was the only exception to this. The table is similar to that of Table 1; however it provides the regression results for value weighted portfolios.

Table 1 presents the results from the regression. A “*” indicates that the results are significant at a 10% level and “**” indicates that the results are significant at a 5% level.

Figure 4 presents the average risk measures for portfolios 1 and 10 for each of the four risk measures. The initial value for each measure has been rebased to equal that of beta. The reason for this is that beta is a more intuitive risk measure than can easily be benchmarked against a beta of 1. The value of beta is more meaningful if viewed independently. The purpose of the graph is simply to observe the movement in values of the risk measures, and how they reacted to changes in the underlying market conditions.

	Beta	**Standard deviation**	**Semi-deviation**	**VaR**
OVERALL				
Equal-weighting		*		
Intercept	-0.04009	-0.02218	0.00934	-0.01696
Coefficient	0.03068	0.57827	0.01257	0.32585
T statistic	0.60021	1.67495	0.54434	1.51168
P-value	0.54952	0.09659	0.58724	0.13329
R-squared	0.00304	0.02322	0.00250	0.01900
UP MARKET				
Equal-weighting				
Intercept	-0.00289	-0.00731	0.01774	0.02160
Coefficient	0.32555	0.55357	0.02364	0.00385
T statistic	1.15217	1.20504	0.73840	0.05629
P-value	0.25334	0.23243	0.46285	0.95528
R-squared	0.01943	0.02121	0.00807	0.00005
DOWN MARKET				
Equal-weighting				
Intercept	-0.05111	-0.04998	-0.01182	-0.04478
Coefficient	0.01088	0.73143	0.01475	0.41110
T statistic	0.17552	1.43689	0.46118	1.27671
P-value	0.86140	0.15710	0.64671	0.20772
R-squared	0.00063	0.04043	0.00432	0.03219

Table 1: Regression results (equal weighted portfolios)

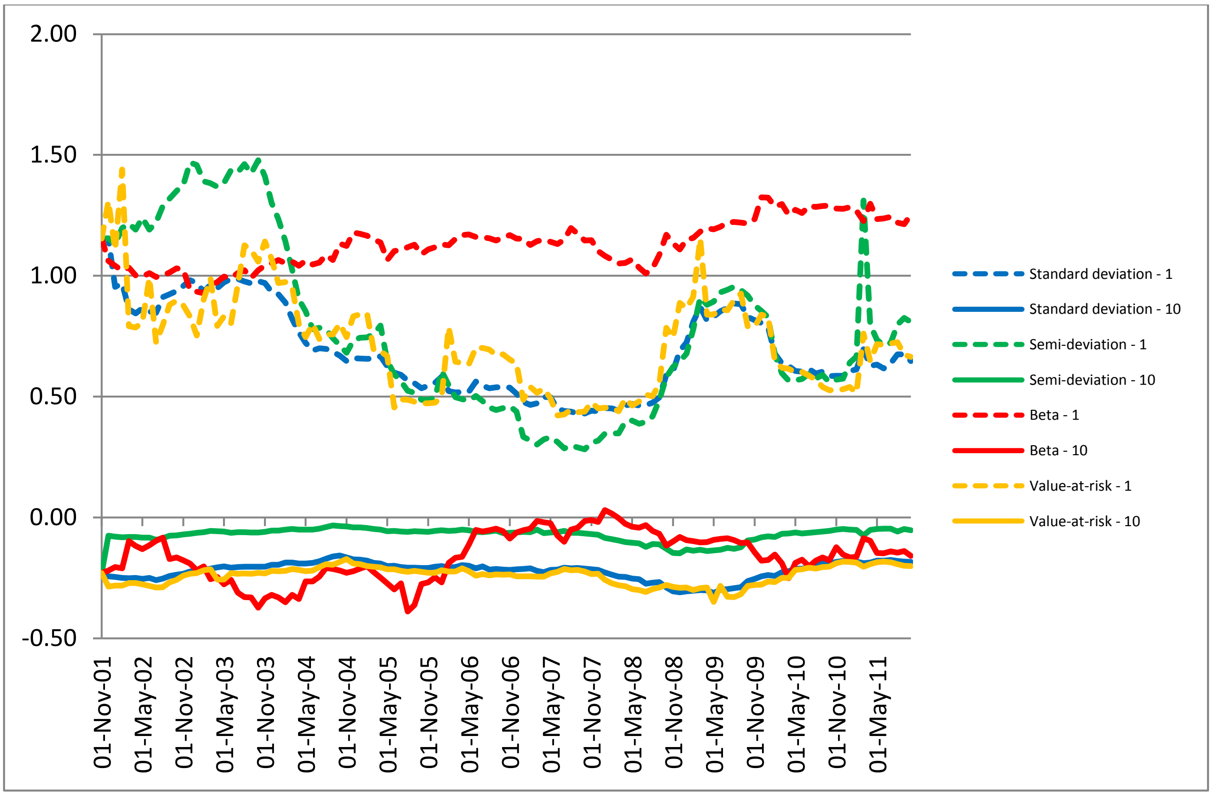

Figure 4: Monthly, average risk measure for both portfolios of each risk measure

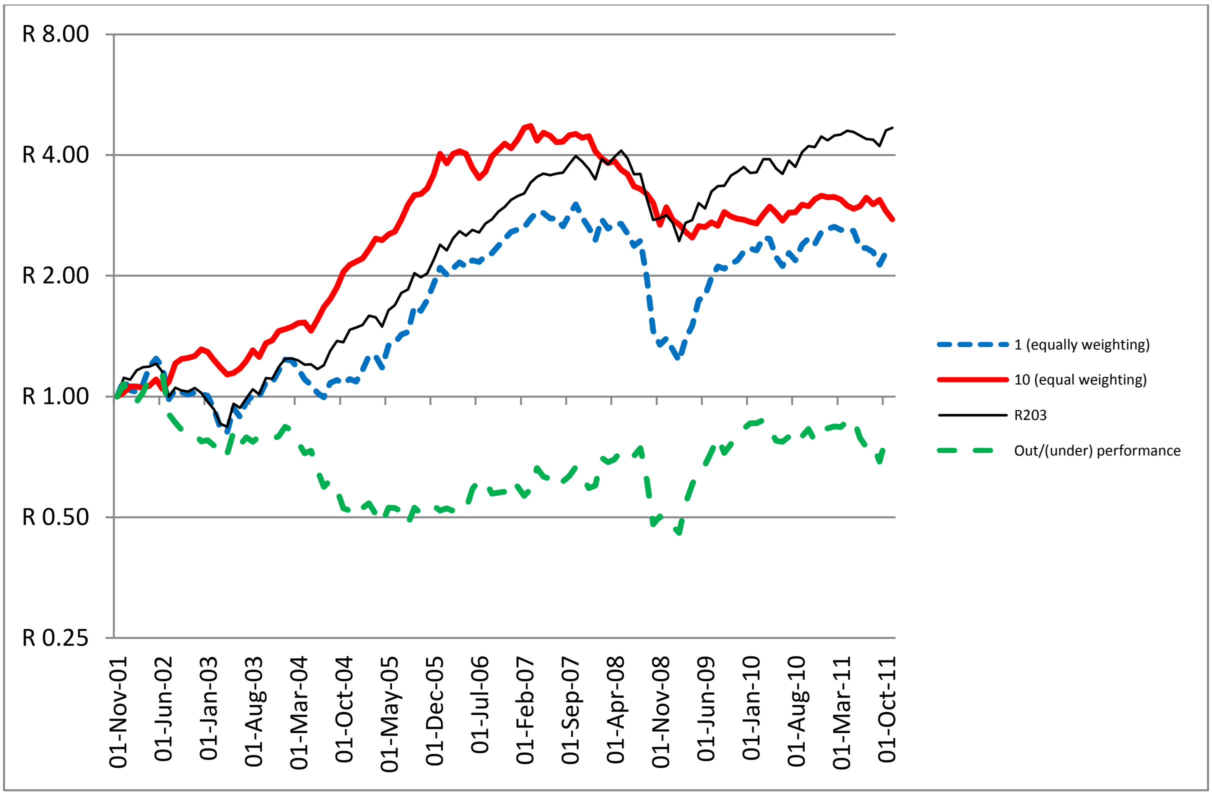

Figure 5: Beta (equal weighting, log scale)

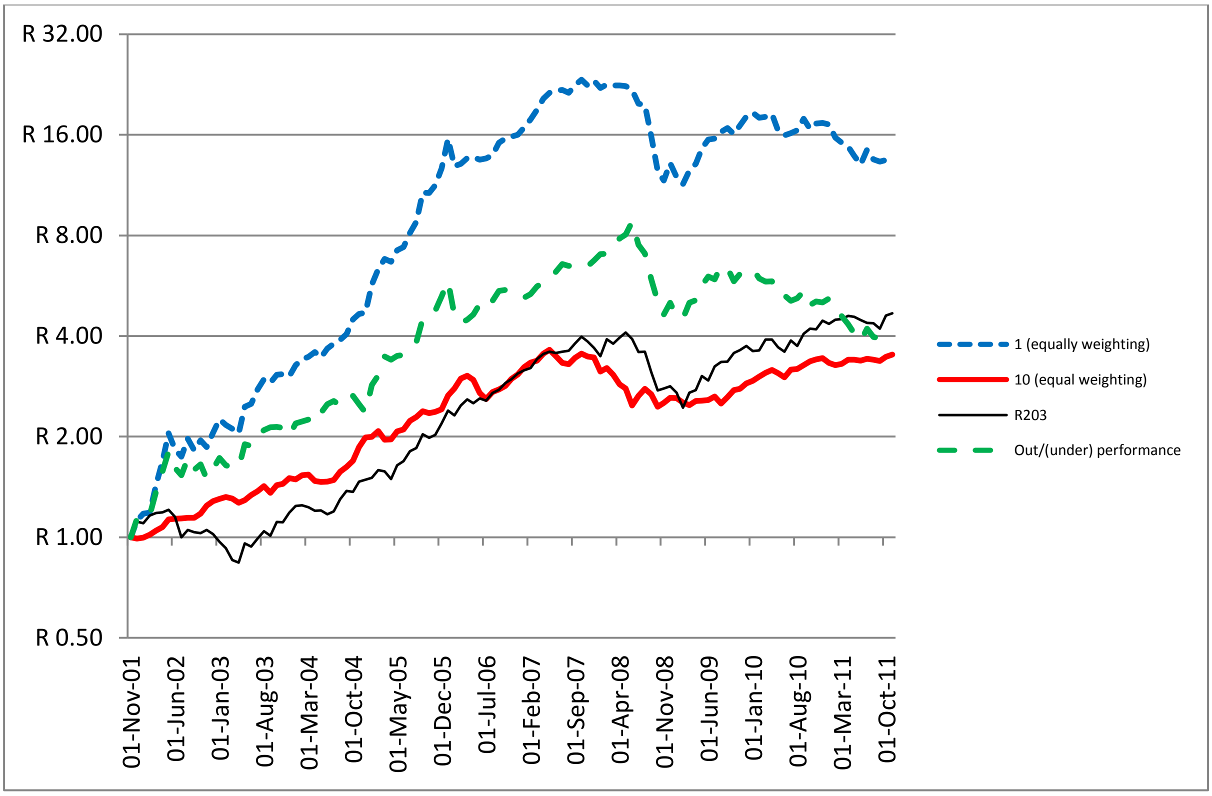

Figure 6: Standard deviation (equal weighting, log scale)

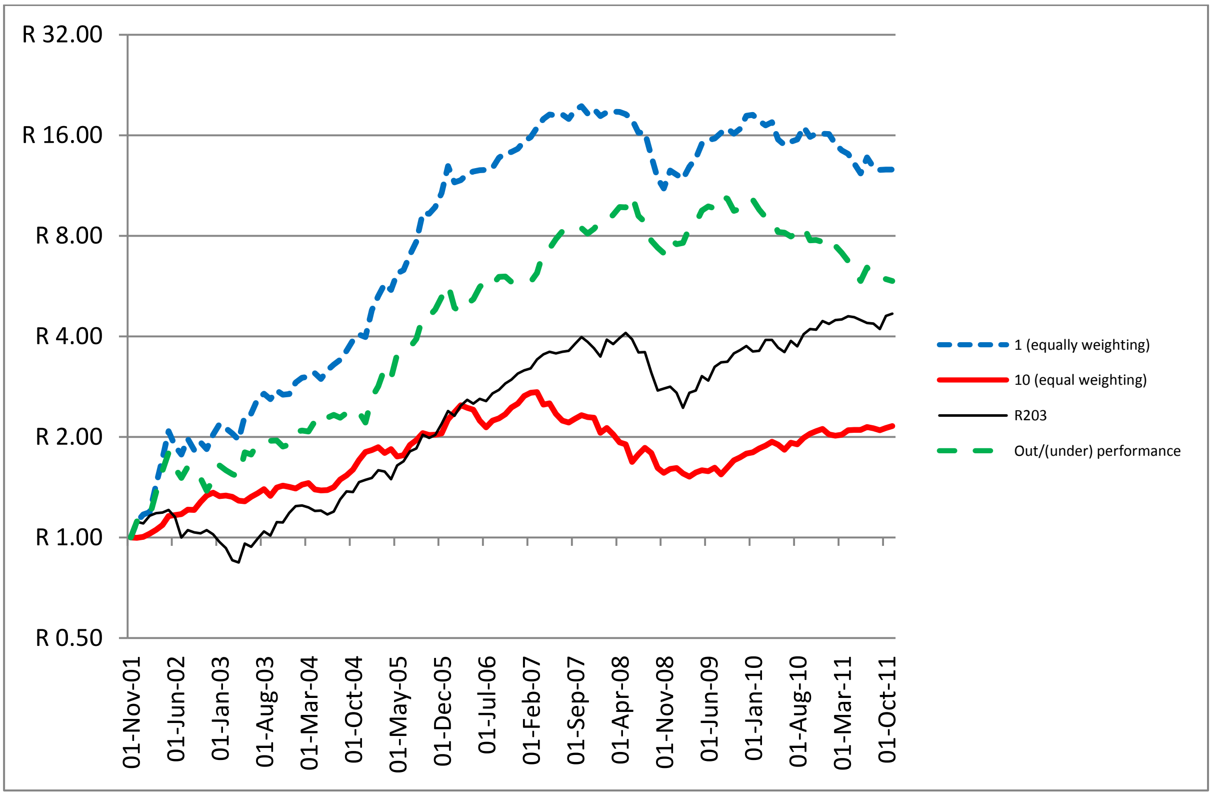

Figure 7: Semi-deviation (equal weighting, log scale)

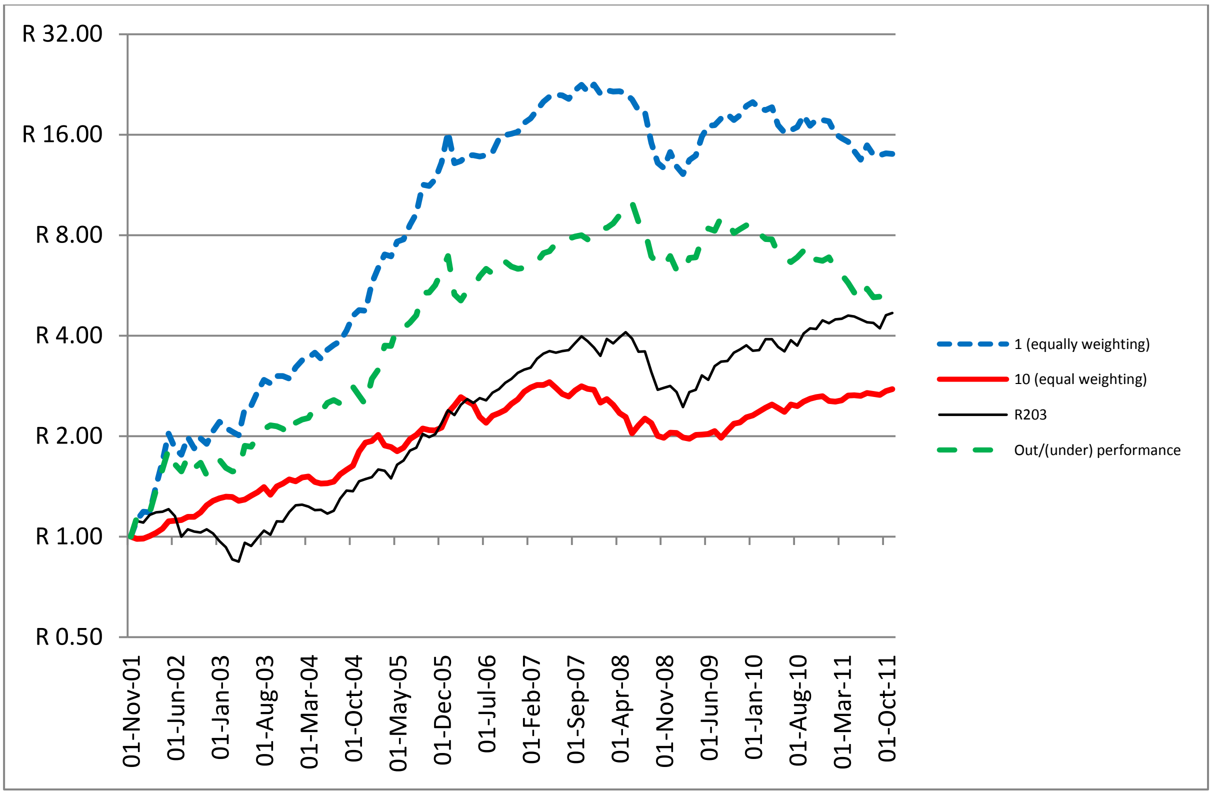

Figure 8: Value-at-risk (equal weighting, log scale)

4.4 Results pertaining to Sub-problem 2

The second sub-problem is to assess to what extent, if any, a relationship between risk and return can be identified in accordance with the conditional framework (both in an up and down market). All risk measures are presented on the same set of axes, so that a comparison between them can easily be made.

In the up market scenario, returns on the portfolios were only taken in to account when the JSE All Share Index (J203) increased during that month. So if the J203 increased in value by the end of the month, returns of the portfolio would be taken into account for that same month. Otherwise, for the duration of month where the J203 decreased, the value of the up market portfolio would not change. For this reason while the up market graph plateaus, the down market graph will not. And vice versa.

The portfolio of shares would be exactly the same for both up and down scenarios, however the cumulative returns would not be.

This enables one to observe is for example: during a month of relative pessimism (indicated by decrease in the J203), a downside risky share may underperform a beta risky share because investors may be more cautious of downside risk during these 'bad' months.

One graph is presented for the up market scenario and one graph is presented for the down market scenario. Both graphs are based on the equal-weighting of portfolios. The two corresponding value weighted graphs can be found in Appendix B.

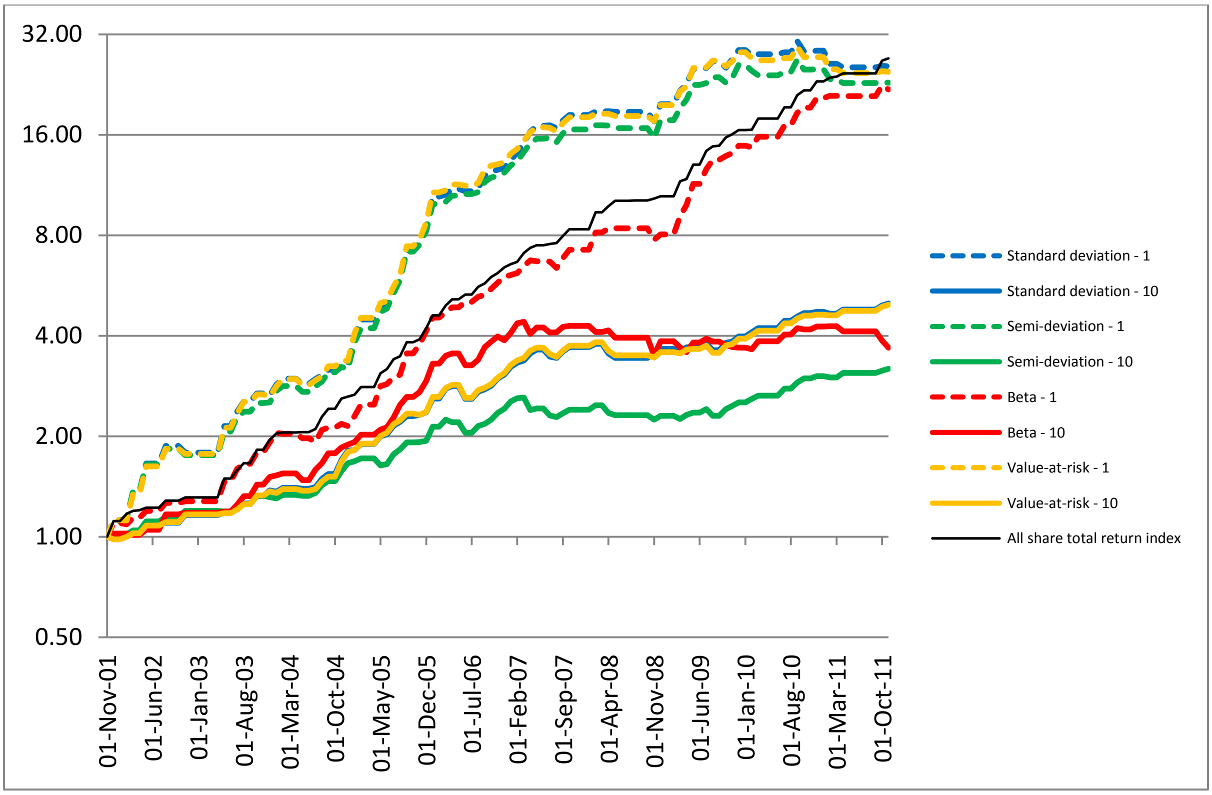

Figure 9: Up market (equal weighting, log scale)

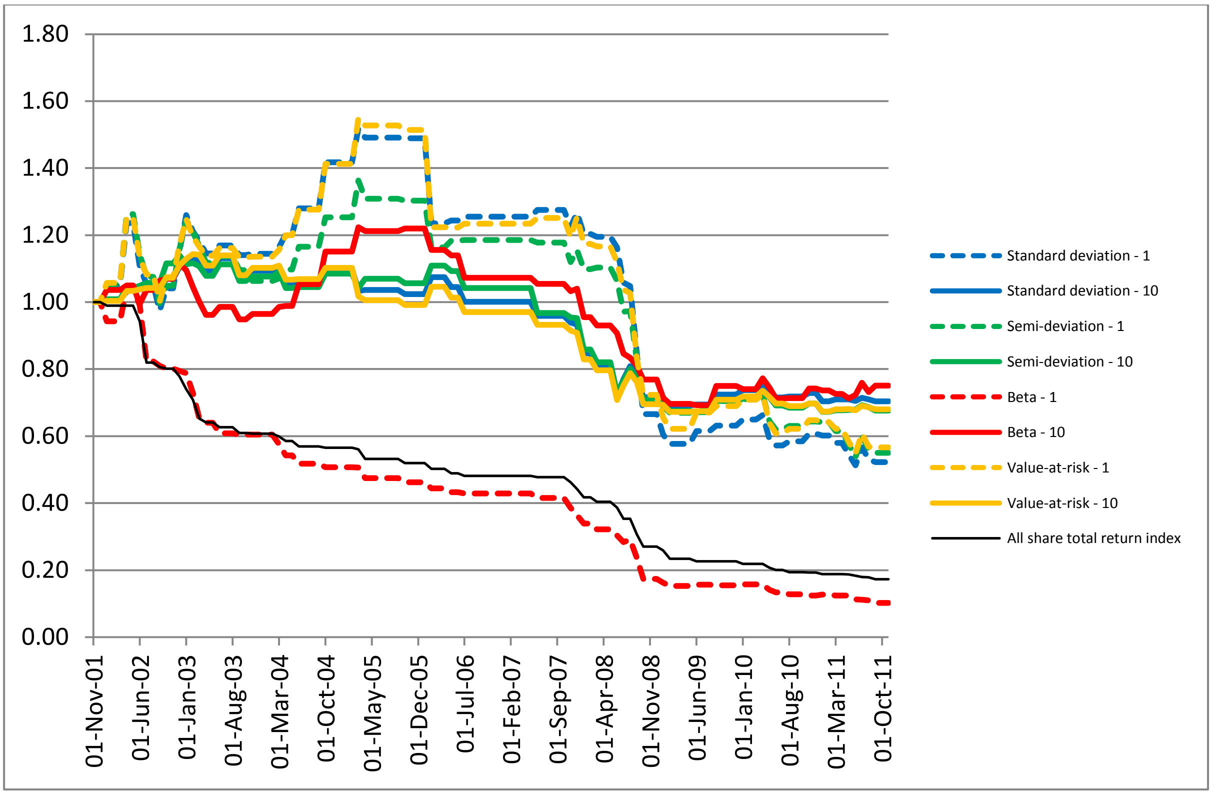

Figure 10: Down market (equal weighting)

4.5 Results pertaining to Sub-problem 3

The third sub-problem is to determine and understand which of the risk measures outperform or underperform one another during each of the four defined sub-periods. Each of the four sub-periods are evaluated exclusively so as to be able to identify any possible prevalence of any of the risk measures during differing underlying market conditions.

One graph is presented for each of the four sub-periods (the graphs are based on the equal weighting of shares within the portfolio). Similar, value weighted graphs can be found in Appendix C. Each of the four defined sub-periods provide a more detailed illustration of which of the risk measures most aptly capture the mood of the market during that sub-period. An additional four graphs have been included in Appendix C. These four equal weighted graphs show each risk measure separately. The graphs have been rebased to R1 for each of the sub-periods. This clearly shows the progression of each of the risk measures on a period by period basis.

The sub-period criteria are expected to yield intuitively similar results to those achieved when separating the results into up and down markets. This is due to the sub-periods being created on a similar basis (also based on the movement of the JSE All Share Index, but with a longer term perspective).

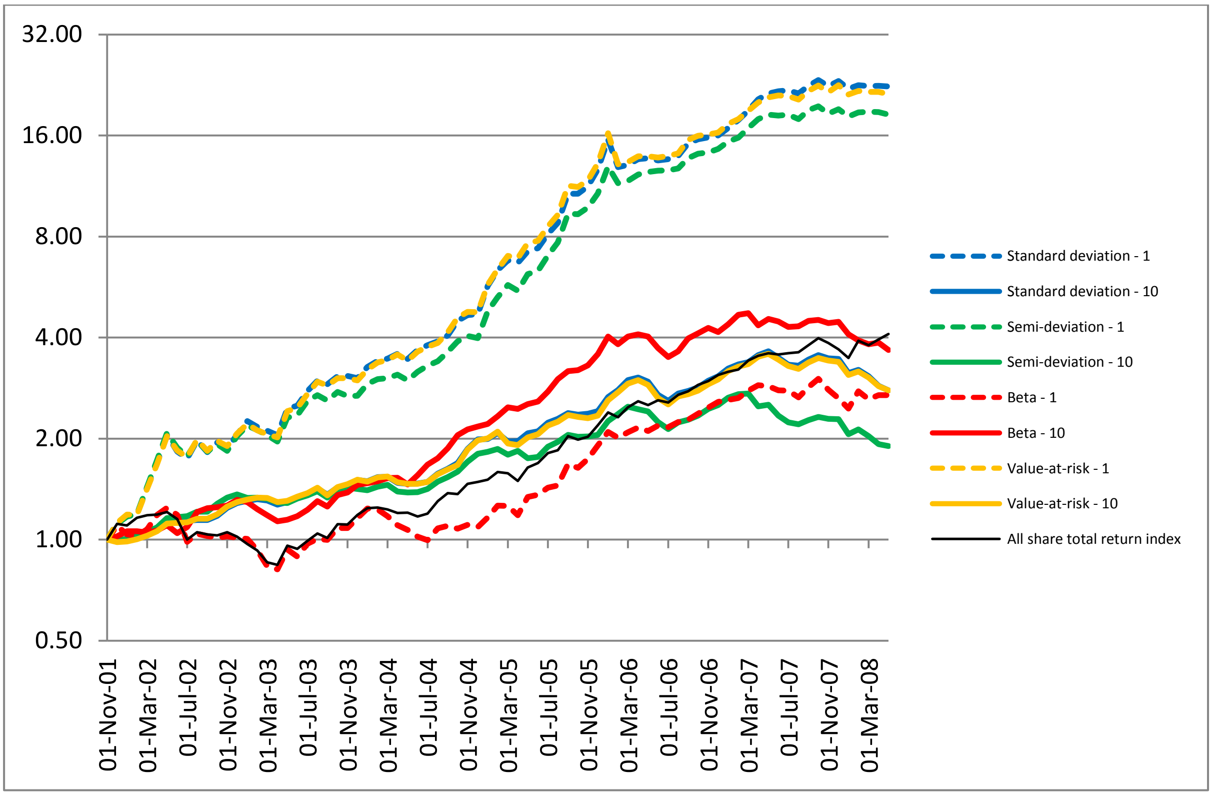

Figure 11: Sub-period 1 (1/12/2001 - 30/5/2008, equal weighting, log scale)

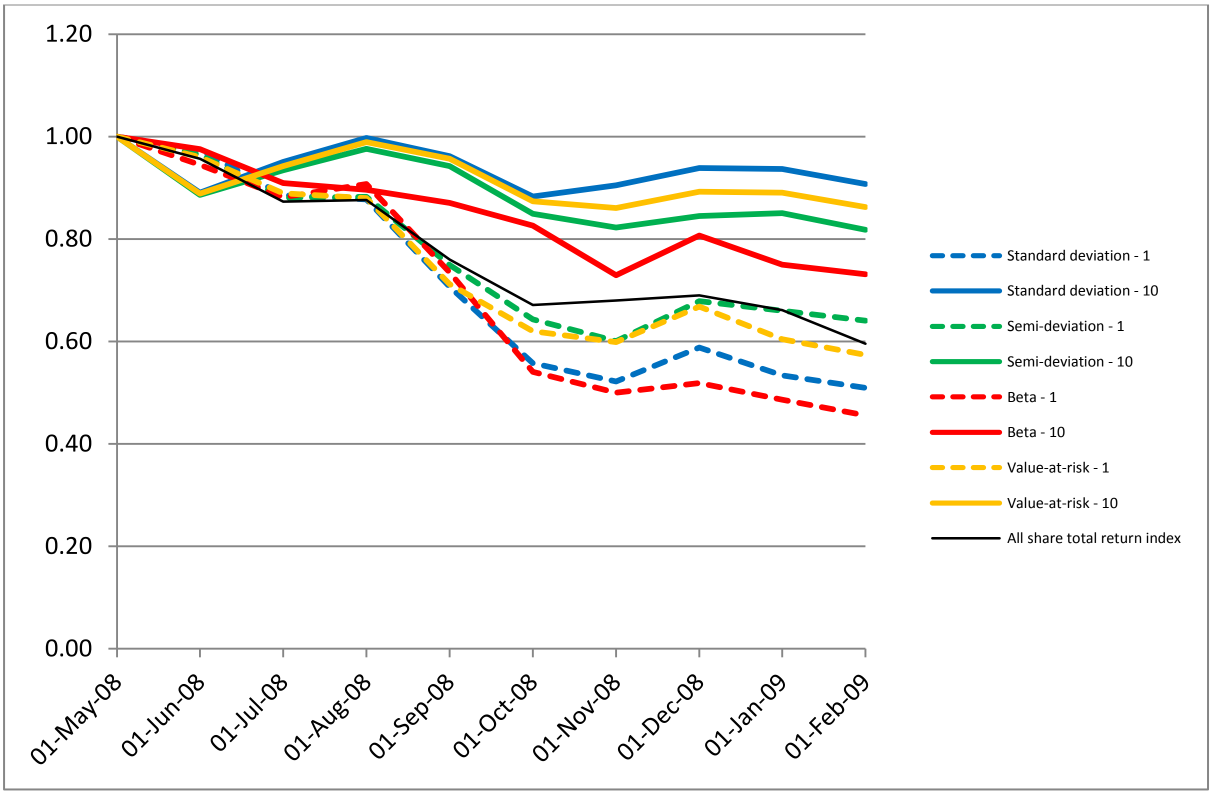

Figure 12: Sub-period 2 (2/6/2008 - 27/2/2009, equal weighting)

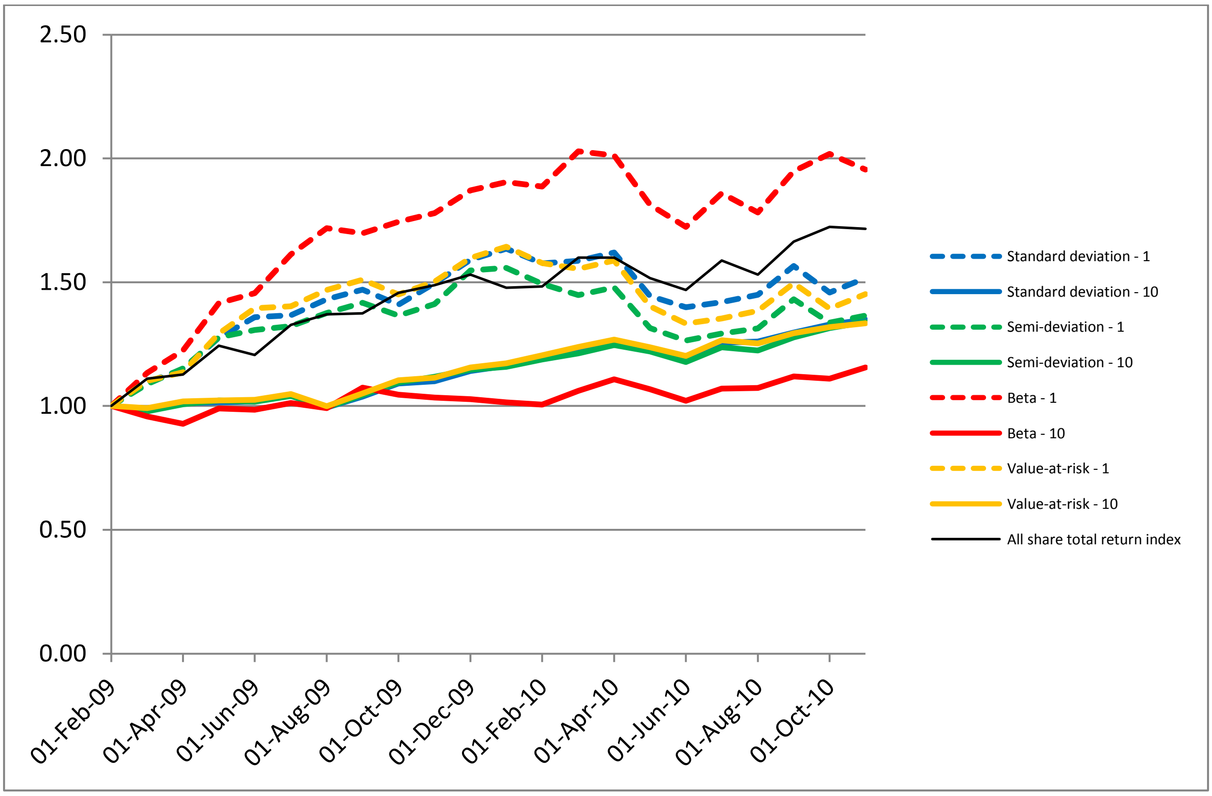

Figure 13: Sub-period 3 (2/3/2009 - 30/11/2010, equal weighting)

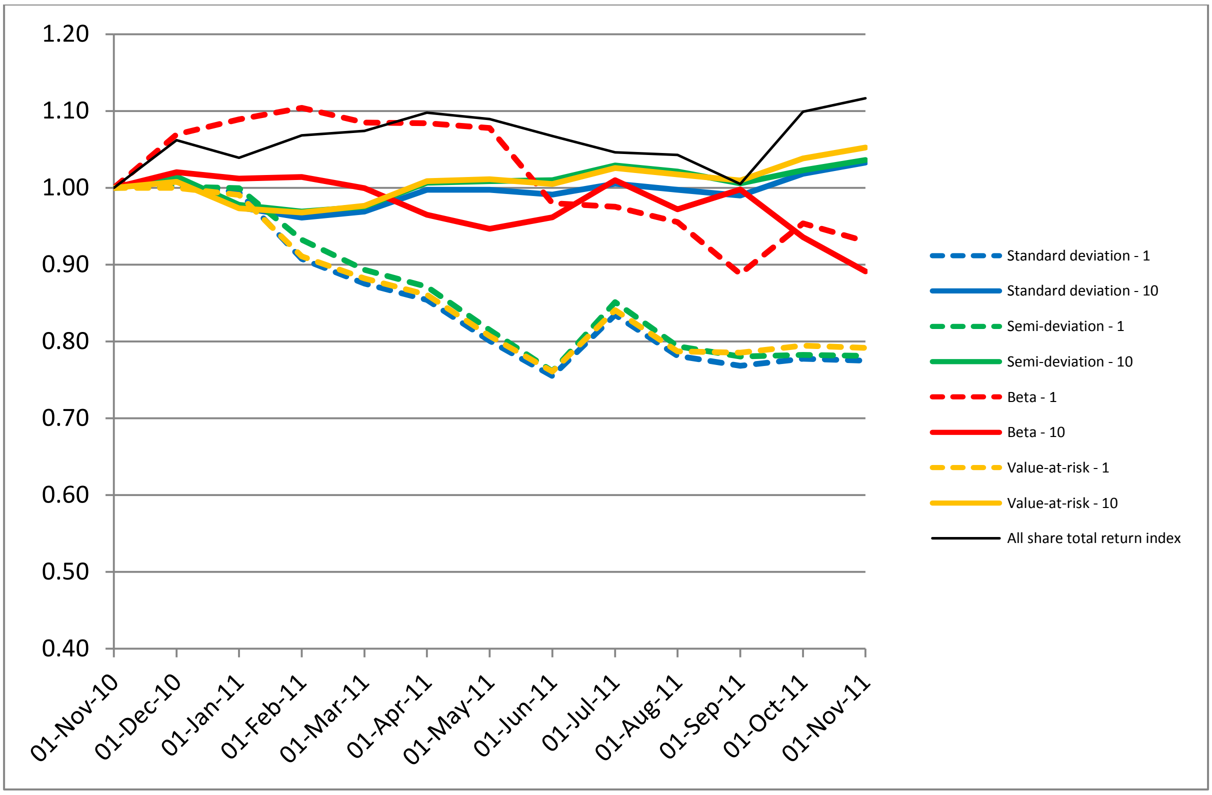

Figure 14: Sub-period 4 (1/12/2010 - 30/11/2011, equal weighting)

4.6 Summary of the results

The overall performance of the most risky and least risky portfolio for each of the four risk measures (in addition to the JSE All Share Total Return Index), can been seen in the following graph. The graph is based on the equal weighting of shares within the portfolios. A log scale of 2 has been used for ease of comparison. This graph spans the full 10 year period of the report. It allows the results from the three sub-problems to be viewed in an overall context. A similar, valued-weighted graph can be found in Appendix D.

Table 2 presents a numerical summary of all results. The monthly percentage returns of each portfolio can clearly be seen. The future values based on what R1 would be if it was invested in each of the portfolios can be seen in Appendix D. This is the summary table of data on which the graphs were drawn.

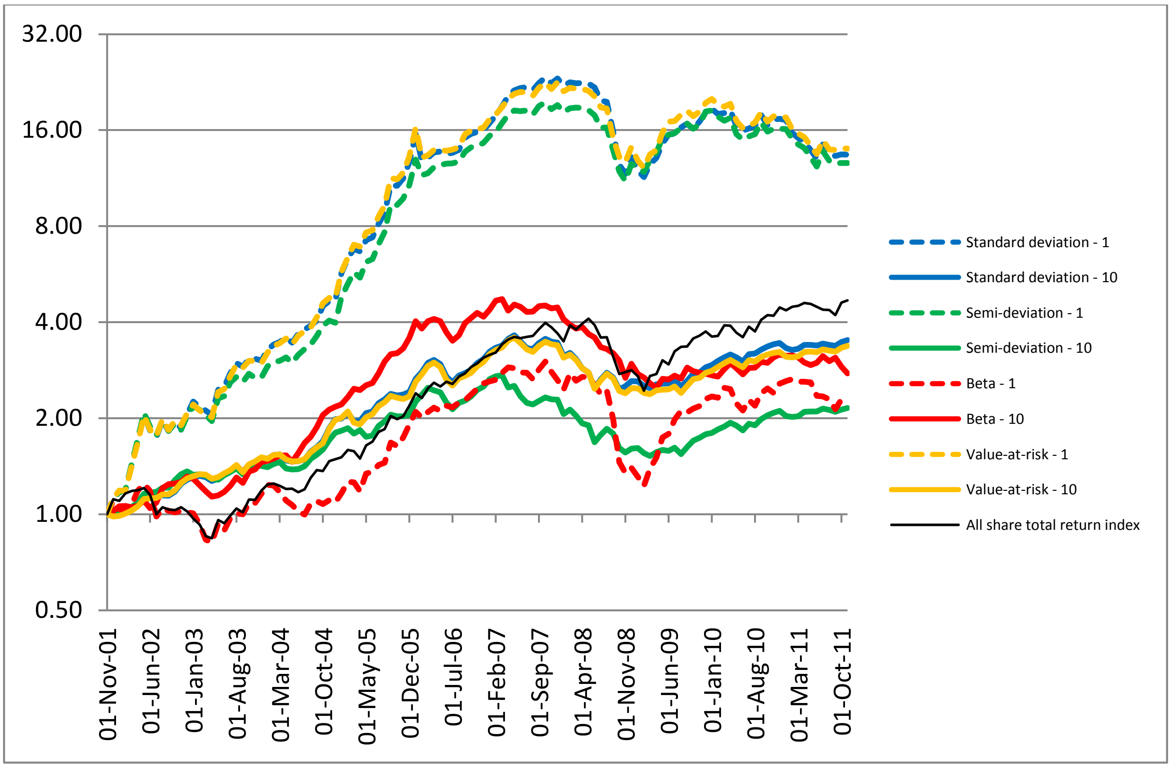

Figure 15: Overall (equal weighting, log scale)

	Portfolio								
	Beta		Standard deviation		Semi-deviation		VaR		All share total return index (R203)*
	1 (most risky)	10 (least risky)	1 (most risky)	10 (least risky)	1 (most risky)	10 (least risky)	1 (most risky)	10 (least risky)	
OVERALL MARKET									
1/12/2001 - 30/11/2011									
Equal weighted return	0.67%	0.85%	2.19%	1.05%	2.13%	0.64%	2.22%	1.02%	1.29%
Value weighted return	0.14%	0.23%	0.27%	0.88%	0.10%	0.88%	0.40%	0.84%	
UP/DOWN MARKET									
Up markets									
Equal weighted return	4.57%	1.91%	4.81%	2.36%	4.64%	1.69%	4.76%	2.35%	4.90%
Value weighted return	4.14%	0.93%	2.44%	2.18%	2.86%	2.09%	2.31%	2.41%	
Down markets									
Equal weighted return	-4.38%	-0.56%	-1.27%	-0.69%	-1.16%	-0.76%	-1.11%	-0.75%	-3.39%
Value weighted return	-5.03%	-0.70%	-2.59%	-0.85%	-3.52%	-0.75%	-2.13%	-1.26%	
SUB-PERIODS									
1/12/2001 - 30/5/2008									
Equal weighted return	1.28%	1.68%	4.07%	1.32%	3.81%	0.83%	4.00%	1.32%	1.83%
Value weighted return	0.60%	0.82%	2.51%	1.41%	1.75%	1.70%	2.56%	1.47%	
2/6/2008 - 27/2/2009									
Equal weighted return	-8.36%	-3.42%	-7.23%	-1.08%	-4.83%	-2.21%	-5.98%	-1.63%	-5.60%
Value weighted return	-9.34%	-2.53%	-11.05%	-1.36%	-7.70%	-3.53%	-9.49%	-2.40%	
2/3/2009 - 30/11/2010									
Equal weighted return	3.25%	0.69%	2.00%	1.43%	1.49%	1.40%	1.79%	1.38%	2.60%
Value weighted return	2.68%	0.20%	0.35%	0.17%	-0.07%	0.02%	0.24%	0.03%	
1/12/2010 - 30/11/2011									
Equal weighted return	-0.60%	-0.96%	-2.10%	0.27%	-2.04%	0.30%	-1.93%	0.43%	0.92%
Value weighted return	0.24%	-1.39%	-5.16%	0.35%	-4.06%	0.41%	-5.22%	0.60%	

Table 2: Summary table – average monthly percentage returns for each portfolio

CHAPTER 5: DISCUSSION OF THE RESULTS

5.1 Introduction

The results pertaining to each of the sub-problems will be discussed separately to the extent that the discussion can be reasonably separated. The discussion will mostly follow the same format as with the presentation of results. Due to some conceptual overlap between sub-problems and the interpretation of their results, the discussion of the results within the sub-periods may overlap. The general discussion, which precedes the more detailed discussion of the sub-problems, will discuss factors affecting most of the results.

As discussed, more weight will be given to results from the equal weighted portfolios as single share irregularities have a lower probability of affecting results than with value weighted portfolios.

5.2 General discussion points

5.2.1 *Outlying returns in value weighted portfolios*

Some of the poor performance of most of the value weighted portfolios is attributable to Lonmin Plc (LON) performing poorly in 2008. Approximately 35% and 40% of its value was lost in September and October 2008 respectively. Mvelaphanda Resources Limited (MVL) also caused some of the noticeable decline in April 2011, two months prior to its delisting. MVL lost approximately 89% of its value during this month. This movement bore less weight in the equal weighted portfolios and as such its impact is less noticeable as compared with its greater impact on the value weighted portfolios.

5.2.2 *Portfolio tracking results*

It is important to assess the reasonability of the portfolio tracking results for two reasons. The first reason is simply to affirm some of the accuracy of the results. The second reason is to benchmark the results against other similar research, which used different proxies for risk.

The most suitable study against which to benchmark the results in this research report is the research by Basiewicz and Auret (2009). Not only was the study conducted on the JSE, but there is a significant time overlap of data, with sub-period 1 in this research report. Their sample period stretched from December 1989 to July 2005.

Their monthly returns due individually to size and book-to-market factors ranged from 0.82% to 1.86%. Their value weighted portfolios performed more poorly than the equal weighted portfolios in their report. The returns for sub-period 1 in this research report are up to 4.07% on an equal weighted basis and up to 2.56% on a value weighted basis.

The returns in this research report are evidently higher than those in Basiewicz and Auret (2009). This yields some *prima facie* evidence in favour of the four measures of risk used in this research report, over other proxies for risk (such as book-to-market ratios) used in Basiewicz and Auret (2009). As both papers used slightly different methodologies and different time periods, one should be cautious about placing too much reliance on the above comparison between returns.

5.2.3 ***Regression statistics***

It is also important to assess the reasonability of the regression results for the same two reasons as for the portfolio tracking results.

The regressions results appear on a whole to lack significance. Of the 24 regressions that were run, two were statistically significant at a 5% level while a further three were significant at a 10% level. Although the results appear weak, all the coefficients point to a positive risk-return relationship. This may appear supportive of the logic of greater risk equals greater return, but careful attention needs to be paid as to under what conditions this relationship is expected to hold.

The explanatory nature (as captured by the r-squared statistic) of each of the risk measures is also quite low. It ranges from 0.005% to 7.98%.

Gujarati (2003) does caution one against overestimating the importance of the r-squared indicator, and rather suggest that the theoretical underpinning of the model is of more importance, including the signs of the coefficients and their statistical significance. Furthermore, the r-squared value is only meaningful when testing a linear relationship. The low r-squared values may therefore simply mean that there is no linear relationship between risk and return. Amenc et al (2011) also considered the possibility of a non-linear relationship. The use of the portfolio tracking methodology in both that and this research specifically deals with the possibility of there being a non-linear relationship.

5.3 Discussion pertaining to sub-problem 1

A high-level discussion of the results will be addressed in this section. Sub-problem 2 and 3 will deal with the same four risk measures but in more detail as each of the four sub-periods are discussed separately.

5.3.1 ***Beta***

The overall regression and portfolio tracking results for beta are weak, and statistically insignificant, although the results do point to a positive risk-return relationship. The r-squared values are 0.30% for equal weighted portfolios and 1.11% for value weighted portfolios. The least risky portfolio has outperformed the most risky portfolio, yet both portfolios had weak returns (0.67% per month for the risky portfolio and 0.85% per month for the least risky portfolio). The value weighted robustness test was also insignificant, and yielded even lower monthly returns (0.14% for the risky portfolio and 0.23% for the least risky portfolio).

This lack of support for beta is in line with local and international studies. In South Africa, van Rensburg and Robertson (2003) and Auret and Sinclaire (2006) did not attempt to use beta to explain share return due to the total lack of support for beta. Fama and French (1992) and Daniel and Titman (1997) are two of many international studies which largely reject beta’s ability to explain share return.

To add any meaning to the beta-return relationship, or rather to the lack thereof, the possibilities for this lack of relationship have been explored.

Two reasons have been identified from the regression results that could explain the lack of support for beta as a measure of risk. Firstly, the beta risk-return relationship may not linear, and although beta may be measuring systematic risk, this may not be able to explain return.

One benefit of the portfolio tracking methodology is that it takes into account non-linear relationships. Tang and Shum (2004) found that the relationship between beta and returns under conditional and non-conditional criteria was non-linear. The results from the portfolio tracking methodology may therefore be more important that the results from the regression, in this regard. The results for beta, under the portfolio tracking methodology are however weak. The beta portfolios show no outperformance and the most risky portfolio underperforms the least risky portfolio.

The second reason for the lack of support for beta deals with the extent to which systematic risk captures the effect of total risk. Montgomery and Singh (1984) concluded that systematic risk only accounts for a small portion of total risk. Lakonishok and Shapiro (1984) found that systematic risk explained very little of the variation of returns in their study. There is a possibility that as discussed by Merton (1987), Malkiel and Xu (2002), Tang and Shum (2004) and Amenc et al (2011), that investors are not fully diversified and therefore systematic risk is not the only risk for which compensation will be received. Although Lakonishok and Shapiro (1986) argued that arbitrageurs will take advantage of any opportunities and remove this risk. A complicating issue for the effectiveness of such arbitrage is the lack of liquidity on the JSE, resulting in such opportunities not being eroded, and therefore not removing the risk.

Another observation which supports the lack of beta, is the variability of its value of risk. It can be seen in Figure 4, that the average beta for the most risky portfolio does not vary significantly (particularly when contrasted to the other risk measures). The average beta for the least risky portfolio does however vary more than the other risk measures. This can possibly explain the results for beta. The large amount of variability of the least risky beta portfolios has enabled it to outperform the most risky beta portfolio.

In conclusion, beta may be an effective risk measure in capturing systematic risk but is unable to explain much of the variation in returns for the overall ten year period in this research report.

5.3.2 ***Standard deviation***

The regression statistics for standard deviation indicate a positive risk-return relationship. This relationship is statistically significant at a 10% level under equal weighting and at a 5% level under value weighted. Although the r-squared values appear to be low, at 2.32% and 3.99% respectively, these results are strongest amongst the four risk measures dealt with this this research report.

The regression results are supported by the portfolio tracking results. Under the equal weighted scenario, standard deviation is the second best performer of the risky portfolios (returning 2.19% per month) and is the top performer of the least risky portfolios (1.05% per month). The value weighted results are largely influenced by Lonmin Plc, which distorted the results, and should perhaps be considered to be an outlier. With the exclusion of this share, standard deviation reverts to the second best and best performing portfolio.

These results are in line with the findings of Lakonishok and Shapiro (1984) and Amenc et al (2011), indicating that standard deviation effectively captures total risk.

The variability in the average standard deviation is reflected in Figure 4. The most risky portfolio shows a constant decrease in standard deviation over the 10 year period, until the crash of 2008/2009. The average standard deviation increased during the crash and dropped thereafter, although not to the low which was experienced prior to the market crash in 2008/2009. The constant decrease of the average standard deviation may point to an improvement in liquidity and therefore lower variability in risk over the years. If one considers the movement in average standard deviation to the movement of the JSE All Share Index one can conclude that standard deviation is a barometer for the mood of the market. Leading up to the market crash of 2008/2009, the standard deviation dropped as investors were calm after a number of good years. The spike reflected investors panic during the crash. This then decreased as investors remained cautious about a market recovery. As expected, the variability of the least risky standard deviation portfolio was low, including the period of the market crash.

The results therefore indicate that standard deviation has effectively captured total risk and provides explanatory evidence for the variability of returns over the full ten year period.

5.3.3 *Semi-deviation*

The regression results for semi-deviation indicate an r-squared value of 0.25% for equal weighted and 1.17% for value weighted, indicating a weak relationship. There is some evidence of a positive risk-return relationship.

The portfolio tracking results are only slightly stronger, but are still quite weak. Semi-deviation is the third best performer of the risky portfolios and is only slightly behind the other measures at a return of 2.13% per month. The least risky portfolio is however the worst performer of all of the risk measures. In the value weighted results, the least risky portfolio has outperformed the most risky portfolio over the ten year period. The most risky portfolio is the worst performing portfolio of all the portfolios (that is including both the risky and least risky portfolios).

The results are therefore inconclusive for semi-deviation. There is no clear support for the measure over the full ten year period. These findings are in line with Liang and Park (2007) where little support was found for semi-deviation as a measure of risk. Estrada (2007) and Liang and Park (2007) commented that investors are more concerned about downside risk than upside risk. Based on this understanding, semi-deviation should return significant results over the full ten year period. These findings are therefore contrary to the understanding of the risk measure. The weak support does not necessarily mean that investors are not more concerned about downside risk, but it can simply mean that this measure of downside risk does not effectively capture the concern of investors.

Figure 4 illustrates that average semi-deviation of the most risky portfolio does react to the underlying market conditions. There was a constant decrease leading up to the market crash of 2008/2009, where it spiked sharply. The average semi-deviation then decreased although remained off its low, indicating some heightened concern about risk. The uncharacteristic movement in 2011 was as a result of an outlying share's movement. The average semi-deviation of the least risky portfolio did not vary much throughout the period.

Over the ten year period the ability of semi-deviation to explain the variability of returns is low. More significant results may arise during both down markets and sub-period 2 as discussed later.

5.3.4 ***Value-at-risk***

The regression results are significant at a 10% level under the value weighted scenario. Under the equal weighted scenario the regression results are not significant. The results for value-at-risk are second to the results from standard deviation. The r-squared values are 1.90% and 2.68% for the equal and value weighted portfolios respectively.

The portfolio tracking results are also significant. Both the equal and value weighted results show that the most risky value-at-risk portfolio is the best performing portfolio (returning 2.22% and 0.4% per month respectively). Of the least risky portfolios, value-at-risk still performs quite strongly.

When examining the movement of the average value-at-risk for the most risky and least risky portfolio in Figure 4, it is clear that value-at-risk moves in line with standard deviation and semi-deviation. Value-at-risk has reacted largely in terms of the movement of the overall market. Its movement, although similar to the other two risk measures, is more volatile and reacts more strongly to the underlying market conditions. The least risky portfolio does however not deviate much.

Value-at-risk, like semi-deviation, is a measure of downside risk, therefore value-at-risk should provide significant results if they managed to capture investors feelings (as described in Estrada (2007) and Liang and Park (2007)).

In line with the results above, Liang and Park (2007) found only some support in favour of value-at-risk. In contrast however, Bali and Cakici (2004) found strong support for value-at-risk, while Amenc et al (2011) found significant support for value-at-risk when looking at a long-term risk-return relationship. Amenc et al (2011) did however not find significant support for value-at-risk over a short-term horizon. Based on this, and their other results, Amenc et al (2011) concluded that time horizon does matter when assessing the risk-return trade-off.

5.4 Discussion pertaining to sub-problem 2

This section discusses the results achieved by the creation of an up and down market criteria.

A major concern with the up-down consideration is that it involves the forecasting of whether the market will move up or down in the following month, which is extremely difficult; however it may be more reasonable and have some degree of accuracy during strong bull or bear markets (where movement has been consistent for a period of time). As a large number of investors may be unable or may not attempt to forecast the movement in the JSE All Share Index, the results from this sub-problem may not be that relevant. The monthly movement of the JSE All Share Index may also not be relevant for two reasons, firstly, traders may bet on only a few shares which are expected to do well over a short term (less than a month). Secondly, a large number of investors may invest for the long term and the forecasting, or idea of short-term risk, of only a single month would not be relevant to them. One can however attempt to counteract this argument by assuming that investors may either consciously or sub-consciously be concerned about different types of risk during good or bad months.

To highlight the difficultly and occasional ease of market prediction, the following table shows the smallest, largest and average monthly movement of the All Share Index (J203).

	Smallest monthly movement	**Largest monthly movement**	**Average monthly movement**
Up market	0.27%	14.03%	4.70%
Down market	-0.06%	-13.96%	-3.57%

Table 3: Monthly percentage movement of the J203 during up and down markets

It is therefore clear that in some months the movement on the All Share Index is extremely small (less than 0.5%). While in other months it may be easier to predict the movement as it can be seen that the movement was approximately a 14% increase or decrease. Based on the average movement (4.70% and -3.57%) it would probably have been difficult to predict the monthly movement of the All Share Index.

Considering the discussion above, investor sentiment and psychology may play an important role in this section. It is possible that investors are more concerned about downside risk than upside risk during different market conditions.

In Lakonishok and Shapiro (1984) and Tang and Shum (2004), the use of an up and down criteria has resulted in significant results being achieved. They argued that the creation of an up and down market added value and significance to the risk-return relationship.

5.4.1 ***Up market***

The equal weighted up market graph in Figure 9 shows a clear picture of the most risky portfolios for each the four risk measures far outperforming the least risky portfolios. The risky portfolios of standard deviation, semi-deviation and value-at-risk track each other almost exactly. The risky beta portfolio closely tracks the R203 index in both the equal and value weighting graphs. The portfolio tracking results shows significant results for standard deviation (4.81% and 2.36% per month for the risky and least risky portfolio respectively) and value-at-risk (4.76% and 2.35% per month for the risky and least risky portfolio respectively). Weaker results were found for beta (4.57% and 1.91% per month for the risky and least risky portfolio respectively) and semi-deviation (4.64% and 1.69% per month for the risky and least risky portfolio respectively). All these portfolios did however underperform a benchmark return of the R203 (which returned 4.90% per month). Once again the assumption of 100% loss upon delisting will lower portfolio returns (although not to that great an extent as not many companies delisted during the up markets months).

The value weighted portfolio tracking results in Figure 17 present a distorted picture where it is difficult to identify significant results.

The regression statistics support similar conclusions that can be reached from the portfolio tracking methodology. Standard deviation is the only measure which stands up to the robustness test of equal and value weighting. The standard deviation-return relationship was significant at a 10% level under the value weighting scenario.

The results for beta are fairly weak. The explanatory power of beta does increase by a factor of 6 over its explanatory power in the overall scenario. This increase can be contrasted to the 100 fold increase in explanatory power as found in Tang and Shum (2004).

The two downside risk measures: semi-deviation and value-at-risk provided very weak regression relates. On a whole these measures were ineffective in explaining returns during the up period. Considering the theory of these measures, this is in line with expectations. The results therefore indicate that investors are not concerned about downside risk (measured by semi-deviation and value-at-risk) during up markets.

While there is some support for standard deviation, the most important conclusion that can be reached from the creation of the up market criteria is the poor performance of the downside risk measures. This conclusion may provide evidence with respect to investor sentiment during specific market conditions.

5.4.2 ***Down market***

Figure 10 reflects that not much difference can be seen for most of the risk measures (in the equal weighted scenario). The only exception was the most risky beta portfolio, which performed extremely poorly, and almost tracked the All Share Total Return Index. This tracking may be due to the method of calculating beta (this tracking was also seen in the up market scenario). As a benchmark, the R203 underperformed all but the most risky beta portfolio by more than 2% per month. The least risky portfolios outperformed the most risky portfolios. During down markets, better performance by less risky assets is in line with theory and logic.

The value weighted graph, in Figure 18, represents a similar situation although there is a greater spread between risk measure returns.

From the portfolio tracking methodology, the only clear conclusion that can be drawn is a lack of support for beta. There is some support for each of the other risk measures.

Unlike in the up market scenario (and Tang and Shum (2004)), the explanatory power of beta is now much lower and statically very insignificant. Standard deviation results are fairly strong. There is no significant result in favour of semi-deviation. There is however significant result in favour of value-at-risk. These are the strongest results of all of the regression that were run in this research report. The explanatory power of value-at-risk is 7.98%.

Considering the theory of risk measures, these results are in line with expectations. Standard deviation represents total risk and as such it is expected to always be relevant. In this case, it is the most relevant measure in the up market scenario and the second most relevant measure in the down market scenario. Semi-deviation, which as the theory dictates, measures downside risk. It has however been unable to effectively measure risk and explain return during the down months. This measure did not explain the risk-return relationship in an up market scenario, possibly as downside risk is not relevant during up markets. The other downside risk measure used, value-at-risk, has explained the risk-return relationship reasonably well during down markets. As with semi-deviation, during up markets, this downside measure has been meaningless, which suggests that the investors are not concerned about downside risk during up markets.

5.5 Discussion pertaining to sub-problem 3

This sub-problem considers each of the four defined sub-periods separately. Each sub-period has different characteristics, and the role of each risk measure may be different in each sub-period. Figure 2 graphically presents the four sub-periods in relation to the movement of the JSE All Share Index.

5.6.1 ***Period 1 (1 December 2001 to 31 May 2008)***

As discussed previously, this sub-period was characterised by an initial poor 18 months, followed by a strong bull market over the remaining five years.

Figure 11 illustrates that the portfolio tracking results are relatively clear for standard deviation, semi-deviation and value-at-risk. As expected the most risky portfolio (1) outperformed the least risky portfolio (10). This outperformance was approximately 3% per month for each of these three risk measures. This is considered to be a considerable return spread. The return spread drastically decreases when the value weighted portfolios are considered as depicted in Figure 19. Only standard deviation and value-at-risk show notable outperformance (approximately 1% per month). Beta, under both portfolio weightings, reflects an inverse risk-return relationship. The least risky beta portfolio is outperforming the most risky beta portfolio. Under the equal weighted scenario, the least risky beta portfolio is the best performer of all of the least risky portfolios. Yet under the value weighted portfolio, the two beta portfolios were the two worst performing portfolios. Furthermore, the beta monthly return spread was less than 1% per month.

During this period, beta on a whole was a poor indicator of returns. Only the least risky beta portfolio showed some promise under equal weighting. This lack of support for beta is in line with previous evidence presented earlier in the research report. The results from the up market category may be compared to the results from the strong bull market during this period. The results of both of these sub-categories are consistent. Beta may be explaining systematic risk but like Tang and Shum (2004) found, specific risk is rewarded in addition to systematic risk due to lack of portfolio diversification.

Standard deviation and value-at-risk provided very similar and convincing results under both equal and value weighting. The strong performance by standard deviation is not surprising, given its strong results in both the up, down and overall scenarios. The performance by both value-at-risk portfolios is more interesting. It closely mirrors the returns of standard deviation. The understanding of value-at-risk is very different to that of standard deviation. Standard deviation measures any deviation around the mean. Value-at-risk, however only measures the maximum expected loss given certain conditions. It is expected that value-at-risk would be more suited to poor market conditions where investors are concerned about how much they would lose. What the evidence is possibly suggesting is that investors are still concerned about downside risk even during an extended period of gains. This possibility is however not corroborated by the poor performance of the other downside risk measure, semi-deviation. The poor results for semi-deviation are consistent with the lack of support for it as a risk measure during up and down markets as well as on a whole.

As a general benchmark, bearing in mind the 100% loss assumption upon delisting, only the risky portfolios of standard deviation and value-at-risk definitively outperform the benchmark of the JSE All Share Total Return Index (R203). Due to the high amount of shares that delisted during this period (78), some of the other portfolios may have also actually outperformed the Total Return Index.

5.6.2 ***Period 2 (1 June 2008 to 28 February 2009)***

This sub-period was characterised by the global market crash. It lasted nine months. The JSE All Share Index lost approximately 42% of its value. There was a large amount of selling both locally and internationally. Investors were very nervous about any so called 'risky' assets. It is interesting to consider which of the four chosen quantifications for risk, best captured risk during this period.

Based on the theoretical understanding of each of the risk measures one can generate an expectation of which risk measure should best capture risk. The two downside risk measures should best capture risk during this period. That is semi-deviation and value-at-risk.

As logically expected, the four least risky portfolios have outperformed the four most risky portfolios. The JSE All Share Total Return Index has split the performance between the least risky and most risky portfolios. This can be seen in Figure 12 and Figure 20.

Standard deviation is the best performing risk measure during this sub-period. Value-at-risk, followed by semi-deviation have been the next best risk measures during this sub-period. This is followed by beta, which has once again been shown to be a poor measure of risk.

It is interesting to note that standard deviation has been the best measure of risk during the market crash as it was during the bull market of the previous sub-period.

This seems to highlight standard deviation's ability to best capture risk during all market conditions. The two downside risk measures show some ability to measure risk during this sub-period. Their results are however not as strong as the theory behind the risk measures may suggest, or alternatively, perhaps investors were not concerned about downside risk during this sub-period. Another possibility is that investors sold all shares, risky and not risky, as all shares were losing value. Investors were concerned about equity associated risk, and switched to less risky asset classes. This concern about all equity associated risk supports the findings in favour of standard deviation as a measure of risk during this sub-period.

The results of this sub-period therefore support the same conclusion as drawn from the results of the down market.

5.6.3 ***Period 3 (1 March 2009 to 30 November 2010)***

This 21 month sub-period covered the recovery of the JSE All Share Index which rose at an average return of 32.63% per annum over the period.

On a whole the most risky portfolios outperformed the least risky portfolios (as seen in Figure 13 and Figure 21). The results for all of the risk measures was however very weak. Only the most risky beta portfolio was able to outperform the JSE All Share Index. This strong performance may be limited to the trend that has been observed with the most risky beta portfolio. It has fairly closely tracked the movement of the JSE All Share Index. It is likely that the reason for this has to do with the way in which beta is calculated.

The 12 delisting which occurred in this period may explain the underperformance of the risk measures to some degree. This is however not expected to have a pervasive effect on the results.

By none of the four risk measures being able to explain much of the return during this sub-period, it would seem that total risk, systematic risk and downside risk has been unable to explain returns.

The only plausible explanation to this occurring is the unpredictable, erratic and inconsistent investing by investors. Behavioural finance may better explain returns during this sub-period.

5.6.4 *Period 4 (1 December 2010 to 30 November 2011)*

As seen in Figures 14 and 22, this period is characterised by the sideways, slightly increasing movement of the JSE All Share Index. The uncertainty of investors during this sub-period is highlighted by the outperformance of the least risky portfolios over their more risky counterparts. Monthly returns for the least risky portfolios (excluding beta) hovered around the 0.3% mark. The risky portfolios lost an average of 2% per month during this sub-period. The value weighted results have been distorted by some single share effects, although these results still point to a similar conclusion.

The results for standard deviation, semi-deviation and value-at-risk are similar. Each of these three risk measures underperform the JSE All Share Index. Beta, as seen in the overall results has presented the least risky portfolio outperforming the most risky portfolio.

The results for this sub-period are similar to those in sub -period 3. They are fairly inconclusive. The inconclusiveness of the results may be as a result of investor behaviour. Investors may be hesitant to invest in risky shares or even equities as a whole. Any investments made may be on a selective basis other than the risk of the shares, as captured by the four chosen measures in this research report.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This final chapter draws conclusions from the results as to the nature of the risk-return relationship. It then provides recommendations to those who could be affected by results from this report. Finally suggestions for future research are given.

6.2 Conclusions of the study

Lakonishok and Shapiro (1986) stated that the effectiveness of risk measures is their ability to explain return. Based on this understanding, this and other literature has been developed.

The main purpose of this report is to analyse the risk-return relationship on the JSE. There are a number of ways in which this relationship may be evaluated. This report has taken a factor approach. Four statistical proxies for risk were chosen to analyse this relationship. The four measures tested are beta, standard deviation, semi-deviation and value-at-risk.

An extensive amount of literature has considered the risk-return relationship in various forms. There are some consistencies to the findings, but regardless of this, there are still a number of contentious views of role of risk in determining returns.

The four factors have been chosen due to their popularity or effectiveness in the studies reviewed in the literature review section. This report has not only highlighted which risk measures are effective but it has also highlighted those which are ineffective, under specific conditions.

Standard deviation yielded the strongest results in this research report. The ability of standard deviation to explain and predict returns was largely robust across the overall time period, up and down markets, sub-periods and under value and equal weighting of portfolios. Lakonishok and Shapiro (1984) and Amenc et al (2011) found similar results.

Very little to no support was found for beta as a measure of risk, including on an overall basis, in up or down markets or during any of the sub-periods. Some support for beta was found for the up market criteria, giving some support to the findings of Tang and Shum (2004).

Semi-deviation, a measure of downside risk, yielded weak results. Even under poor market conditions, be it during the down market or during sub-period two, semi-deviation was unable to explain returns. Liang and Park (2007) also found little support for semi-deviation as a measure of risk.

The second measure of downside risk, value-at-risk, provided much stronger results than semi-deviation. Its strongest results were during down markets. It did however provide significant results on an overall basis. Even during up markets and the bull market of sub-period one, value-at-risk was able to explain returns to some extent. Bali and Cakici (2004) and Amenc et al (2011) found strong support for value-at-risk while Liang and Park (2007) found some weak support for value-at-risk as a measure of risk.

6.3 Recommendations

This report identified two groups of stakeholders who might be affected by the results of this research. These stakeholders are academics (in the field of finance) and practitioners (which includes private and institutional investors).

Both stakeholders are influenced by similar conclusions which can be drawn from this report. The most important being the understanding of risk. If one can better understand risk, one can achieve greater returns. Not only is it therefore practically relevant, but academics can better understand investor behaviour, asset pricing models and conditional criteria under which this theory may hold.

With an enhanced understanding of how beta, standard deviation, semi-deviation and value-at-risk affect returns, practitioners are able to develop strategies based on the insight given to these risk measures under certain criteria. Academics can extrapolate the findings in this report to either support or challenge the accepted theory of the risk-return trade-off.

6.4 Suggestions for further research

An alternative approach to this research is that investors may perceive and react differently to risk and as such, a behavioural finance approach may yield interesting results.

This research can be added to in a number of ways. Firstly a multivariate analysis could also be undertaken. Additional research can take into account the 'January' effect, attempt to control the same results for certain factors (such as size) or consider the short term reversal effect. Additionally, research may separate the sample of shares into different industries. Auret and Sinclaire (2006) and Mutooni and Muller (2007) noted peculiarities in the JSE. It being dominated by resource shares which may possibly be impacted on by different factors (for example resource prices). Additional explanatory factors in any combination can also be considered.

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APPENDIX A

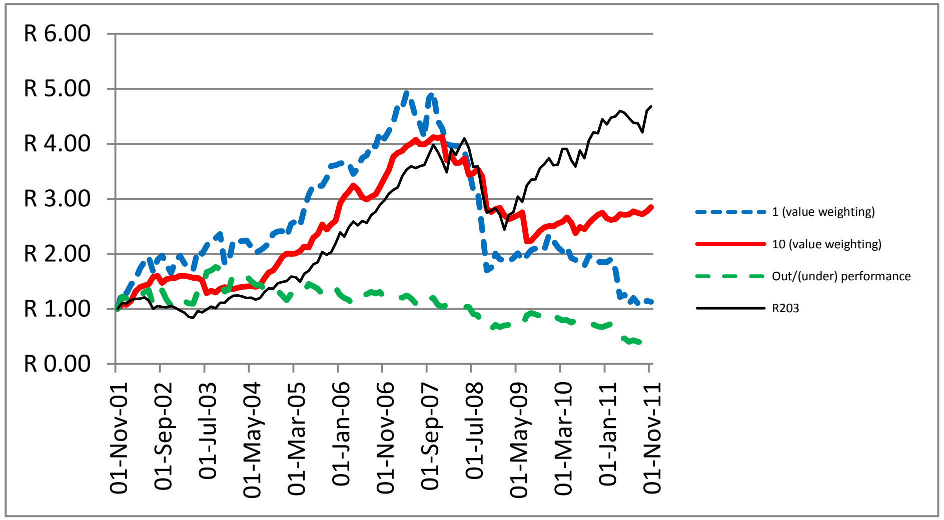

Figure 16: Semi-deviation (value weighting)

	Beta	Standard deviation	Semi-deviation	VaR
OVERALL				
Value-weighting		**		*
Intercept	-0.08152	-0.05445	-0.02067	-0.04584
Coefficient	0.06240	0.92632	0.02822	0.49223
T statistic	1.15167	2.21525	1.18409	1.80192
P-value	0.25179	0.02866	0.23876	0.07411
R-squared	0.01112	0.03993	0.01174	0.02678
UP MARKET				
Value-weighting		*		
Intercept	-0.02424	-0.05026	-0.00812	-0.02704
Coefficient	0.04324	1.00044	0.03224	0.32311
T statistic	0.58958	1.67932	0.99747	0.82462
P-value	0.55746	0.09775	0.32213	0.41252
R-squared	0.00516	0.04039	0.01463	0.01005
DOWN MARKET				
Value-weighting				**
Intercept	-0.08637	-0.06259	-0.03740	-0.07368
Coefficient	0.03377	0.87055	0.02236	0.74687
T statistic	0.49508	1.50087	0.65963	2.06102
P-value	0.62275	0.13981	0.51258	0.04463
R-squared	0.00498	0.04395	0.00880	0.07977

Table 4: Regression results (value weighted portfolios)

APPENDIX B

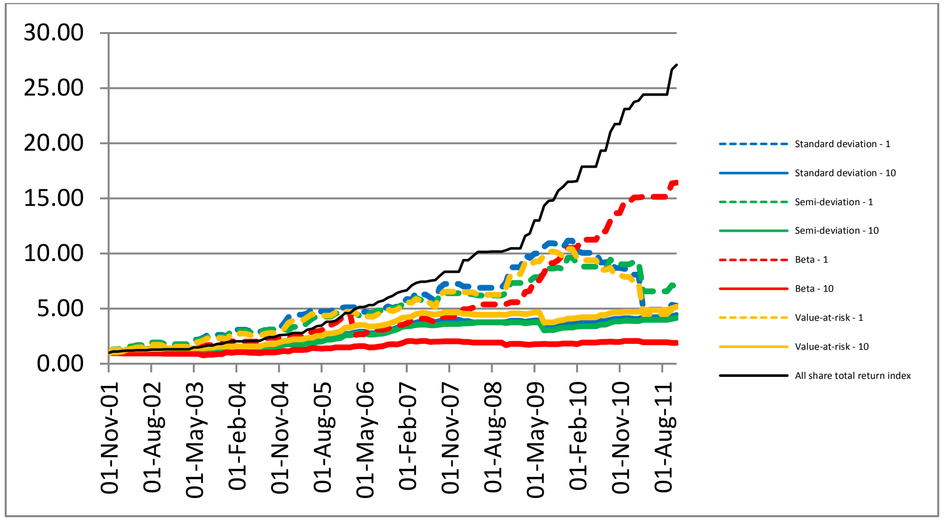

Figure 17: Up market (value weighting)

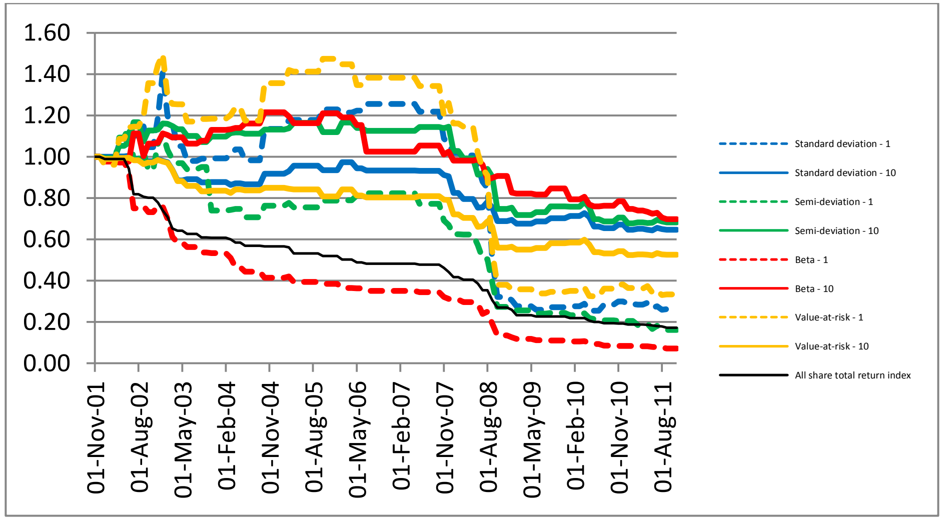

Figure 18: Down market (value weighting)

APPENDIX C

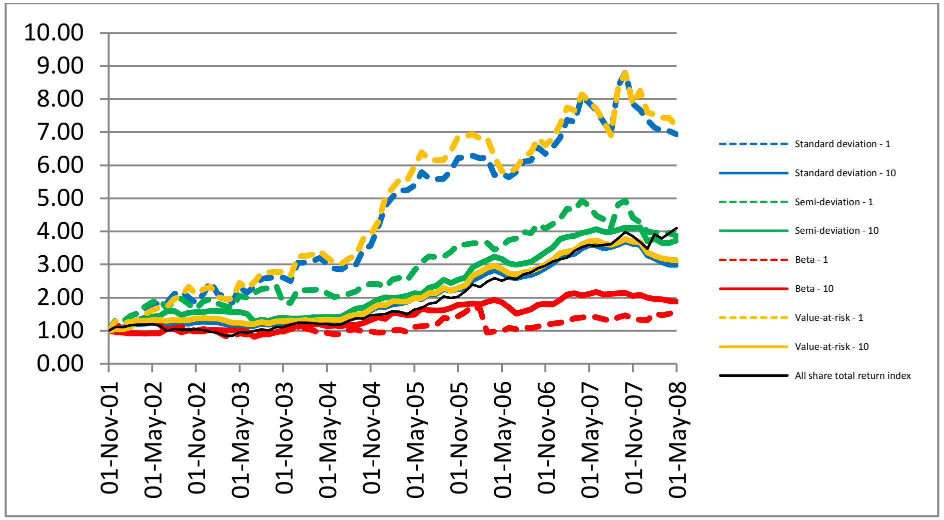

Figure 19: Sub-period 1 (1/12/2001 - 30/5/2008, value weighting)

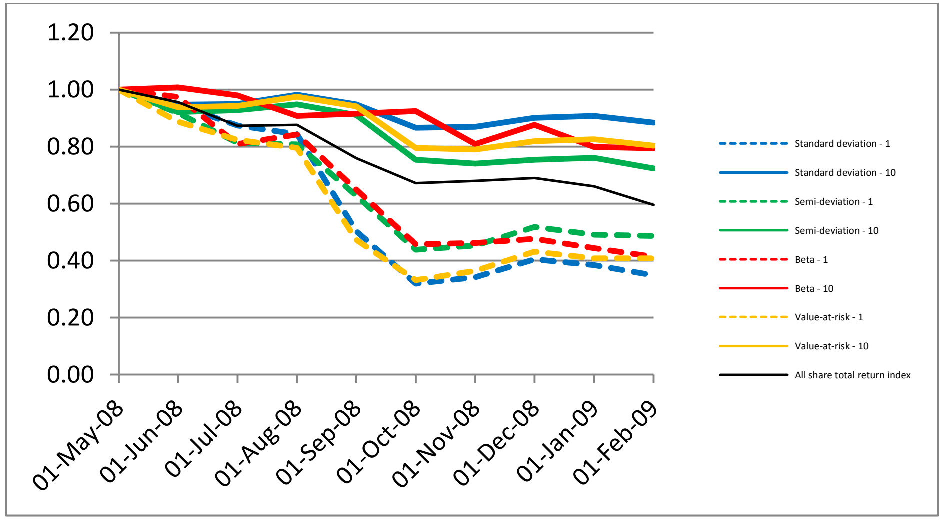

Figure 20: Sub-period 2 (2/6/2008 - 27/2/2009, value weighting)

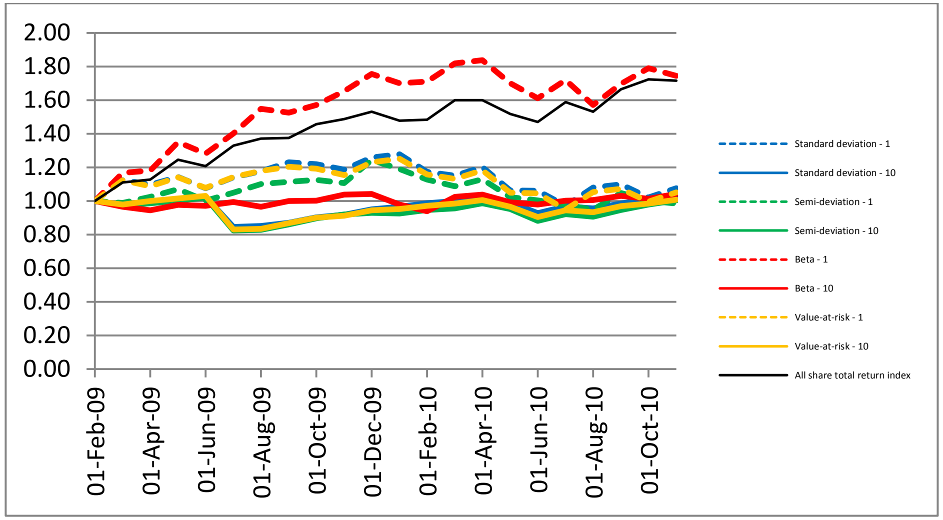

Figure 21: Sub-period 3 (2/3/2009 - 30/11/2010, value weighting)

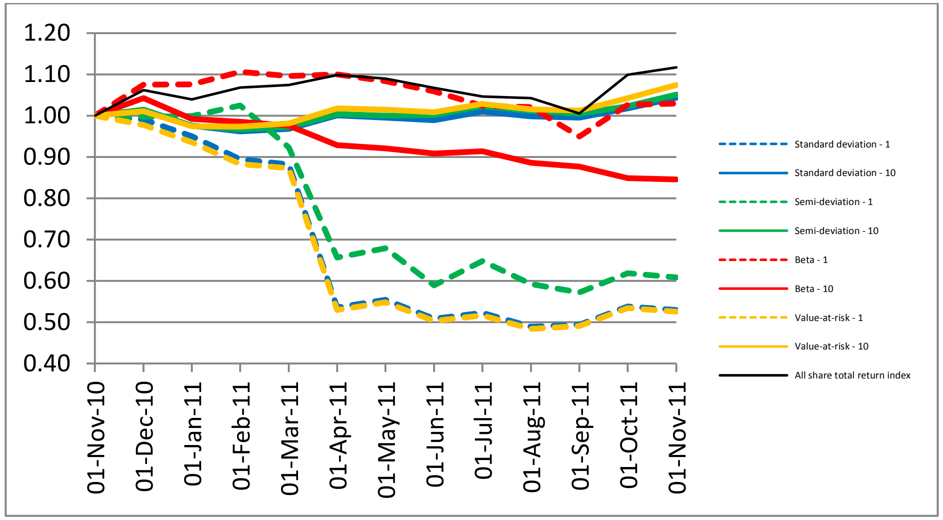

Figure 22: Sub-period 4 (1/12/2010 - 30/11/2011, value weighting)

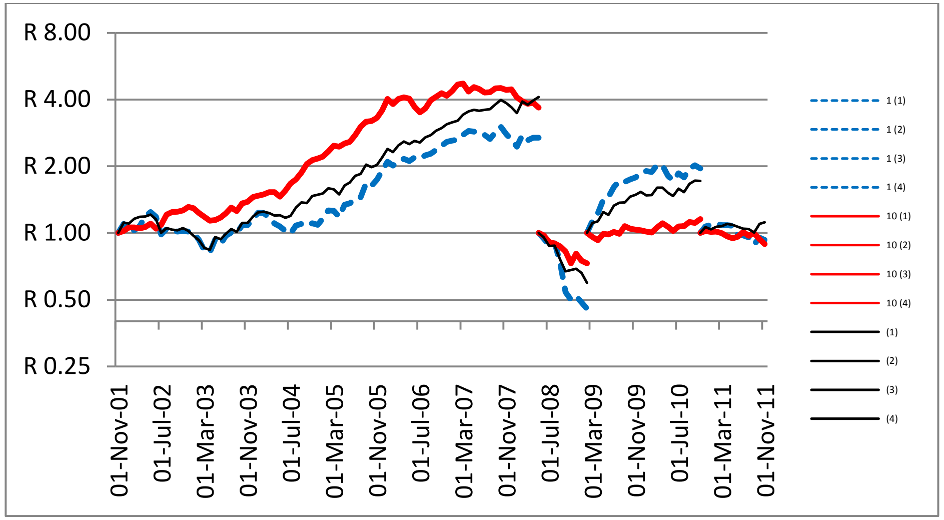

Figure 23: Beta (equal weighting, with rebasing for sub-periods)

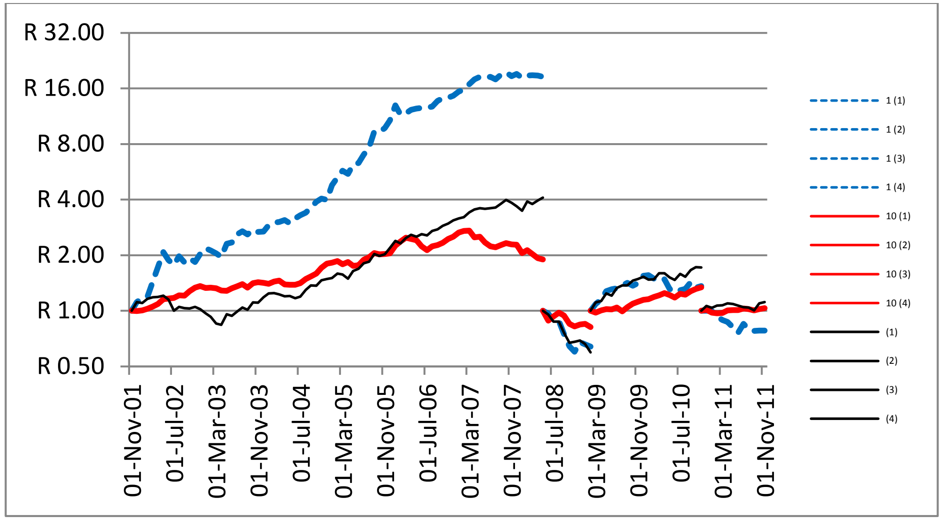

Figure 25: Semi-deviation (equal weighting, with rebasing of sub-periods)

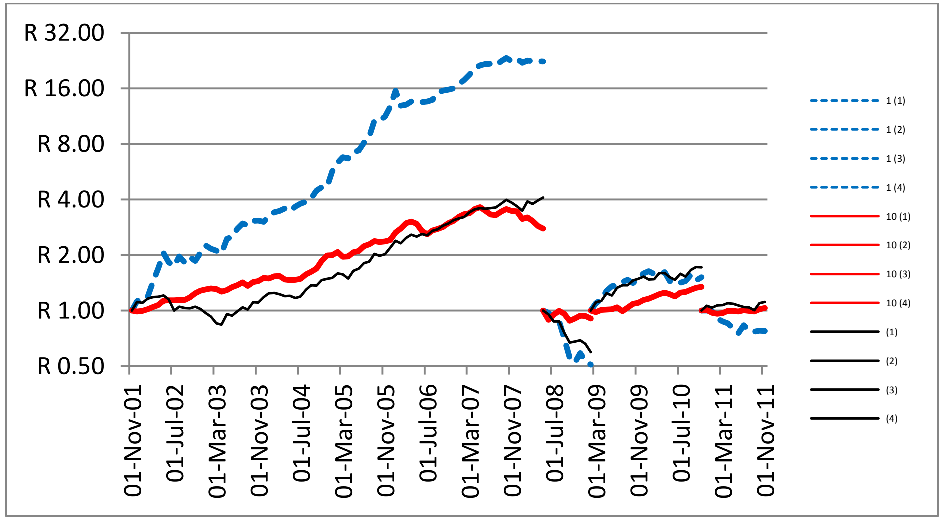

Figure 24: Std deviation (equal weighting, with rebasing of sub-periods)

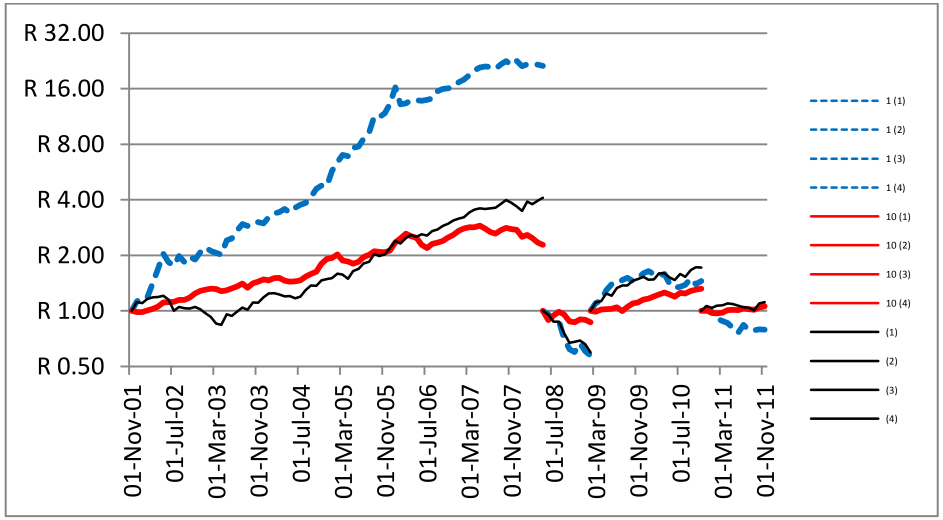

Figure 26: VaR (equal weighting, with the rebasing of sub-periods)

APPENDIX D

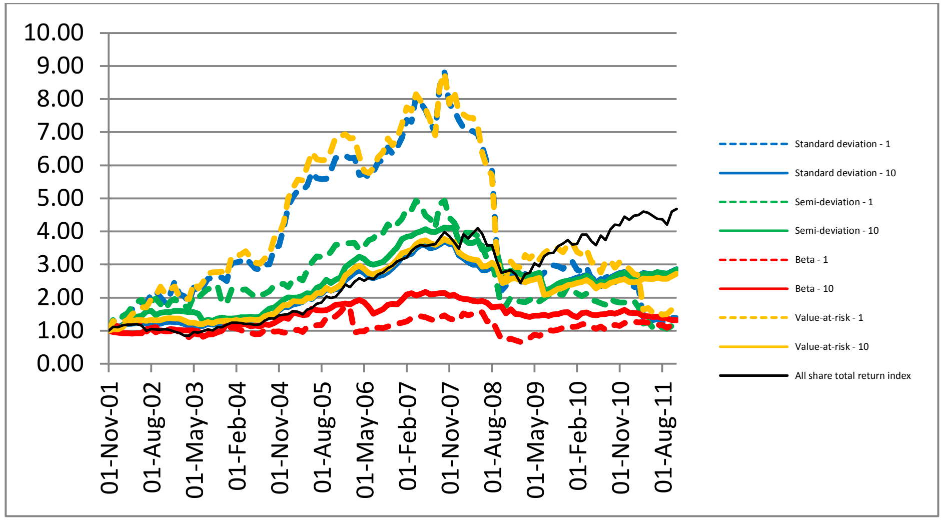

Figure 27: Overall (value weighting)

	Portfolio								
	Beta		Standard deviation		Semi-deviation		VaR		All share total return index (R203)*
	1 (most risky)	10 (least risky)	1 (most risky)	10 (least risky)	1 (most risky)	10 (least risky)	1 (most risky)	10 (least risky)	
OVERALL MARKET									
1/12/2001 - 30/11/2011									
Equal weighted return	2.2340	2.7642	13.3935	3.5185	12.6100	2.1552	14.0054	3.3693	4.6771
Value weighted return	1.1796	1.3187	1.3772	2.8570	1.1275	2.8486	1.6148	2.7222	
UP/DOWN MARKET									
Up markets									
Equal weighted return	21.8899	3.6828	25.6547	4.9995	22.9007	3.1864	24.7060	4.9542	27.1113
Value weighted return	16.4155	1.8889	5.2637	4.4148	7.0010	4.1751	4.8310	5.1844	
Down markets									
Equal weighted return	0.1021	0.7506	0.5221	0.7038	0.5506	0.6764	0.5669	0.6801	0.1725
Value weighted return	0.0719	0.6981	0.2616	0.6471	0.1610	0.6823	0.3343	0.5251	
SUB-PERIODS									
1/12/2001 - 30/5/2008									
Equal weighted return	2.6948	3.6726	22.3907	2.7857	18.4749	1.8988	21.2399	2.7838	4.0998
Value weighted return	1.5892	1.8840	6.9332	2.9912	3.8709	3.7312	7.1665	3.1330	
2/6/2008 - 27/2/2009									
Equal weighted return	0.4556	0.7310	0.5092	0.9073	0.6403	0.8180	0.5738	0.8624	0.5956
Value weighted return	0.4136	0.7944	0.3485	0.8838	0.4862	0.7236	0.4076	0.8033	
2/3/2009 - 30/11/2010									
Equal weighted return	1.9555	1.1553	1.5162	1.3480	1.3649	1.3394	1.4513	1.3337	1.7155
Value weighted return	1.7442	1.0423	1.0764	1.0364	0.9849	1.0040	1.0515	1.0067	
1/12/2010 - 30/11/2011									
Equal weighted return	0.9305	0.8912	0.7749	1.0328	0.7810	1.0360	0.7918	1.0522	1.1165
Value weighted return	1.0290	0.8454	0.5295	1.0428	0.6083	1.0509	0.5258	1.0744	

Table 5: Summary table based on R1 invested on inception of the portfolio