The Performance of an Efficient Portfolio Index During Extreme Market Conditions In South Africa

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ABSTRACT

Modern portfolio theory dates back to the work of Markowitz (1952), when he first introduced the concept of efficient portfolio selection, suggesting that there is only one combination of shares that would maximise an investors returns for a given level of risk. Since this introduction, portfolio selection has evolved producing concepts and tools such as the Capital Asset Pricing Model or CAPM (Tobin 1958; Sharpe 1963), the Arbitrage Pricing Theory (Ross 1976) and the 3 Factor Model (Fama and French 1996a, 1996b).

This research seeks to develop an Index based on the efficient portfolio concepts of Markowitz (1952) for the JSE and evaluates the performance of this index relative to the J203 or All share index which was used as the benchmark index. Over the period January 2002 till December 2009, when accumulating the abnormal returns or excess returns of the efficient portfolio index over the market index, for the full duration of the analysis period, the efficient portfolio index returned a 3.8% year on year premium return over the market benchmark. The research however, did not yield a statistically significant difference between the returns of the efficient portfolio index and the returns of the market index.

The research goes on to search for any conditional influences on the performance of the efficient portfolio, specifically during bull and bear market conditions. Using a t-test there was no difference found in the performance of the index between the two conditional states of the market.

DECLARATION

I, Yaseen Surtee, declare that this research report is my own, unaided work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

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Yaseen Surtee

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1 INTRODUCTION

1.1 Purpose of the study

The purpose of this research is to test the effectiveness of the portfolio selection concepts introduced by Harry Markowitz (1952; 1959) on which Modern Portfolio Theory is based. Using the concepts developed by Markowitz, an efficient portfolio index based on securities from the JSE Securities Exchange was developed and its movements tracked through the period 2002 to 2009. The selected period offers an opportunity to evaluate the performance of such an index against a market benchmark through varying market conditions, including extraordinary growth as well as a recessionary pullback.

1.2 Context of the study

The majority of literature available on portfolio theory focuses on models that can trace their genealogy to the ground breaking work of Markowitz, (1952; 1959). Markowitz (1952) laid the foundation for portfolio selection models through the advances of Mean-Variance Theory on portfolio selection. Supported by Tobin (1958) it provided a way to select an investment portfolio that would either maximise return for a given level of risk, or minimise risk for given expected return. At the time the computational power required to process the portfolio optimisation algorithms was not available, leading to Sharpe's simplification of the mathematical requirements and the introduction of the CAPM (Sharpe 1963). This forms the basis for most asset pricing models in use today. The mean-variance concepts of the efficient portfolio theory relies on key assumptions which have been extensively investigated, defended and criticised (Markowitz 1952; Markowitz 1959; Sharpe 1963; Lintner 1965; Fama 1970, 1971; Black 1972; Merton 1973; Markowitz 1976; Ross 1976). Amongst the concerns levelled is the use of statistical analysis to predict an optimal portfolio, which implies that the returns of a portfolio follow a normal distribution (Liesenfeld and Jung 2000). With the computational power currently available, the original portfolio selection concepts of

Markowitz can be tested and thereby gauge the performance of an efficient portfolio against the market.

The JSE Securities Exchange (JSE) has operated as an exchange from 1887 and is the premier exchange in Africa located in Sandton in Johannesburg, South Africa (JSE 2009a). Lyndon and Juh (2006) describe the birth of the JSE primarily as a need to support the mining companies that formed shortly after the discovery of gold in the Witwatersrand. The exchange offers a market in which to trade equity, bonds, warrants, ETFs (Exchange traded funds) and derivatives, amongst other products. Stocks traded on the exchange came under severe pressure during the recent global economic crises in 2008, with the All Share index losing about 45% of its value over a 6 month period from the 21st May to 21st November during 2008. The performance of all the shares listed on the JSE over the last 10 years is shown in Figure 1 below.

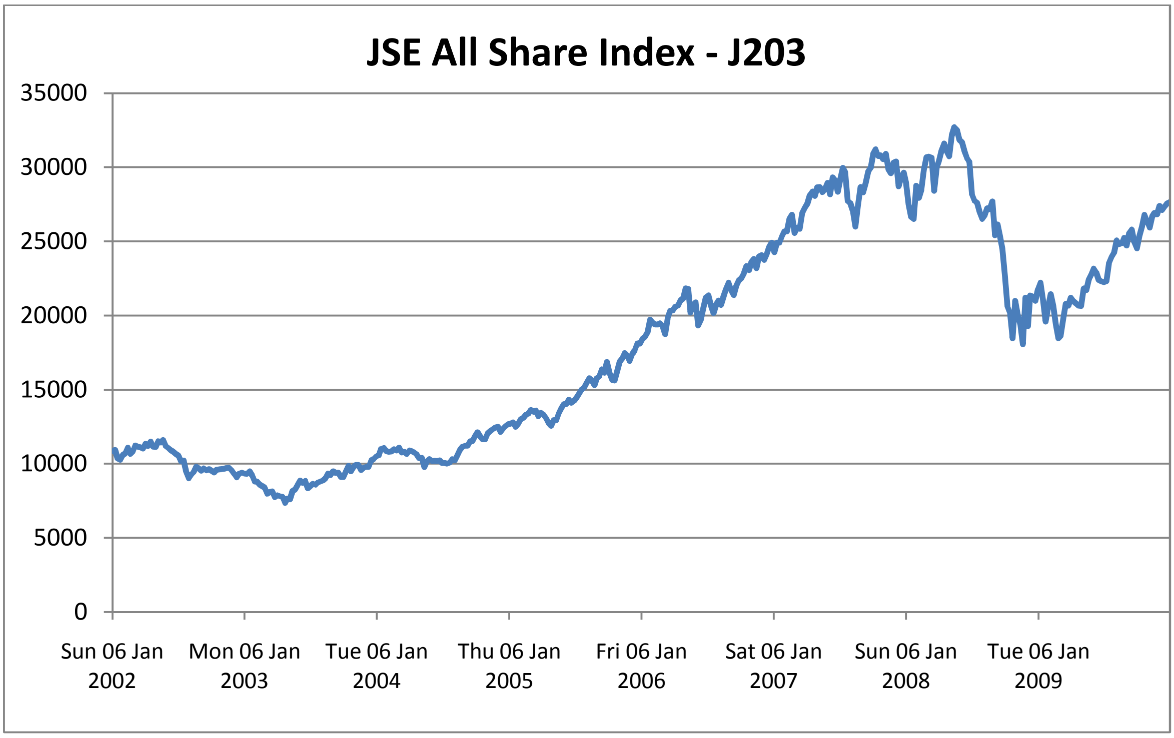

Figure 1 : Performance of the JSE all share (data obtained from I-Net Bridge).

The JSE performance over the past decade offers interesting analysis opportunity when considering the varying market conditions experienced during this period.

These variations in conditions should test the assumptions on which Markowitz has based the portfolio selection concepts.

1.3 Problem statement

1.3.1 *Main problem*

The purpose of this research is to develop an efficient portfolio index for JSE stocks and evaluate its effectiveness by comparing its performance relative to a benchmark market index in the form of the JSE all share index. The behaviour of the index was analysed through extreme market periods to search for conditional relationships between the state of the market and the performance of the efficient portfolio.

1.3.2 *Subs problem*

The first sub-problem is to develop an index based on a mean-variance efficient portfolio and evaluate its performance relative to a benchmark market index.

The second sub-problem is to determine if there is a conditional relationship between the efficient portfolio index and the state of the market, specifically, bull and bear market periods.

1.4 Significance of the study

The study fills a gap in that it potentially qualifies the assumptions on which many current portfolio selection models have been based. Sharpe (1963) developed a simplified way to overcome the computational obstacles that were present during the period in which Markowitz developed the Efficient Portfolio Theory. It was from this simplification by Sharpe (1963) that the Capital Asset Pricing Model (CAPM) was developed. It would be interesting to see what the actual results would be, without simplification now that computer processing is so easily available, of a direct application of Markowitz's original work.

The study will provide guidance to investors as there is currently no efficient portfolio index, based on the JSE, against which investors can benchmark their portfolios. Rubinstein (2002) states how Markowitz's approach has become a tool used by institutional investors to aid in portfolio structuring as well as a performance measurement benchmark. The researcher intends to provide additional evidence to support decision making around the use of mean-variance portfolio selection models.

1.5 Delimitations of the study

- The study will focus on portfolio selection of assets composed of equity stocks only within the JSE main board and will exclude any blending of risk-free assets.
- The Index will be based on data from January 2002 to December 2009.
- The research will look for similarities in behaviour of an efficient portfolio in similar market conditions, specifically bull and bear conditions, but will not investigate the reasons for these should they exist.

1.6 Definition of terms

- 'J203' is the code assigned to the all share index on the JSE main board and was initiated on 24 June 2002 as part of the FTSE/JSE Africa Index Series which replaced the JSE Actuarial Indices. Indicative values for the FTSE/JSE Africa Index Series have been calculated and published since 2nd January 2002 (JSE 2009b).
- 'Bull Market' refers to a period where the monthly return of a share is greater than or equal to that of the risk-free return in that period (Pettengill, Sundaram and Mathur 1995) and is associated with a period of market growth.
- 'Bear Market' refers to a period where the monthly return of a share is less than the risk-free return in that period (Pettengill et al. 1995) and is associated with a period of market stagnation or decline.

- ‘Type I error’ occurs when a statistical hypothesis test incorrectly rejects a null hypothesis that is actually true (Albright, Winston and Zappe 2008). A type II error is committed when a test incorrectly accepts the null hypothesis that is false (Albright et al. 2008).
- Random Walk in a financial context refers to the uncertainty of the next movement of an asset, (Fama 1965a), analogous to the path walked by a disorientated individual.
- Mean–Variance are statistical parameters that describes a distribution of occurrences (Albright et al. 2008).
- Arbitrage is the practice of taking advantage of a state of imbalance between an asset listed on different markets and thereby making a risk-free profit by buying the asset at the lower price in one market and selling at the higher price in the other (Roll and Ross 1995).

1.7 Assumptions

- When considering the performance of the efficient portfolio index, the influence of transaction costs was assumed to be negligible.

2 LITERATURE REVIEW

2.1 Introduction

The literature review will introduce the fundamental concepts of Modern Portfolio Theory. The intention is to place the actual research into the context of portfolio selection concepts and models that are used by individual and institutional investors.

Section 2.2 covers the fundamental concept of the Efficient Markets Hypothesis and the related theories describing stock price movements, specifically the Random Walk Theory and Fair game theory. These concepts are necessary in understanding the construction and application of the pricing models that utilise these theories as assumptions, (Sharpe 1963; Lintner 1965; Fama 1965a, 1970; Peters 1989; Scott 1991). The review also covers the psychological approach to decision making under risk, as ultimately fear and emotion influence human decision making, (Kahneman and Tversky 1979; Bondt and Thaler 1985; Shefrin and Statman 2000).

Section 2.3 discusses the popular asset pricing models used in portfolio selection and leads to the hypothesis for the first sub-problem around the relative performance of an efficient portfolio index. Section 2.4 introduces and discusses the conditional effects of bull and bear markets on expected stock returns. Finally the literature review will be concluded with hypothesises for the research listed.

2.2 Efficient Markets Hypothesis

2.2.1 *Random walk theory*

Fama (1965a) defines a market with random walk as one that has successive price changes being independent of each other. The implication is that the past history of stock price changes cannot be used to inform about the future. As a result sophisticated models and techniques are meaningless unless an investor or analysts has some information that is not already known by the market and will therefore in the near future change the intrinsic value of the share leading to an anticipated price movement, (Fama 1965a). The first statement and test of the random walk theory was made by Bachelier in 1900 according to Fama (1970). Fama (1965a), also explains an efficient market to be a market that is used by a large number of rational, risk averse and profit-maximising investors trying to predict future values of securities where current information is almost freely available. In such a market and considering the Random Walk Theory, unless an investor is in possession of unknown information which will be available and reacted upon by the market at some future time, his stock selection is expected to perform no better than a randomly selected stock or portfolio, (Fama 1965a).

Fair Game theory implies that future prices cannot be predicted using currently available information (Scott 1991). An interpretation of the fair game theory is that the condition of market equilibrium can be stated in terms of expected returns and that these expected returns for a fair game process is zero, (Fama 1970). The random walk model should be considered an extension of the fair game model, according to (Fama 1970), adding that the expected returns have a mean and distribution that is repeatable and independent of information affecting stock valuations . When the sequence of stock prices in a time series has a bias, this is referred to as a sub-Martingale process. Should there be no bias this series then represent a random walk or alternatively a Martingale process,(Fama 1970).

Peters (1989), defines the efficient market hypothesis stating that all new information is immediately reacted to and fully reflected in the market price. Peters argues though, that markets do not behave purely according to the random walk theory but rather they follow a biased random process. Peters suggests that market prices do not reflect new information immediately and therefore have a biased random walk. He suggests that past events influence the future over the long-term and calls this dependence, “persistence”. The suggestion is that a market will continue following a subtle trend due to a memory effect until an event occurs that may cause a different memory and trend effect. He refers to this as sentiment. Using Hurst Rescaled range analysis (R/S) and analysing 30 year Treasury Bonds and monthly S&P500 returns, he quantified the bias for each against a scale of 0 to 1, (Peters 1989). The middle value of 0.5 indicates a purely random walk process while values greater than 0.5 indicate a positive persistence meaning a past positive trend is likely to continue positive, while a value less than 0.5 indicates anti-persistence or a change in trend in the upcoming period compared to the past period. Peters calculated a value of 0.61 for stocks and 0.64 for the Treasury bonds. Peters therefore suggest that it should be theoretically possible to forecast returns on the stock market. Peters' (1989) findings and conclusions were later questioned and explained to be potentially inaccurate by Ambrose, Ancel and Griffiths (1993) who identified estimation errors in the (R/S) method used by Peters (1989). Upon recalculation Ambrose, et al., (1993) found no statistical evidence to suggest that stocks follow any other pattern but that of a random walk.

2.2.2 *The Efficient Markets Hypothesis*

Fama (1970) investigates the theory and empirical evidence that describes the efficient markets hypothesis. Fama (1970) defines the efficient markets model, as market prices at any point fully reflecting all available information. He also introduces three information subsets within which to test the hypothesis, i.e. the reaction of market prices to information being efficient. The subsets will potentially specify the conditions of deviations from the hypothesis should there be such a finding. The first subset, weak form, evaluates the market reaction to purely historical price information of stocks. Secondly, semi-strong form relates to publicly available information such as the release of year-end financial performance reports or corporate activity announcements. Finally, strong form, considers the possibility of monopolistic holders of information. Fama (1970) found evidence of inefficiency only in the strong form case. He also goes on to list three potential reasons for market inefficiency; 1) the presence of transaction costs, 2) all information is free from costs and available to all and 3) all investors interpret and react to the available information consistently.

2.2.3 *Rational Behaviour in stock markets*

The excessive volatility in stock markets following crashes seems to question the efficient market hypothesis as prices differ from valuations based on fundamentals, (Scott 1991), and the volatility appears to be aggravated by financial instruments such as futures trading. Scott lists efficient markets hypothesis with the speculative bubble model, noise trading and overreaction as pricing models for stocks. He refers to the efficient markets hypothesis as a rational pricing theory while the latter three he refers to as irrational pricing theories used as an alternative to explain empirical differences or excess volatility evident in stock markets. In Scott's review he finds that the volatility is only evident in stock markets and is not the case in Bond markets. The price deviations from fundamental values potentially result from investors reacting to fads and popular trends and being driven by a myopic view of anticipated returns, (Scott 1991).

Bondt and Thaler (1985) investigated whether overreaction to unexpected and dramatic news is evident in capital markets. Their findings were consistent with overreaction hypothesis as they found a significant difference in Cumulative averaged residual returns between two sets of portfolios setup conditionally based on past performance. They defined winner portfolios as a collection of stocks that have showed excess returns relative to the market over five years. Loser portfolios, in contrast, showed poorer returns for at least a five year period. The results showed that cumulative average returns reversed, in that the loser portfolio outperformed the winner portfolio by 26% for a 36 month period after portfolio formation. Within their research, Bondt and Thaler (1985), also found evidence of the January effect more pronounced on the loser portfolio which shows a pattern of substantial increase in share prices during January, an observation supported by other researchers, (Reinganum and Shapiro 1987; Ritter 1988; Keim 1990).

There potentially exists two perspectives in understanding capital markets, specifically, those based on standard finance and those based on behavioural finance, Shefrin and Statman (2000). Investors that adhere to standard financial theories are considered rational and utilitarian in that they are driven to maximise a utility while being risk averse. Behavioural investors on the other hand are subject to temptation in their quest to beat the market. Shefrin and Statman (2000) argue towards a more combined approach to understanding stock market behaviour by developing asset pricing models that incorporate behavioural factors. The behavioural characteristics according to Shefrin and Statman (2000) include susceptibility to frames and other cognitive errors, varying attitudes toward risk, aversion to regret, imperfect self-control, and preferences as to both utilitarian and value-expressive characteristics. Kahneman and Tversky (1979) show evidence of behaviour of decision makers in conditions of uncertainty that contradict the assumptions of utility theory on which standard financial models such as efficient markets hypothesis and CAPM are based. They find that people overweight outcomes that are based on certainty over outcomes based on probability, and refer to this as the certainty effect. This contradicts the theory of a rational investor who will always select based on probability.

2.3 Efficient Portfolios

2.3.1 *The Beginning of Modern Portfolio Theory*

Before 1952 Financial innovation was uninspiring up until the catalytic work of Harry Markowitz (1952) which has led to the development of Modern Portfolio Theory (MPT). Before this, investors focused on trying to value individual stocks on discounting future dividend payments, (Varian 1993). There was also an understanding that by simply increasing the number of different stock holdings this would reduce risk. Markowitz (1952) introduced the concept of Portfolio Theory providing a mathematical and statistical approach to evaluating risk and return of stocks. Markowitz (1952; 1976) describes a portfolio as a collection of stocks whose returns can be represented by a probability distribution. The mean of the distribution is the expected return of the portfolio while the spread of the distribution is an indication of the portfolio’s risk. The major factor of Markowitz’s portfolio selection concepts is that the variance or spread of the portfolio cannot merely be reduced by adding different stocks but rather by choosing stocks that do not behave in the same way (Rubinstein 2002). This introduced the concept of covariance between assets within a portfolio and their contribution to the overall variance of the portfolio (Rubinstein 2002). The fundamental equations stated by Markowitz calculate the expected returns of a portfolio and the resulting portfolio variance, (Markowitz 1952; Markowitz 1959). The expected return of the portfolio is given by the expression;

$$E(R_p) = \sum x_i R_i \qquad (1)$$

where x_i is the weighting of asset i in the portfolio and R_i is the expected return of the individual asset. The variance of the portfolio is given by the expression

$$\sigma_p^2 = \sum_i \sum_j x_i x_j \sigma_i \sigma_j \rho_{ij}$$

Where σ_i and σ_j are the standard deviation of R_i and R_j and ρ_{ij} is the correlation coefficient between R_i and R_j. The expression can be simplified by introducing, σ_{ij} which is the covariance between R_i and R_j, and is determined by

$$\sigma_{ij} = \sigma_i \sigma_j \rho_{ij}$$

. Therefore,

$$\sigma_p^2 = \sum_i \sum_j x_i x_j \sigma_{ij} \qquad (2)$$

By plotting all the various portfolio combinations and configurations of available stocks on a Risk vs. Return graph, an attainable region is depicted. The top edge of this region represents portfolios for which there are no other combinations that will provide a superior return at a given level of risk, i.e. a set of mean-variance efficient combinations, (Markowitz 1952; Markowitz 1959; Markowitz 1976, 1999). Over time this set has become known as the efficient portfolio frontier.

With Markowitz having laid the foundation for modelling portfolio selection, Tobin (1958), interested in liquidity preferences, considered the effect of adding a risk-free asset to the efficient portfolio. The risk-free asset is assumed to have a zero variance of expected returns. Tobin (1958) discovered that the optimum portfolio can be achieved by holding two asset classes; a portfolio on the efficient frontier as developed by Markowitz (1952); and an amount of the risk-free asset. Any combination can be achieved by an investor, by simply varying the weighting between the risk-free asset and the efficient portfolio, (Varian 1993). The resulting expect return and associated risk lies on the straight line connecting the two coordinates for the risk-free asset and the efficient portfolio plotted on the risk vs. expected return graph.

The researcher therefore proposes the following hypothesis.

> The null hypothesis states that the performance of an efficient portfolio index will yield returns that are equal to the market index on the JSE.
>
> The alternative hypothesis states that the performance of an efficient portfolio index will yield returns that are different to the market index on the JSE.

2.3.2 *Capital Asset Pricing Model - CAPM*

The models of Markowitz (1952) and Tobin (1958) required considerable computational resources particularly when the number of securities increase. This is a result of determining the covariance between all possible security combinations. Sharpe (1963), postulated that the interrelationships between the returns of securities can be more simply described by their relationship to a single underlying factor or index. The most relevant being the market index itself. The return of a security i at time t is therefore represented by the expression,

$$R_{it} = a + bR_{mt} + \epsilon_{it} \qquad (3)$$

The expression includes an error term, ϵ_{it}, which is expected to have zero value; the term a indicates the expected return of the security when the market has zero return and b is a coefficient that indicates the sensitivity factor of the securities' return relative to the market. The model is often referred to as the single factor model. The coefficients for securities are easily calculated using a least squares regression and can be used to construct covariances which can then be used to determine optimal portfolios (Varian 1993). Sharpe (1964) and Linter (1965), building on this linear relationship between an asset and the market, than developed the Capital Asset Pricing Model (CAPM) that is used to determine the expected rate of return that an investor would demand should he invest in the asset. Sharpe (Sharpe 1991) lists some of the assumptions of the CAPM:

- All investors follow the prescriptions of Markowitz' portfolio theory which reverts the market to equilibrium conditions.
- The market consists of a large number of participants each with access to the same information sets.
- All investors are in agreement concerning expected returns and covariance
- Investors may either borrow or lend a risk free asset.
- Investors can take negative positions in one or more assets.
- There are no transaction costs
- Investors are fully invested implying the constraint $\sum_i X_i = 1$, where X_i is the proportion of the total portfolio allocated to asset i.

Under these assumptions Sharpe (1964) and simultaneously Lintner (1965), developed the CAPM for a single period which is expressed as follows:

$$E(R_i) = R_f + \left[E(R_m) - R_f\right] \times \beta_{im} \qquad (4)$$

Where $E(R_i)$ is the expected return of asset i, R_f is the risk-free rate, $E(R_m)$ is the expected return of the market and β_{im}, is the systematic risk of the asset relative to the risk of the market and is determined from:

$$\beta_{im} = \frac{Covariance(R_i, R_m)}{varaince(R_m)} \qquad (5)$$

The Sharpe-Lintner CAPM was modified by Black (1972) arguing that the unrestricted borrowing and lending of the risk-free asset is an unrealistic assumption and shows the model is still applicable and less restrictive by replacing the risk-free asset with an asset that is independent of the movement of the market. Black (1972) shows the expected return can be determined using the expression;

$$E(R_i) = E(R_z) + [E(R_m) - E(R_z)] \times \beta_{im} \qquad (6)$$

where $E(R_z)$ is the expected return of a zero-beta portfolio or asset that is independent of the movement of the market.

2.3.3 *The Sharpe Ratio*

In 1966, William Forsyth Sharpe introduced what was later to be referred to as the Sharpe ratio (Sharpe 1966). During first reference, Sharpe originally called it the "reward-to-variability" ratio which was a direct indicator of its purpose in that it quantified the relationship between the two opposing factors to investors of reward and variability. More specifically the Sharpe ratio is a measure of the excess return (or Risk Premium) per unit of risk in an investment asset. The ratio was recently revised by Sharpe (1994) into the form below.

$$S = \frac{R - R_f}{\sigma} = \frac{E[R - R_f]}{\sqrt{R - R_f}}$$

Assuming the risk free rate remains constant,

$$S = \frac{E[R - R_f]}{\sqrt{R}}$$

where R is the asset return, R_f is the return on a benchmark asset, such as the risk free rate of return; $E[R - R_f]$ is the expected value of the excess of the asset return over the benchmark return, and σ is the standard deviation of the excess of the asset return over the benchmark return.

Criticism has been levelled against the use of the Sharpe ratio under declining market conditions as well as when the distribution of returns deviate from a normal distribution (Scholz 2007). Scholz (2007) reviews the problems in reliably evaluating fund performance based on Sharpe ratios during periods of declining markets, which naturally generate negative Sharpe ratios. Scholz presents refinements to the Sharpe ratio and compares them with the original Sharpe ratio and shows that only the so-called normalised Sharpe ratio produces meaningful results, not only for bear markets, but for any other market period as well.

2.3.4 *Intertemporal Capital Asset Pricing Model – ICAPM*

Merton (1973) develops a multi-factor model that looks to address some of the short-comings of the Sharpe-Lintner (1963; 1965) CAPM. Merton makes the assumption that trading in assets takes place continually in time as opposed to the single period nature of the CAPM. He argues that along with the assumption of negligible transaction costs and complete divisibility of assets, traders react to new information or expectations about future asset performances and would accordingly prefer to change portfolios at any time. Merton compares the decision making assumptions of an intertemporal investor with that of a CAPM investor by suggesting that a single-period investor does not consider events beyond the present period; while the intertemporal investor looks to maximise total utility by considering events beyond the present period. He selects his portfolio by taking into account the relationship between current period returns and the returns that will be available in the future. Merton develops an expression that is solved using the mathematical technique of Itō's Lemma, which is used to find the differential of a function of a stochastic process.

Fama (1996) looks to improve on the ICAPM developed by Merton (1973), indicating that the Merton model is perhaps unattractive due to the degree of difficulty in construction and insight drawn from the outputs. Fama (1996) reconstructs an ICAPM building on the notion that ICAPM investors hold multifactor-efficient portfolios while CAPM investors hold mean-variance efficient portfolios. The improvement to the model arises as the ICAPM investor is also interested in hedging future consumption-investment opportunities such as relative prices of consumption goods and the risk-return tradeoffs they will face in capital markets, (Fama 1996). Hence an additional hedging portfolio is added to the ICAPM.

2.3.5 *Arbitrage Pricing Theory – APT*

The arbitrage pricing theory was presented by Ross (1976) as an alternative to the mean-variance efficient asset pricing models. Roll and Ross (1995) suggest that the expected returns of a security or portfolio is not sufficiently explained by a single factor, i.e. the covariance to the market index as in the case with the CAPM of Sharpe and Lintner (1964; 1965). They explain that only a few systematic factors affect the long-term returns of financial assets. The returns of an asset over a coming period are due to anticipated and unanticipated events (Roll and Ross 1995), but the impact of the anticipated event should already have been accounted for in the price of the asset. Roll and Ross (1995) differentiate between systematic risk, as those events that influence the economy as a whole and thereby impact all assets but at different levels, against idiosyncratic risk that impact on individual firms or sectors only. The latter is what appropriate diversification is intended to dissipate. Therefore large portfolios are mainly affected by systematic factors (Roll and Ross 1995). Roll and Ross (1995) suggest from empirical data that a four factor model is sufficient to capture the influences of systematic events, and the expected return of an asset in access of a riskless asset can be written as follows:

$$E = r + (E_1 - r).b_1 + (E_2 - r).b_2 + (E_3 - r).b_3 + (E_4 - r).b_4 \qquad (7)$$

The APT model by Roll and Ross (1995) states that the expected return on any asset, E, exceeds the riskless return, r, by an amount equal to the sum of the products of the market prices of risk, $E_f - r$, and the sensitivities of the asset to each of the respective factors represented by b_f, noting that f refers to the applicable systematic factor.

According to the empirical research conducted by Roll and Ross, (1995) the following four economic factors adequately capture most other economic factors necessary to explain returns of assets in stock markets:

- unanticipated changes in inflation
- unanticipated changes in industrial production
- unanticipated changes in risk premiums (as measured by the spread between low grade and high grade bonds)
- unanticipated changes in the slope of the term structure of interest rates

2.3.6 *Fama & French – 3 factor model*

The single-factor CAPM has been criticised for its inability to explain many of the empirical patterns evident on stock returns, (Fama and French 1996a, 1996b). Fama and French suggest that β (Beta) is an inadequate market proxy which fails to accommodate additional factors such as firm size, earnings-to-price ratio, cashflow-to-price ratio, leverage, book-to-market equity ratio and sales growth.

Fama and French (1992), suggest though that the combination of size and book-to-market are adequate in explaining average returns of stocks as the two factors alone capture factors such as leverage and E/P ratios. Fama and French (1996b) propose the following 3-factor model to explain the expected return of a portfolio in excess of the risk-free rate.

$$E(R_i) - R_f = b_i\left[E(R_m) - R_f\right] + s_i E(SMB) + h_i E(HML) \qquad (8)$$

The three factors are: 1) the excess expected return of the market over the risk-free rate, 2) the difference between the return on a portfolio of small stocks and the return on a portfolio of large stocks (SMB, small minus big); and 3) the difference between the return on a portfolio of high book-to-market stocks and the return on a portfolio of low book-to-market stocks (HML, high minus low). The factor coefficients b_i, s_i, and h_i are the slopes in the time-series regression,

$$R_i - R_f = \alpha_i + b_i(R_m - R_f) + s_i SMB + h_i HML + \varepsilon_i \qquad (9)$$

Where α_i is the intercept term and ε_i is an error term.

2.3.7 *Beyond Portfolio Theory*

The financial world has been presented with a host of models from which to select and use in portfolio selection over the last 60 years initiated by the work of Markowitz in 1952, (Ambachtsheer 2005). Ambachtsheer (2005) suggests that the thinking now shifts to how to best to use the available models as investors, both individual and institutional, develop and implement strategies for portfolio selection. For consideration, Ambachtsheer discusses the issues of Information theory and Principal-agent theory. Information theory considers the asymmetric nature of information between buyers and sellers of market participants and more importantly the consequences thereof. The principle-agent theory, according to Ambachtsheer, addresses whether the economic interests of principles in the form of individual investors and the agents who represent them are aligned. He lists five factors that incorporate the two issues as they affect the value creation prospects of investors. These are; 1) Agency issues particularly linked to interest conflicts between directors and shareholders, 2) Governance issues, 3) Risk issues related to excessive/irresponsible risk appetites, 4) Investment beliefs and finally 5) Financial engineering or the complicated innovation that is often used but misunderstood.

2.4 Bull and Bear Markets – Conditional effects

Levy (1974) investigated the correlation between historical Beta coefficients and future portfolio returns. Over a 10 year period, Levy (1974), looked to determine Beta's under different conditions, specifically bull and bear market conditions. Levy hypothesised that high beta stocks will do better than the market in bullish years, and that low beta stocks will do worse and that the reverse should hold for bearish years. To measure this hypothesis Levy states that historical betas and subsequent returns should be positively correlated during an advancing market, negatively correlated during a declining market and uncorrelated during a flat market. Levy initially measured betas and computed returns based on weekly returns for each calendar year. The results yielded little significance. He then considered that market advances or declines do not fit perfectly into calendar year periods and would impact on the relationship between Beta and returns. Levy (1974) therefore repeated the analysis but now defined primary bull and bear periods. He segregated six consecutive periods separated by a minimum 15% swing in returns from 1961 to 1970. His results now showed significant correlation between beta values from a previous period and the next periods return, finding that in bullish periods those portfolios with the largest beta values had the largest returns and smaller betas lead to smaller returns. In a downturn the portfolios with the largest betas produced the largest losses and those with smaller betas lost less.

Jagannathan and Wang (1996) discuss the efficacy of the CAPM of Sharpe and Lintner (1964; 1965) specifically the expectation that the relation between required expected return and beta is linear. Jagannathan and Wang (1996), review the work of Fama and French (1992), where they find that the Sharpe-Lintner CAPM does not sufficiently explain the cross-section of average returns and resign the model to being inappropriate. Jagannathan and Wang, however explain that the reason for this is the static nature of the model, as it assumes that betas of assets remain constant over time. They introduce a conditional-CAPM where beta values for an asset vary over time in relation to the business cycle. Through empirical analysis, Jagannathan and Wang (1996) demonstrate that the conditional-CAPM is able to explain 30 percent of the cross-sectional variation in average returns of portfolios as compared to just 1 percent for static CAPM. They are able to improve the effectiveness of the model as it explains over 50% percent of variation, by introducing human capital as a wealth measure. This inclusion was a result of considering the unsuitability of using a value-weighted portfolio of all stocks as a market proxy in the analysis and criticism of the CAPM as done by Fama and French (1992).

Similar findings were obtained by Bali, Cakici and Tang (2009) as they investigated the cross-sectional relation between conditional betas and expected stock returns on US exchanges for the sample period of July 1963 to December 2004. The work of Bali, et al was different though as they computed betas and returns based on daily return data as opposed to monthly or weekly data. They obtained statistically significant evidence both at the portfolio-level analyses and the firm-level cross-sectional regressions supporting the positive relation between the conditional betas and the cross-section of average returns.

Lakhan (2006) used a dual beta model to identify whether the premiums for size, value and momentum effects vary according to bull or bear stock market conditions on the JSE securities exchange. Following the studies of international markets (Jagannathan and Wang 1996; Bali et al. 2009), Lakhan finds that there is a significant relationship between dual beta and realised returns and that this relationship is not symmetrical across bull and bear markets.

This research will not involve working directly with Betas; however understanding how Betas and Returns are conditionally related may provide insight into the performance of an Efficient Portfolio Index under extreme conditions.

The researcher therefore proposes the following hypothesis.

> The null hypothesis states that the performance of an efficient portfolio index relative to the market index will be the same through bull and bear market conditions on the JSE.
>
> The alternative hypothesis states that the performance of an efficient portfolio index relative to the market index will be different through bull and bear market conditions on the JSE.

2.5 Conclusion of Literature Review

The literature review covers some of the fundamental concepts that describe the behaviour of stock returns. The topic of portfolio selection has been extensively researched evident by the vast literature available. The earliest description of stock market behaviour, referred to as the random walk theory, was presented in 1900 by Bachelier, who suggested that successive returns of stocks are independent of past behaviour. Another major concept discussed is the Efficient Markets Hypothesis which forms the base assumption of many pricing models. The Efficient Markets Hypothesis states that the intrinsic value of an asset is fully reflected in the market price at all times.

The review then covers the more popular portfolio selection techniques and asset pricing models that have been developed. The earlier models originated from the mean-variance concepts of Harry Markowitz and are of the single factor, single period form. The primary model is the Capital Asset Pricing Model (CAPM) which has been extensively modified into many variants. The origin of these models can be traced to the original concept of the mean-variance efficient frontier of Markowitz. At the time the solutions to the efficient frontier was computational intensive and not practical with the available technology of the time. Ultimately the resulting simplification assumptions led to the development of the CAPM and the use of Beta as a proxy of asset behaviour relative to the market. Inevitably alternative models, the more popular of these have been covered in the literature review, have been developed including multi-factor models and those linked to behavioural traits of investors. It is within this context that the purpose of this research is based, by returning to the founding concepts of Markowitz and developing an efficient portfolio index the researcher seeks to compare its performance to the general market returns.

The review goes further to present research into the conditional factors influencing asset returns specifically performance under bull and bear market conditions. The researcher investigates what impact bull and bear market conditions have on an efficient portfolio.

3 HYPOTHESES

3.1 Efficient portfolio index performance

The null hypothesis states that the performance of an efficient portfolio index will yield returns that are equal to the market index on the JSE.

The alternative hypothesis states that the performance of an efficient portfolio index will yield returns that are different to the market index on the JSE.

$$H_0: \quad \mu_{AR} = 0$$

$$H_A: \quad \mu_{AR} \neq 0$$

where μ_{AR} refers to the mean of the abnormal returns. The abnormal return in this context refers to the difference between the portfolio return and the return of the market index for each time period.

3.2 Bull and Bear market influence

The null hypothesis states that the performance of an efficient portfolio index relative to the market index will be the same through bull and bear market conditions on the JSE.

The alternative hypothesis states that the performance of an efficient portfolio index relative to the market index will be different through bull and bear market conditions on the JSE.

$$H_0: \quad \mu_{AR(Bull)} = \mu_{AR(Bear)}$$

$$H_A:: \quad \mu_{AR(Bull)} \neq \mu_{AR(Bear)}$$

4 RESEARCH METHODOLOGY

This section describes the methodology that was followed to test the hypotheses that have been put forward.

4.1 Research methodology

This study uses a quantitative methodology. A study that involves large amounts of data analysis cannot be accurately interpreted intuitively but requires a more precise approach to uncover valuable information (Albright et al. 2008). The nature of this research subject and the research problem necessitate the measurement and statistical evaluation of stock returns. A quantitative approach is therefore most suitable for this research.

4.2 Research Design

The research has been conducted using a statistical approach to evaluate the performance of the Efficient Portfolio Index against the benchmark of the market index on the JSE. The use of statistical testing for significance, allows useful and appropriate interpretation of results from which logical inferences can be drawn, (Patell 1976). Analysis is done using historical data on the JSE. Since portfolio selection will be dictated by the mean-variance optimisation concept of Markowitz (1952; 1959), the study offers a perspective as if it were an actual application of the concepts. An alternative may have been to use a simulation approach; however this is not necessary considering the availability of data.

4.3 Population and sample

4.3.1 *Population*

The population comprises the universe of companies listed on the JSE between the periods January 2002 till December 2009 and their associated stock prices.

The start date for the analysis period was chosen to coincide with the date from which the J203, benchmark index, was first measured.

4.3.2 *Sample and sampling method*

The sample for this study comprises the top 100 ordinary shares that were listed on the main board of the JSE during the period 1st January 2002 to 31 December 2009. For the duration of each analysis segment, i.e. in between portfolio rebalancing dates, each selected share must have been listed for the duration of the segment.

4.4 The research instrument

The data for the study was obtained by selecting portfolios that lie along the mean-variance efficient frontier as described by Markowitz (1952; 1959). The returns of the portfolio are tracked producing an index from which data analysis was performed. The portfolio was re-balanced at specified intervals to maintain the mean-variance efficiency. The evaluation period that was selected offers an opportunity to analyse the performance of the index under extreme conditions that include strong growth phases, referred to as bull runs, and market pull backs more commonly known as bear periods.

4.5 Procedure for data collection

Share data was extracted off the I-Net bridge database. The data is comprised of the weekly share prices of all stocks listed on the JSE. Only the top 100 shares measured by total market capitalisation are considered at each re-balancing interval. This is necessary as the researcher uses a personally developed Excel Spreadsheet program that seeks out the efficient portfolio using an iterative process. The variables are therefore limited in order to allow a solution to be found within a reasonable length of time when considering the available computational power.

To construct an efficient portfolio, the weekly returns are calculated using equation (10).

$$R_{i,t} = \ln\left(\frac{P_{i,t} + D_{i,t}}{P_{i,t-1}}\right) \qquad (10)$$

where $R_{i,t}$ is the return for a share *i* in week t, $P_{i,t}$ is the share price of share *i* in week *t*, $P_{i,t-1}$ is the share price of share *i* in month t-1 and $D_{i,t}$ is the dividend on share *i* should the ex-dividend date fall within week t. The logarithmic method of calculating returns caters for continuous growth as opposed to the discrete method calculated by dividing the price difference plus dividends received by the previous asset price. Empirical evidence suggests that logarithmic returns are more likely to be normally distributed and therefore conform to standard statistical techniques (Strong 1992).

The choice of measurement intervals requires consideration. The returns can be computed using daily, weekly or monthly share price data. Strong (1992) recommends the use of shorter intervals based on empirical evidence of studies into the efficiency of estimates of expected returns associated with event studies. Bondt and Thaler (1985) have criticised the use of short intervals particularly the use of daily returns as such studies are susceptible to errors arising from thin trading. Thinly traded shares, according to Bondt and Thaler (1985), potentially produce infrequent magnified returns and may therefore impact on statistical analysis. Polson and Tew (2000) in contrast suggest the use of high frequency data to retain valuable statistical data concerning the estimation of variance and co-variance of future returns that is otherwise lost through the use of monthly or weekly data. This research therefore utilises weekly data to mitigate against the issues mentioned in the literature around the use of extreme low or high frequency data.

The returns of individual shares are then used to construct an efficient frontier along which the efficient portfolio lies. The actual portfolio is selected at the tangent of the line that extends from the riskless asset within the Risk-Return plot and the efficient portfolio (Tobin 1958). The intersection is the optimal portfolio, as an investor can obtain any possible combination of Risk and Return by holding appropriate proportions of the riskless asset and the efficient portfolio (Varian 1993). The graphical depiction of this arrangement is shown in figure 2 below.

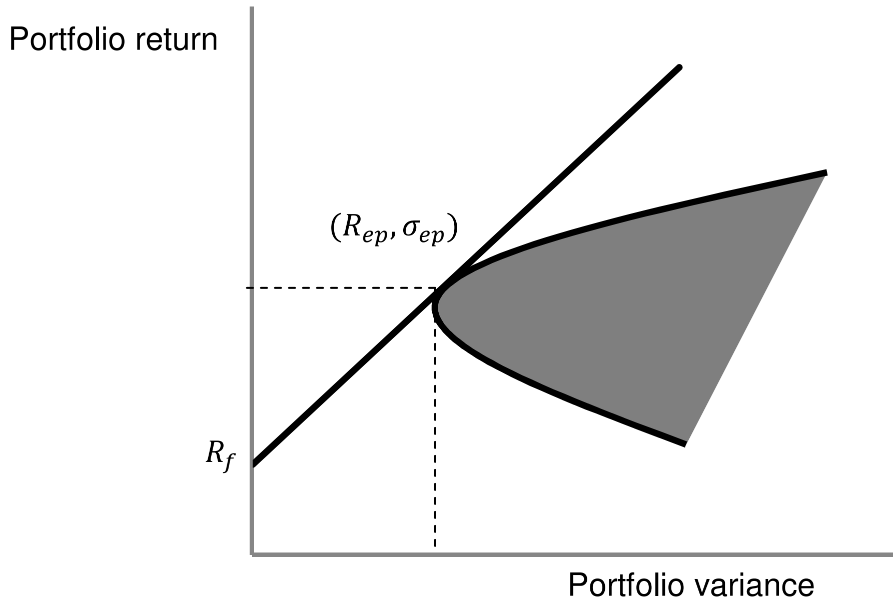

Figure 2: The efficient portfolio shown on the efficient frontier

The coordinates (R_{ep}, σ_{ep}) indicate the expected return and variance of the efficient portfolio and R_f is the riskless asset taken as the government R157 bond. Brennan (1997) argues that the typical use of a short term treasury bill potentially introduces errors in long run valuations, however since the portfolio will be rebalanced frequently, the impact of choosing the R157 bond is expected to be minimal. The portfolio is re-balanced every six months to reduce the impact of assuming no transaction costs but also to maintain the mean-variance efficiency of the index. At each rebalancing point 60 data points are used. Strong (1992) discusses different estimation periods from 3 months to 5 years. By choosing 60 weeks this accommodates the influence on recent and relevant events on firms while avoiding potentially outdated events from impacting on the analysis. The shorter period also results in more firms being included as any missing data will lead to the firm being excluded from the estimation period and therefore from inclusion in the portfolio. Strong (1992) also discusses the importance of selecting a relevant market index. The JSE all share is used as the benchmark index in the form of J203 index. The portfolio value will not have dividends added back. This is to ensure an appropriate comparison to the J203 which excludes reinvested dividends, as opposed to the J203T. The resulting portfolio is used to produce the Efficient Portfolio Index. The exclusion of dividends is not expected to influence the research outcomes as long as the comparative index is consistent.

4.6 Data analysis and interpretation

The resulting data consists of weekly returns of the portfolio. For a specified period, the mean of the difference between the portfolio returns and the market returns is tested for significant deviation from zero. The specified period is changed relevant to the hypothesis being tested. For the hypothesis that tests if the performance of an efficient portfolio index will yield returns that are equal or different to the market index on the JSE, the period covers the entire data range of the study; while the data range to test conditional performance during bull and bear markets, the data range is segregated in-line with these conditions. The segregation criterion for this purpose is described later.

4.6.1 *Statistical analysis*

Abnormal returns are usually utilised in event studies involving the empirical analysis of the impact of economic events on a portfolio or asset (Strong 1992). Strong (1992) describes how in these studies the distribution of the return of an asset, influenced by an event, is compared to the distribution of expected returns of the asset without anticipating this event. The abnormal return can be defined as the access return of the asset in relation to a benchmark. The abnormal return of an asset i as described by Strong (1992) can be expressed as follows:

$$AR_i = E(R_i|y_i) - E(R_i) \qquad (11)$$

Where $E(R_i|y_i)$ is the return of the asset conditional on the signal y_i. The basic structure of a typical event study may then compute the mean abnormal return across firms in the sample, possibly cumulated over the test period, to test whether $AR_i = 0$ using a test statistic of the form, (Strong 1992):

$$\frac{mean\ abnormal\ return}{standard\ deviation}$$

In this study the researcher defines the abnormal return of the efficient portfolio as

$$AR_{ep} = R_{ep} - R_m \qquad (12)$$

Most studies utilise the cumulative abnormal returns in event studies. Strong (1992) indicates that the reason for using cumulative abnormal returns is to completely capture the effect of an event over a particular period. Strong (1992) supporting the suggestion of (Ball and Brown 1968), that due to inaccuracy of knowing exactly when the influence of an event starts impacting on returns; it is best to cumulate abnormal returns over the testing period. An example provided by Strong (1992) is the case of an earnings announcement by a firm. Information about the earnings of a firm is often known and reacted to by investors before the actual announcement date. Since this study does not analyse reactions to specific events, the mean of the abnormal returns, μ_{AR} will be used in addition to the CAR.

Ball and Brown (1968) conducted simulation studies evaluating, amongst other factors, the suitability of using the t-test in analysing security returns. Ball and Brown (1968) compared the t-test against two other significance tests 1) a sign test and 2) a Wilcoxon signed rank test. One of the assumptions of the t-test is that the returns are normally distributed. If this is not the case then the sampling distribution may not resemble the actual distribution. The consequence of this, according to Ball and Brown (1968), is that the probability of making a type I error is increased.

Liesenfeld and Jung (2000) tested how accurately stochastic volatility models, based on assumptions that distributions are normal, describe the latent volatility of stock returns. The paper compared the normal distribution, the *t*-distribution and the GED distribution and found that the normal distribution did not adequately capture the heavy-tails of the distribution of returns and found that the *t*-distribution represented a significant improvement in all series that were tested. The mixture of normal distributions hypothesis suggests that stock returns can be described by a combination of overlapping normal distributions each with its own mean and variance (Fama 1963, 1965b; Fielitz and Rozelle 1983). Fielitz and Rozelle (1983) analysed empirical data of the daily returns of 50 stocks from a US market, performing stability-under-addition analysis to evaluate consistency of data against the mixture of normal distributions hypothesis and against a mixture of distributions described by the stable but non-normal Paretian model. The results showed that the majority of distributions were consistent with the mixture-of-distributions hypothesis but could not conclusively decide if they were normal or not.

The studies of Ball and Brown (1968) show little difference between the statistical test methodologies. In their analysis of the t-tests, the differences between the actual and assumed normal distribution of the test statistics seem small. They find that the t-test was well specified while certain non-parametric tests are not. This finding will therefore be used as a motivation to make use of the t-test in this study.

4.6.2 *Defining bull and bear market periods*

In order to investigate the hypothesis that relates to the conditional performance during bull and bear markets, an appropriate method is required to identify and segregate the test period into bull and bear market conditions. Fabozzi and Francis (1977, 1979) define a bull (bear) market as one that has a positive (negative) monthly return. Klein and Rosenfeld (1987) define a bull (bear) month when the market's monthly return is positive (negative) and is greater (less) than one-half of the market's standard deviation of monthly returns calculated over the entire testing period. For months where returns are within one-half the standard deviation, these months are considered normal. Bhardwaj & Brooks (1993) however, classify months as a bull (bear) market if the monthly market return is higher (lower) than the median market return for the entire period that is examined.

Yet another approach is offered by Pettengill, Sundaram and Mathur (1995), who refer to a bull market as a period where the monthly return of a share is greater than or equal to that of the risk-free return in that period, while all other periods are classified as bear periods. The approach of (Pettengill et al. 1995) is used in this study.

4.7 Limitations of the study

- The computation of the efficient portfolio was done using an excel spreadsheet which limits the number of shares considered in the sample when solving for the efficient portfolio to 100. Only the top 100 shares rated by market capitalisation have therefore been considered. This may result in the calculated portfolio not being the most efficient possible.
- The portfolio is re-balanced every six months and the infrequency of this choice implies that the portfolio may not remain efficient between re-balancing intervals. This potentially may deflect the performance of the portfolio away from the true efficient portfolio.

4.8 Validity and reliability

4.8.1 *External validity*

External validity refers to the extent to which generalisations into other areas can be made from the results of a specific study (Leedy and Ormrod 2005). Leedy & Ormrod (2005) state that the external validity of a study can be improved by using a representative sample and by finding results that are consistent with similar studies.

The literature review did not reveal many studies with the specific intentions of this research; however the individual components of this research, specifically the efficient portfolio concepts, the analysis techniques in computing portfolio and market returns and the statistical tests are all popular and well tested methods. The vast amount of literature on these individual components provides confidence in the external validity of this research.

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4.8.2 *Internal validity*

Leedy & Ormrod (2005) define internal validity as the extent to which the researcher is able to draw accurate conclusions from the study. They state that the internal validity of a study can be improved by reducing the possibility that the research results came about due to reasons other than those concluded in the study.

The sample in this study is believed to be representative and statistically large considering the period that is being studied. There may be an impact from the limitation on the number of companies considered in determining the efficient portfolio as described in section 3.7; however the use of the top 100 shares ensures liquidity and reduces the impact of thin trading. To evaluate the potential impact of this limitation, the market capitalisation contribution from the top 100 shares towards the total market was calculated for the first and last re-balancing dates, these being on the 6th of January 2002 and the 5th of July 2009 respectively. The top 100 shares contribute 98.9% and 95.1% for the respective dates, considering that this group make up most of the value of the total market, this limitation does not appear to be significant.

4.9 Reliability

Reliability examines how consistent results are within a study (Leedy and Ormrod 2005). Checks and corrections are done on the various data that was used to ensure its reliability. This includes a comparison of the bull and bear periods categorisations identified by using the Pettengill et al (1995) criterion, against at least one of the other methods identified in the literature review. A test for normality is also conducted on the distributions of returns.

5 PRESENTATION OF RESULTS

5.1 Data Integrity

To verify the integrity of the data used in the research report, a comparison was done against another data source in order to validate the correctness of the data used in the analysis. The original data was obtained off the i-net bridge database and this was compared to data extracted off the sharenet website. Ten randomly selected share codes from the sample of shares were selected for this comparison. The table below compares the average of the weekly returns for the ten shares from each data source for the duration of the analysis period.

Table 1: Comparison of Data from different sources

Share code	Share name	Data source	Averaged weekly returns	Diff
PGR	Pergrin	I-net	0.356%	0.000%
		Sharenet	0.356%	
SBK	Stanbank	I-net	0.282%	0.000%
		Sharenet	0.282%	
MFL	Metrofile	I-net	-0.542%	0.000%
		Sharenet	-0.542%	
ATN	Altron	I-net	0.295%	0.000%
		Sharenet	0.295%	
CRM	Ceramic	I-net	0.152%	0.000%
		Sharenet	0.152%	
NTC	Netcare	I-net	0.370%	0.000%
		Sharenet	0.370%	
ASR	Assore	I-net	0.676%	0.000%
		Sharenet	0.676%	
GFI	GFields	I-net	0.124%	0.000%
		Sharenet	0.124%	
INL	Investec	I-net	0.114%	0.000%
		Sharenet	0.114%	
NHM	Northam	I-net	0.285%	0.000%
		Sharenet	0.285%	

No variances or errors were detected in share prices between the two sources. It can therefore be concluded that the data set is accurate and correct.

A further analysis was done to test the Bear vs Bull classification criterion, used in the study, against an alternative method. In this study, the method described by Pettengill et al. (1995) was employed and this was compared to the method of Klein and Rosenfeld (1987). The comparison is listed in table 2 below and shows a difference in classification between the two methods for periods 7 and 10, where the method of Klein and Rosenfeld (1987) appears to be more bearish in its approach. The comparison does not appear to raise much concern over the use the Pettengill et al. (1995) method.

Table 2: Bull vs Bear conditions classification, method comparison

Period	Date Range	Pettengill et al. 1995 classification	Klein and Rosenfeld (1987) classification
1	Jan 02 - Jun 02	Bear	Bear
2	Jul 02 - Dec 02	Bear	Bear
3	Jan 03 - Jun 03	Bear	Bear
4	Jul 03 - Dec 03	Bull	Bull
5	Jan 04 - Jun 04	Bear	Bear
6	Jul 04 - Dec 04	Bull	Bull
7	Jan 05 - Jun 05	Bull	Bear
8	Jul 05 - Dec 05	Bull	Bull
9	Jan 06 - Jun 06	Bull	Bull
10	Jul 06 - Dec 06	Bull	Bear
11	Jan 07 - Jun 07	Bull	Bull
12	Jul 07 - Dec 07	Bear	Bear
13	Jan 08 - Jun 08	Bear	Bear
14	Jul 08 - Dec 08	Bear	Bear
15	Jan 09 - Jun 09	Bear	Bear
16	Jul 09 - Dec 09	Bull	Bull

5.2 Efficient Portfolio Index Performance

A promising finding would be if the efficient portfolio index were to significantly out-perform the market. The performance of the efficient portfolio can be evaluated from the cumulative abnormal returns of the efficient portfolio but more rigorously from the results of the mean abnormal returns. The hypotheses used are listed below.

The null hypothesis states that the performance of an efficient portfolio index will yield returns that are equal to the market index on the JSE.

The alternative hypothesis states that the performance of an efficient portfolio index will yield returns that are different to the market index on the JSE.

The performance trends of the Efficient Portfolio index and the All Share index are shown in figure 3 below. The two indices can be interpreted by considering that the chart indicates the growth of an investment of one rand in each of the indices evaluated weekly from January 2002 till December 2009. At the end of the analysis period and after an eight year investment duration, the market index achieved a value of 2.55. This compares poorly against the value of 3.47 for the Efficient Portfolio Index. The Market generated an 11.7% year-on-year growth from January 2002 till December 2009 while the Efficient Portfolio generated 15.6% year-on-year growth for the same period.

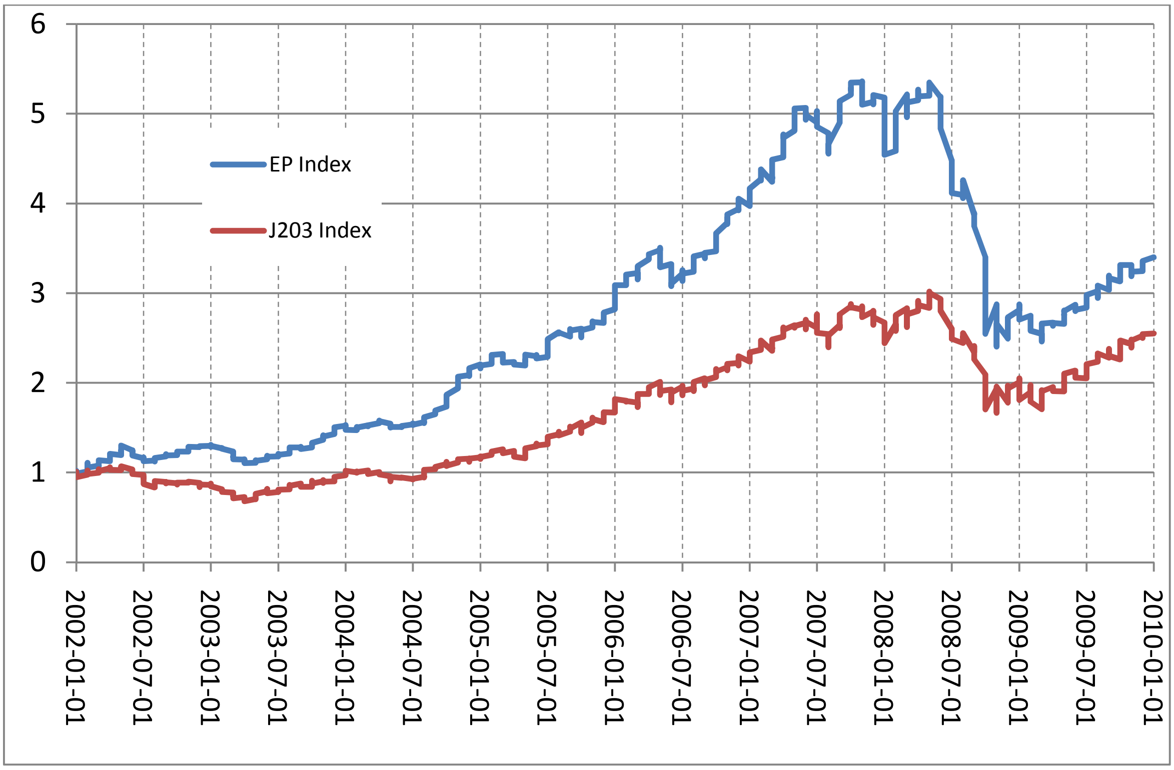


Figure 3: Performance chart for the Efficient Portfolio index and the All Share index

Table 3 shows the statistical analysis results of the overall performance of the efficient portfolio index in relation to the market index. Over the entire duration of the analysis period, the mean return of the Efficient Portfolio index, in excess of the market returns, is positive. This equates to an annualised out performance of 4.0% of the Efficient Portfolio over that achieved by the market. The magnitude of the out-performance is not statistically significant though, and the hypothesis test yields a finding in favour of the null hypothesis. The alternate hypothesis is therefore rejected and suggests that there is no difference between the average returns of the efficient portfolio and the average returns of the market.

Table 3: The performance of the Efficient Portfolio – Statistical results

	Mean AR	CAR	Std Deviation	n	Significance level	Transformation coefficient	Significance confidence intervals	Hypothesis
Overall EP Performance	0.073%	30.67%	2.01%	417	5%	Z = 0.75	+/- 1.96	Accept H_O, Reject H_A

The cumulative abnormal returns through the full duration of the analysis returned a 30.7% additional return of the Efficient Portfolio Index over the Market Index. This result contradicts the hypothesis test and suggests that the Efficient Portfolio Index substantially out performs the Market index.

An additional trend was added into figure 4 which plots the difference between the Efficient Portfolio index and the market index through the analysis period which has been named the Delta index (Δ index). This allows a different perspective of the behaviour of the portfolio. The Δ index grows steadily from the beginning of the period till the market crash in 2008. This indicates a steady outperformance of the portfolio over the market. During the recession the Δ index deteriorates dramatically and suggests that the portfolio performance is significantly inferior to the performance of the market. Since the market crash though, the Δ index has remained relatively flat.

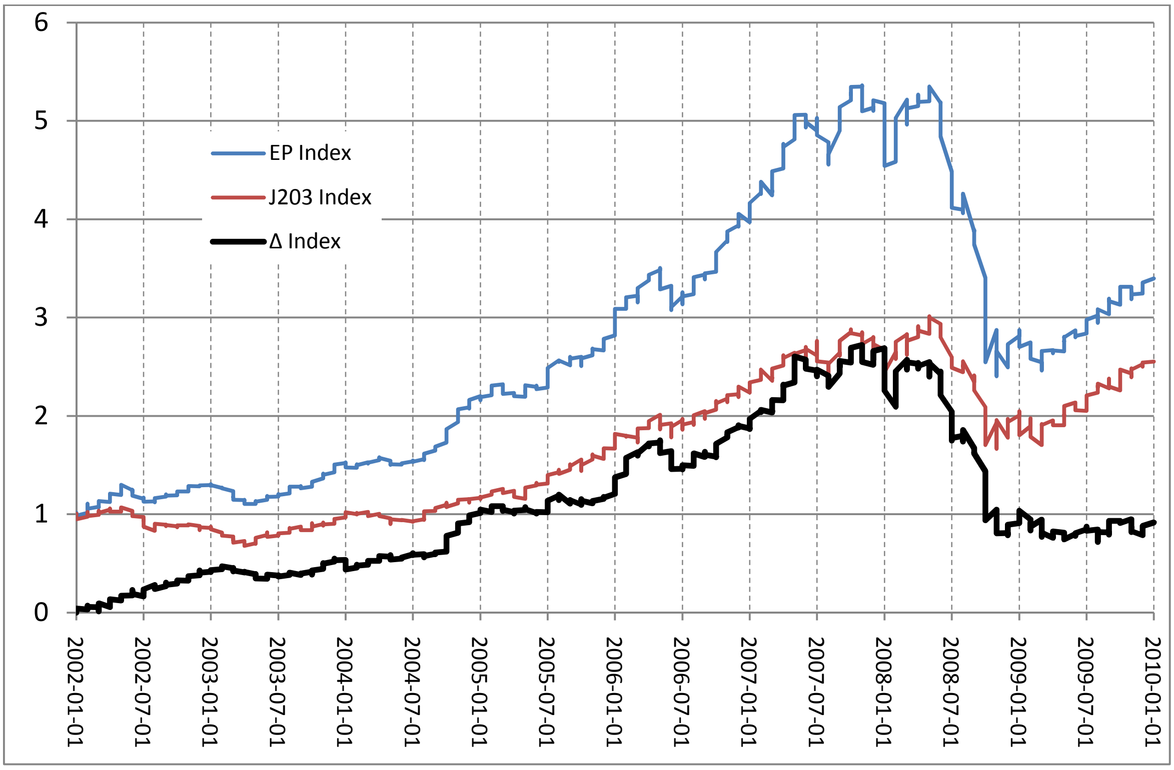
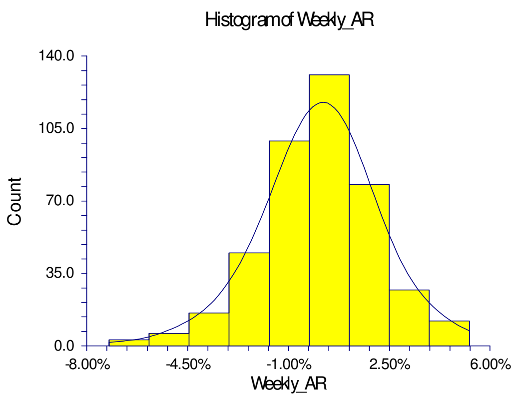


Figure 4: Trend of difference between indices

Figure 5 shows the distribution and the normal probability plot for the overall abnormal returns of the portfolio. The normality test rejected the distribution as being normal. The detailed statistical analysis can be found in the appendices.



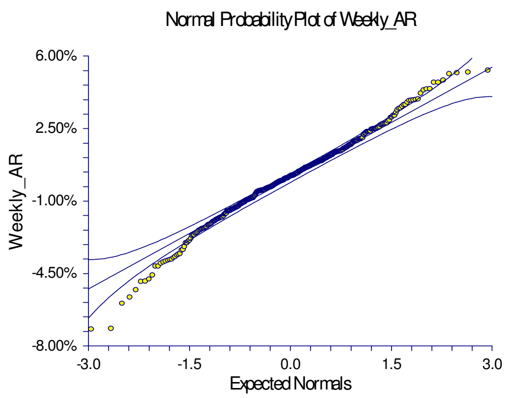


Figure 5: Distribution and normal probability plot for overall performance of the Efficient Portfolio index

5.3 Bull and Bear market influence

The following hypothesis was tested to determine any conditional effects that could influence the performance of the efficient portfolio index.

> The null hypothesis states that the performance of an efficient portfolio index relative to the market index will be the same through bull and bear market conditions on the JSE.
>
> The alternative hypothesis states that the performance of an efficient portfolio index relative to the market index will be different through bull and bear market conditions on the JSE.

Using the criteria described by Pettengill et al. (1995), the periods between rebalancing intervals were classified into Bull and Bear market conditions. This is represented graphically in figure 6 below.

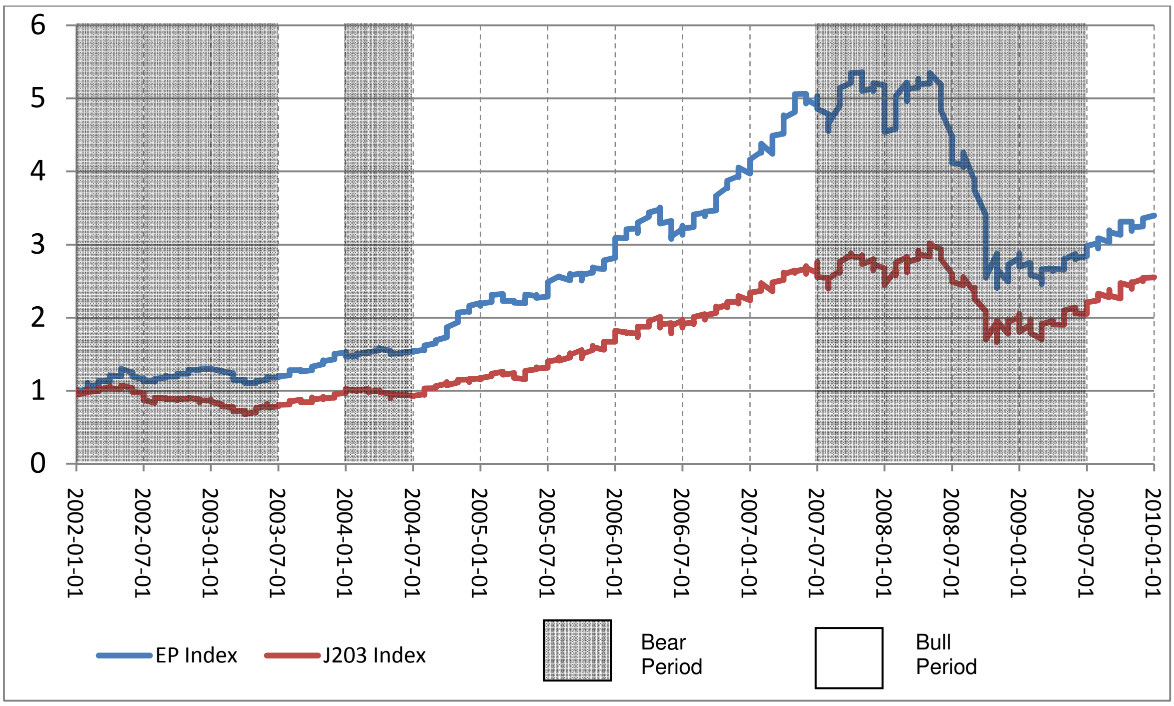


Figure 6: Bull and Bear market classification per period.

The weekly abnormal returns were then grouped for each type of market condition and analysed together. The results of the statistical analysis are shown in table 4.

Table 4: Conditional effect on Efficient Portfolio index - statistical summary

	Mean AR	CAR	Std Deviation	n	Significance level	Transformation coefficient	Significance confidence intervals	Hypothesis
Overall EP Performance	0.073%	30.7%	2.01%	417				
Bear Market	0.051%	10.6%	2.34%	208	5%	t = - 0.23	+/- 1.96	Accept H_O, Reject H_A
Bull Market	0.096%	20.1%	1.61%	209				

When comparing the relative performance of the Efficient Portfolio index during varying market conditions, the portfolio performed more favourably during bull market conditions, with abnormal returns for bull conditions calculated at 0.096% compared to 0.051% for bear conditions, based on weekly returns. This equates to a 5.2% annualised outperformance for bull conditions compared to a more conservative 2.8% annualised abnormal return under bear market conditions. The cumulative abnormal returns under bullish conditions were almost twice as high as compared to bearish conditions in the market at 20.1% and 10.6% respectively. The t-test however did not reveal a significant finding and supports the null hypothesis while rejecting the alternate hypothesis, suggesting that there is no conditional effect on the performance of the Efficient Portfolio index based on bull and bear market conditions.

Figure 7 shows the distribution and the normal probability plot for the abnormal returns of the portfolio under bear market conditions. The normality test rejected the distribution as being normal. Figure 8 shows the distribution and the normal probability plot for the abnormal returns of the portfolio under bull market conditions. The normality test accepted the distribution as being normal. The detailed statistical analysis can be found in the appendices.

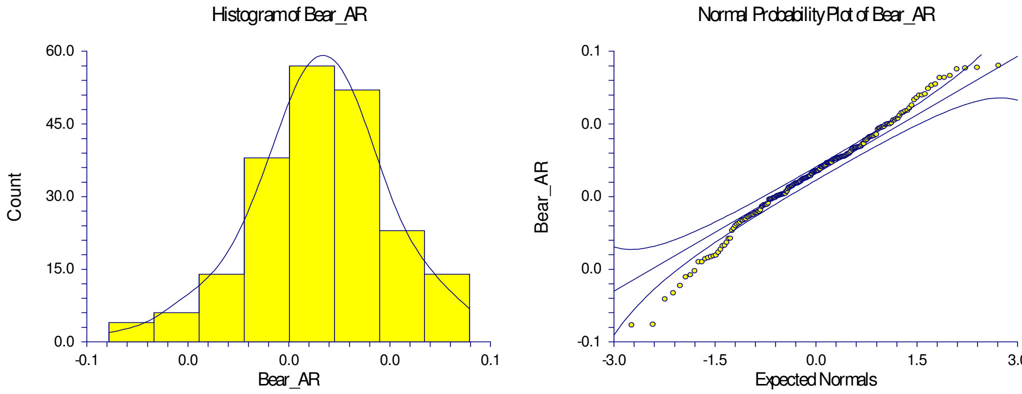


Figure 7: Distribution and normal probability plot for Bear market conditions of the Efficient Portfolio index

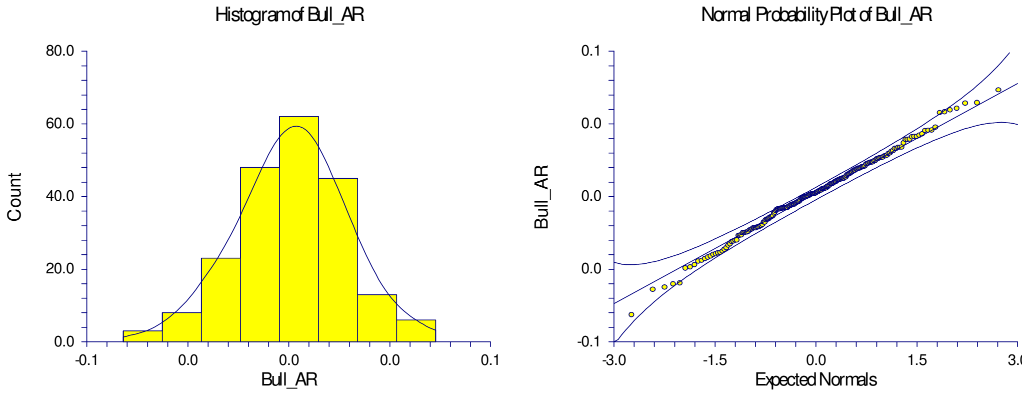


Figure 8: Distribution and normal probability plot for Bull market conditions for the Efficient Portfolio index

6 INTERPRETATION OF RESULTS

6.1 Efficient Portfolio Index Performance

Based on the results of the hypothesis test there does not appear to be a significant difference in the performance of the efficient portfolio index and the performance of the market index over the period Jan 2002 till Dec 2009 on the JSE.

The evaluation technique of using the abnormal returns and testing for statistically significant deviations of the mean abnormal returns from zero appears to be overly rigorous. Visually the efficient portfolio index appears to notably outperform the market index particularly for the period leading up to the market crash in 2008 where the total returns of the efficient portfolio had reached almost two times the levels of returns achieved by the market. This observation is supported by analysing the cumulative abnormal returns which indicate a strong outperformance of the efficient portfolio over the market.

When evaluating the shape of the distribution of the overall returns, the hypothesis test for normality suggests that the distribution is non-normal. This may explain the conservative finding of the efficient portfolio performance hypothesis. As suggested by Scholz (2007), the reliability of the Sharpe ratio in evaluating the performance of an investment becomes questionable. Since the efficient portfolio at each rebalance interval was obtained by maximising the Sharpe ratio, the selected portfolio may not have been the true efficient portfolio. The deviation from normality may also support the criticism of the t-test made by Ball and Brown (1968) who stated that since the t-test assumes a normal distribution, should the distribution be non-normal, this would increase the probability of the test generating a type I error.

An interesting observation was made when evaluating the trend of the difference between the two indices through the evaluation period. From inception the efficient portfolio index steadily outperforms the market index evident in the growth of the Δ index up to 2008. During the market crash in 2008 the performance of the efficient portfolio dramatically deteriorates. In addition, since the crash the performance of the efficient portfolio appears to be flat in relation to the market, as is evident in the Δ index shown in figure 4. Table 5 offers an interesting visual relationship between the efficient portfolio parameters as measured at each of the rebalance interval dates, which may direct attention towards a possible explanation for the change in portfolio performance pre, during and post the market crash. The change in pattern of the efficient portfolio behaviour coincides with the periods where the portfolio standard deviation increases appreciably to almost twice the values measured in previous periods. Perhaps this suggests that the volatility in the market has a negative impact on reliably determining the efficient portfolio.

Table 5: Efficient portfolio parameters

Rebalance Dates	Portfolio returns	Portfolio variance	Portfolio standard deviation	Sharpe ratio
2002/01/06	46.85%	0.000142	1.19%	32.99
2002/07/07	44.86%	0.000127	1.13%	33.13
2003/01/05	39.22%	0.000092	0.96%	33.11
2003/07/06	25.10%	0.000148	1.22%	14.47
2004/01/04	42.31%	0.000102	1.01%	34.44
2004/07/04	48.15%	0.000075	0.87%	46.96
2005/01/02	55.91%	0.000100	1.00%	48.48
2005/07/03	42.91%	0.000136	1.16%	30.41
2006/01/01	52.00%	0.000085	0.92%	48.32
2006/07/02	59.79%	0.000248	1.58%	33.19
2007/01/07	54.91%	0.000209	1.45%	32.80
2007/07/01	62.27%	0.000258	1.60%	34.13
2008/01/06	50.79%	0.000212	1.45%	29.76
2008/07/06	51.95%	0.000834	2.89%	15.39
2009/01/04	-0.72%	0.001140	3.38%	-2.44
2009/07/05	17.09%	0.001234	3.51%	2.73

6.2 Bull and Bear market influence

The hypothesis test for bull and bear market conditionality yielded similar results to the overall performance of the efficient portfolio with no significant difference being found between the two conditional states of the market on the performance of the efficient portfolio index.

There is also a noticeable difference between the standard deviations of the weekly abnormal returns for the two conditional categories displayed in the statistical summary in table 4, where the abnormal returns during bear market conditions are more volatile as compared to bull market conditions. This finding is potentially explained by the theories describing the expected rational behaviour of the markets, where rational behaviour is questioned during times of uncertainty leading to measured differences between shares prices and their intrinsic value calculated based on fundamentals (Kahneman and Tversky 1979; Bondt and Thaler 1985; Scott 1991). Emotional decisions will lead to more price movements and more variability in markets.

The variability is further evident in the normality test for each of the two conditional states shown in figures 7 and 8. The test for normality indicated that the bull market distribution was likely to be normal while the bear market distribution was not. Related to the hypothesis test for conditional influences, Scott (1991), describes how deviations from normality may influence the reliability of the t-test in analysing distributions due to the sample not being representative of the population. This may have influenced the outcome of the t-test.

As with the overall performance analysis, the cumulative abnormal returns suggested a different result though, with the performance of the efficient portfolio under bull conditions being substantially better than the performance under bear market conditions.

7 CONCLUSION AND RECOMMENDATIONS

The objective of this research was to establish an efficient portfolio index for the JSE using the theories of Markowitz, (1952; 1959; 1976). The performance of this efficient portfolio was then evaluated against a benchmark proxy for the market in the form of the J203 JSE all-share index. The analysis period that was chosen included the 2008 global economic crisis that resulted in extreme market conditions seeing a significant market collapse. This allowed an analysis of the conditional influences of the market on the performance of the efficient portfolio index. During the literature review there was little evidence of such an index being available and no similar research available to compare findings too. The findings should therefore provide investors an additional benchmark by which to gauge their chosen trading strategies against.

The analysis did not produce a statistically significant finding when evaluating the mean excess weekly returns of the efficient portfolio index over that of the market index, and suggested no difference between the average returns of the index and the average returns of the market. An alternative evaluation method was used, by accumulating the excess returns over the duration of the analysis period. This indicated a strong outperformance of the efficient portfolio index over the market index. A further change in trend was observed in the relative performance of the index over the period of the market crash in 2008 where the efficient portfolio performed extremely favourably before the crash, but completely reversed this performance during the actual market retraction. Since the crash however the relative performance of the index has been flat.

When testing for conditional effects during bull and bear market conditions, the statistical t-test concluded that there was no difference in the mean excess returns between the two market states. When calculating the cumulative weekly abnormal returns for each condition and comparing against each other, the performance of the efficient portfolio during bull market conditions outperforms the efficient portfolio during bear market conditions by 100%.

7.1 Limitations

The perspective of this research and the resulting construction of the efficient portfolio was done in-line with a typical trading strategy and therefore considered the impact of transaction costs and thin trading. This influenced the choice of rebalance frequency to a 6 monthly rebalance interval. It is expected that between rebalancing intervals the selected efficient portfolio may have deviated from the true efficient portfolio and may result in the performance of the efficient portfolio index being different from the theoretically efficient portfolio index.

The distribution of the abnormal returns, particularly during bear market conditions, was not normal. According to Ball and Brown (1968) this may compromise the reliability of the t-test to evaluate the performance of the efficient portfolio and may have affected outcome of the hypothesis tests.

7.2 Future Research

The following areas could form the basis of future research.

Firstly, a study could be done to investigate the reasons for the change in performance of the efficient portfolio before and after the market crash, specifically the poor performance during the market pullback and indifferent performance following the crash. This may provide insight and guide trading strategies that may be based on the efficient portfolio theory.

Secondly, the study can be repeated over different historical periods for the JSE. The selected periods should include market pullbacks of the same magnitude as the 2008 crash, to seek similar behavioural patterns of the efficient portfolio index as observed in this study. An alternative study could seek for the same behaviour of the efficient portfolio over the 2008 crash, but on different stock exchanges. Should the behaviour be the same, this could trigger additional research into the reasons for this behaviour.

Thirdly, a potentially valuable study could be commissioned to review the impact of varying the rebalance intervals to seek out the most economical rebalance frequency, by weighing up the benefit of staying close to the true efficient portfolio against incurring higher transaction costs.

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APPENDICES

Appendix 1: Rebalance dates and portfolio composition – Jan 02 to Dec 04

2002/01/06		2002/07/07		2003/01/05		2003/07/06		2004/01/04		2004/07/04	
Share Code	%	Share Code	%	Share Code	%	Share Code	%	Share Code	%	Share Code	%
ABL	0.00%	ABL	0.00%	ABL	0.00%	ABL	0.00%	ABL	1.63%	ABL	5.00%
AEG	0.00%	AEG	0.00%	AEG	2.17%	ACL	0.00%	ACL	0.00%	ACL	1.60%
AFE	0.00%	AFE	0.00%	AFE	0.00%	ACP	5.00%	AEG	0.00%	AEG	0.00%
AFR	0.00%	AFR	0.00%	AFR	0.00%	AEG	0.02%	AFE	0.00%	AFE	0.00%
AFX	0.00%	AFX	0.00%	AFX	0.00%	AFE	0.04%	AFR	0.00%	AFR	0.00%
AGI	3.64%	AGI	0.96%	AGL	0.00%	AFR	0.00%	AFX	0.00%	AFX	0.00%
AGL	0.00%	AGL	0.00%	ALT	0.00%	AFX	0.03%	AGL	0.00%	AGL	0.00%
ALT	0.00%	ALT	0.00%	AMS	0.00%	AGL	0.00%	ALT	1.56%	ALT	0.34%
AMS	0.00%	AMS	0.00%	ANG	0.00%	ALT	0.02%	AMS	0.00%	AMS	0.00%
ANG	0.00%	ANG	0.00%	APN	0.00%	AMS	0.00%	ANG	0.00%	ANG	0.00%
APN	0.00%	APN	0.00%	ARI	0.00%	ANG	0.00%	APK	5.00%	APN	3.51%
ARI	0.00%	ARI	0.00%	ARL	1.16%	APN	1.21%	APN	5.00%	ARI	0.00%
ASA	0.00%	ARL	4.97%	ASA	0.00%	ARI	0.19%	ARI	0.00%	ARL	5.00%
ASR	5.00%	ASA	0.00%	ASR	5.00%	ARL	3.08%	ARL	3.23%	ASA	0.00%
ATN	0.00%	ASR	5.00%	ATN	2.13%	ASA	1.36%	ASA	0.00%	ASR	0.00%
ATNP	0.00%	ATN	0.00%	ATNP	0.04%	ASR	3.18%	ASR	0.00%	ATN	5.00%
BAT	0.00%	ATNP	3.74%	BAT	0.00%	ATN	1.49%	ATN	1.92%	ATNP	3.00%
BEL	1.67%	BAT	0.00%	BEL	4.50%	ATNP	0.98%	ATNP	0.61%	BIL	0.00%
BIL	0.00%	BEL	0.00%	BIL	0.00%	BAT	0.00%	BIL	0.00%	BVT	0.00%
BVT	0.00%	BIL	0.00%	BVT	0.00%	BEL	0.00%	BVT	0.00%	CAT	0.00%
CAT	2.32%	BVT	0.00%	CAT	0.00%	BIL	0.00%	CAT	0.00%	CLH	0.00%
CLI	0.00%	CAT	3.95%	CLH	5.00%	BVT	0.00%	CLH	0.00%	CLS	0.00%
CLS	0.00%	CLH	5.00%	CLS	0.00%	CAT	2.14%	CLS	0.00%	CRM	0.00%
COM	0.00%	CLS	0.00%	CRM	3.17%	CLH	3.95%	CRM	0.00%	CSO	0.00%
CRM	5.00%	CRM	5.00%	CSO	0.00%	CLS	0.00%	CSO	0.00%	DDT	0.00%
CSO	5.00%	CSO	5.00%	CVI	5.00%	CRM	0.80%	CVI	0.00%	DRD	0.00%
CVI	0.00%	CVI	5.00%	DDT	0.00%	CSO	0.00%	DDT	0.00%	DST	0.95%
DDT	0.00%	DDT	0.00%	DLV	4.48%	CVI	0.01%	DRD	0.00%	DSY	4.00%
DLV	0.00%	DLV	0.00%	DRD	0.76%	DDT	0.00%	DST	0.00%	DTA	0.00%
DRD	5.00%	DRD	5.00%	DST	0.00%	DLV	0.16%	DSY	0.00%	DTC	0.00%
DST	0.10%	DST	5.00%	DSY	0.00%	DRD	0.00%	DTA	0.00%	EHS	0.00%
DSY	0.00%	DSY	0.00%	DTA	0.75%	DST	0.15%	DTC	0.00%	FPT	0.37%
DTA	5.00%	DTA	0.29%	DTC	0.00%	DSY	0.25%	EHS	0.00%	FSR	0.00%
DTC	0.00%	DTC	0.00%	EHS	5.00%	DTA	0.00%	FPT	3.91%	GDF	3.90%
EHS	0.00%	EHS	0.30%	FPT	0.00%	DTC	0.00%	FSR	0.00%	GFI	0.00%
FPT	0.00%	FPT	0.00%	FSR	0.00%	EHS	0.00%	GDF	5.00%	GMB	2.48%
FSR	0.00%	FSR	0.00%	GDF	0.61%	FPT	3.23%	GFI	0.00%	GND	5.00%
GFI	5.00%	GFI	0.51%	GFI	1.82%	FSR	0.00%	GMB	1.19%	GRT	0.00%
GIJ	0.00%	GMB	2.53%	GRT	0.00%	GDF	3.73%	GRT	0.00%	HAR	0.00%
GMB	0.00%	GRT	0.00%	HAR	0.00%	GFI	0.00%	HAR	0.00%	HYP	2.54%
GRT	0.00%	HAR	1.16%	HCI	0.00%	GRT	1.89%	HYP	5.00%	ILA	1.35%
HAR	0.41%	HCI	0.00%	HYP	0.00%	HAR	0.00%	ILA	0.00%	ILV	2.18%
HCI	0.00%	HYP	0.00%	ILV	0.00%	HYP	2.12%	ILV	0.00%	IMP	0.00%
HYP	2.69%	ILV	1.46%	IMP	0.79%	ILV	1.26%	IMP	0.00%	INL	0.00%
ILV	4.02%	IMP	0.00%	INL	0.00%	IMP	0.00%	INL	0.00%	INP	0.00%
IMP	0.00%	INL	0.00%	INP	0.00%	INL	0.00%	INP	0.00%	IPL	0.00%
INL	0.00%	INP	0.00%	IPL	0.00%	INP	0.00%	IPL	2.05%	ITE	1.58%
INP	0.00%	IPL	0.00%	ITE	5.00%	IPL	0.93%	ITE	4.83%	JCD	0.00%
IPL	0.00%	ITE	3.58%	JCD	0.00%	ITE	3.32%	JCD	0.00%	JDG	0.00%
ITE	0.00%	JDG	0.00%	JDG	0.00%	JCD	0.00%	JDG	4.78%	KGM	5.00%
JDG	0.00%	LBH	0.00%	LBH	0.99%	JDG	3.14%	LBH	0.00%	LBH	0.00%
LBH	0.00%	LON	0.00%	LON	0.00%	LBH	0.00%	LON	0.00%	LON	0.00%

2002/01/06		2002/07/07		2003/01/05		2003/07/06		2004/01/04		2004/07/04	
Share Code	%	Share Code	%	Share Code	%	Share Code	%	Share Code	%	Share Code	%
LON	0.00%	MDC	0.00%	MDC	3.58%	LON	0.00%	MDC	5.00%	MDC	3.85%
MDC	5.00%	MET	0.00%	MET	0.00%	MDC	1.58%	MET	0.00%	MET	0.00%
MET	0.00%	MFL	0.00%	MPC	0.00%	MET	0.00%	MPC	0.00%	MPC	2.45%
MFL	0.00%	MPC	0.00%	MRF	0.00%	MPC	1.39%	MRF	0.00%	MRF	0.00%
MPC	0.00%	MRF	0.94%	MSM	0.63%	MRF	0.00%	MSM	0.00%	MSM	0.00%
MRF	2.59%	MSM	5.00%	MTA	5.00%	MSM	3.02%	MST	0.00%	MTA	5.00%
MSM	0.00%	MTA	5.00%	MTN	0.00%	MTA	3.00%	MTA	2.67%	MTN	1.04%
MTN	0.00%	MTN	0.00%	MUR	5.00%	MTN	1.42%	MTN	5.00%	MUR	3.36%
MUR	5.00%	MTX	0.00%	MVL	0.00%	MUR	1.83%	MUR	0.00%	MVL	0.00%
NED	0.00%	MUR	4.02%	NED	0.57%	MVL	0.00%	MVL	0.00%	NED	0.00%
NHM	0.00%	MVL	0.00%	NHM	0.00%	NED	0.00%	NED	0.00%	NHM	0.00%
NPK	0.00%	NED	0.00%	NPK	2.45%	NHM	0.00%	NHM	0.00%	NPK	0.00%
NPN	0.00%	NHM	0.00%	NPN	0.00%	NPK	0.06%	NPK	0.00%	NPN	0.00%
NTC	5.00%	NPK	0.00%	NTC	0.25%	NPN	1.15%	NPN	0.00%	NTC	0.12%
OCE	5.00%	NPN	0.00%	OCE	1.96%	NTC	1.26%	NTC	5.00%	OCE	0.00%
OML	0.00%	NTC	5.00%	OML	0.00%	OCE	0.27%	OCE	0.00%	OML	0.00%
PAM	0.00%	OCE	3.84%	OMN	5.00%	OML	0.00%	OML	0.00%	OMN	0.00%
PAP	0.00%	OML	0.00%	PAM	5.00%	OMN	5.00%	OMN	0.00%	PAM	0.00%
PGR	0.00%	PAM	4.97%	PAP	1.72%	PAM	0.00%	PAM	0.00%	PAP	1.16%
PIK	0.00%	PAP	0.00%	PGR	0.00%	PAP	3.22%	PAP	5.00%	PIK	0.00%
PPC	2.37%	PGR	0.00%	PIK	0.00%	PIK	1.01%	PIK	0.00%	PPC	2.26%
PWK	0.00%	PIK	0.00%	PPC	3.41%	PPC	3.02%	PPC	0.00%	PWK	0.00%
RBW	4.53%	PPC	0.00%	PWK	0.00%	PWK	1.31%	PWK	0.00%	RAH	1.63%
RDF	5.00%	PWK	0.00%	RBW	0.00%	RBW	1.48%	RBW	4.84%	RBW	0.00%
RLO	5.00%	RBW	0.00%	RDF	0.00%	RDF	1.84%	RDF	2.23%	RDF	0.00%
RMH	0.00%	RDF	0.00%	RLO	0.00%	RLO	0.00%	RLO	0.00%	RLO	3.57%
RNG	2.25%	RLO	0.00%	RMH	0.00%	RMH	0.00%	RMH	0.00%	RMH	2.25%
SAB	0.00%	RMH	0.00%	RNG	0.00%	RNG	3.05%	RNG	3.39%	RNG	0.00%
SAC	0.00%	RNG	0.29%	SAB	0.00%	SAB	0.00%	SAB	0.00%	SAB	0.78%
SAP	0.00%	SAB	0.00%	SAC	0.00%	SAC	2.39%	SAC	5.00%	SAC	0.00%
SBK	0.00%	SAC	0.00%	SAP	0.00%	SAP	0.00%	SAP	0.00%	SAP	0.00%
SBO	0.00%	SAP	0.00%	SBK	0.00%	SBK	0.35%	SBK	0.00%	SBK	0.00%
SHF	0.00%	SBK	0.00%	SHF	0.00%	SHF	0.00%	SHF	0.00%	SHF	0.00%
SHP	0.00%	SHF	0.00%	SHP	0.00%	SHP	0.00%	SHP	0.00%	SHP	0.00%
SLM	0.00%	SHP	2.60%	SLM	0.00%	SLM	0.00%	SLM	0.00%	SLM	0.00%
SNT	0.00%	SLM	0.00%	SNT	0.00%	SNT	0.64%	SNT	5.00%	SNT	0.00%
SOL	2.35%	SNT	0.00%	SOL	2.22%	SOL	0.00%	SOL	0.00%	SOL	0.00%
SPG	0.00%	SOL	0.00%	SPG	0.00%	SPG	0.06%	SPG	0.00%	SPG	0.63%
SUI	0.00%	SPG	0.00%	SUI	1.36%	SUI	0.99%	SUI	3.54%	SUI	0.62%
SYC	5.00%	SUI	0.00%	SYC	0.00%	SYC	2.17%	SYC	5.00%	SYC	3.47%
TDH	0.00%	SYC	0.00%	TDH	0.00%	TDH	0.70%	TDH	0.00%	TDH	0.00%
TFG	0.00%	TDH	0.00%	TFG	3.50%	TFG	4.31%	TFG	2.28%	TFG	0.00%
TRE	3.36%	TFG	0.00%	TRE	0.00%	TRE	0.00%	TRE	0.00%	TRE	5.00%
TRU	0.00%	TRE	4.89%	TRU	0.00%	TRU	2.72%	TRU	0.00%	TRU	0.00%
TSX	0.00%	TRU	0.00%	TSX	5.00%	TSX	1.92%	TSX	0.00%	TSX	0.00%
WHL	0.00%	TSX	0.00%	WBO	5.00%	WBO	2.91%	WBO	0.35%	WBO	5.00%
ZCI	0.00%	WHL	0.00%	WHL	0.00%	WHL	2.23%	WHL	0.00%	WHL	0.00%
ZSA	2.70%	ZSA	5.00%	ZSA	0.00%	ZSA	0.00%	ZSA	0.00%	ZSA	5.00%

Appendix 2: Rebalance dates and portfolio composition – Jan 05 to Dec 07

2005/01/02		2005/07/03		2006/01/01		2006/07/02		2007/01/07		2007/07/01	
Share Code	%	Share Code	%	Share Code	%	Share Code	%	Share Code	%	Share Code	%
ABL	0.00%	ABL	0.00%	ABL	0.00%	ABL	2.63%	ABL	0.00%	ABL	0.00%
ACL	3.49%	ACL	0.00%	ACL	0.00%	ACL	0.00%	ACL	0.00%	ACL	0.00%
AEG	0.00%	AEG	0.02%	AEG	0.00%	AEG	0.00%	ACP	0.00%	AEG	1.33%
AFE	0.00%	AFE	0.83%	AFE	2.57%	AFE	0.00%	AEG	0.00%	AFE	0.00%
AFR	0.00%	AFR	0.02%	AFR	0.00%	AFX	0.46%	AFE	0.00%	AFX	0.00%
AFX	0.00%	AFX	0.37%	AFX	0.00%	AGL	0.00%	AFR	4.67%	AGL	0.00%
AGL	0.00%	AGL	0.34%	AGL	0.00%	ALT	0.00%	AFX	0.40%	ALT	0.00%
ALT	0.00%	ALT	0.75%	ALT	0.00%	AMS	2.81%	AGL	0.00%	AMS	0.00%
AMS	0.00%	AMS	1.33%	AMS	1.59%	ANG	0.00%	ALT	0.00%	ANG	0.00%
ANG	0.00%	ANG	0.60%	ANG	0.00%	APN	0.00%	AMS	0.00%	APN	0.00%
APK	0.00%	APK	1.01%	APN	5.00%	AQP	5.00%	ANG	0.00%	AQP	1.34%
APN	5.00%	APN	2.09%	ARI	2.03%	ARI	0.00%	APN	0.00%	ARI	2.68%
ARI	0.00%	ARI	0.25%	ARL	0.00%	ARL	0.00%	AQP	3.64%	ARL	0.00%
ARL	2.77%	ARL	1.41%	ASA	0.00%	ASA	0.00%	ARI	5.00%	ASA	0.00%
ASA	1.45%	ASA	1.73%	ASR	2.30%	ASR	2.85%	ARL	5.00%	ASR	5.00%
ASR	0.00%	ASR	2.33%	ATN	0.00%	ATN	0.00%	ASA	0.00%	ATN	0.00%
ATN	1.01%	ATN	1.21%	ATNP	0.00%	ATNP	0.00%	ASR	3.58%	ATNP	5.00%
ATNP	0.00%	ATNP	0.92%	BAT	4.71%	AVI	0.00%	ATN	0.00%	AVI	0.00%
BIL	0.00%	BIL	0.84%	BCX	0.89%	BAT	0.00%	ATNP	0.00%	BEL	5.00%
BVT	3.60%	BVT	0.68%	BIL	0.00%	BIL	0.00%	AVI	0.00%	BIL	0.00%
CAT	0.00%	CAT	0.47%	BVT	0.00%	BVT	0.00%	BAT	0.00%	BVT	0.00%
CLH	2.60%	CLH	1.66%	CAT	0.00%	CAT	0.00%	BIL	0.00%	CAT	0.00%
CLS	0.00%	CLS	0.07%	CLS	0.00%	CLS	0.00%	BVT	0.00%	CLS	0.54%
CML	0.00%	CML	0.20%	CML	0.00%	CML	0.00%	CAT	0.00%	CSO	5.00%
CPL	0.27%	CPL	1.90%	CPI	0.00%	CRM	0.00%	CLH	5.00%	DDT	0.03%
CRM	5.00%	CRM	1.72%	CRM	5.00%	CSO	0.00%	CLS	0.00%	DST	5.00%
CSO	0.74%	CSO	1.20%	CSO	0.00%	DDT	0.00%	CPI	0.00%	DSY	0.00%
CVI	1.47%	CVI	1.93%	DDT	0.00%	DRD	0.00%	CRM	0.00%	DTC	0.00%
DDT	0.00%	DDT	0.00%	DRD	0.63%	DST	1.24%	CSO	5.00%	EHS	0.00%
DRD	0.00%	DRD	0.00%	DST	1.88%	DSY	0.00%	DDT	0.00%	EMI	0.00%
DST	1.40%	DST	1.77%	DSY	0.00%	DTC	5.00%	DST	1.46%	FPT	0.00%
DSY	2.23%	DSY	1.06%	DTC	0.03%	EHS	0.00%	DSY	0.00%	FSR	0.00%
DTA	0.00%	DTA	1.08%	EHS	0.00%	EMI	0.00%	DTC	0.00%	GDF	5.00%
DTC	0.00%	DTC	0.14%	EMI	1.70%	FPT	0.00%	EHS	0.00%	GFI	0.00%
EHS	0.00%	EHS	2.37%	FPT	1.78%	FSR	0.00%	EMI	0.00%	GND	5.00%
FPT	0.00%	EMI	1.39%	FSR	0.00%	GDF	0.00%	FPT	0.00%	GRF	0.00%
FSR	0.00%	FPT	1.44%	GDF	0.00%	GFI	0.00%	FSR	0.00%	GRT	0.00%
GDF	5.00%	FSR	0.79%	GFI	0.00%	GND	0.00%	GDF	0.00%	HAR	0.00%
GFI	0.00%	GDF	1.74%	GND	0.00%	GRF	0.00%	GFI	0.00%	HCI	5.00%
GND	5.00%	GFI	0.48%	GRF	0.00%	GRT	0.00%	GND	0.00%	HYP	0.00%
GRT	0.00%	GND	1.76%	GRT	0.95%	HAR	0.00%	GRF	5.00%	ILV	1.93%
HAR	0.00%	GRT	1.73%	HAR	0.00%	HCI	0.00%	GRT	0.00%	IMP	0.00%
HCI	1.42%	HAR	0.00%	HCI	4.05%	HYP	2.29%	HAR	0.00%	INL	0.00%
HYP	0.47%	HCI	3.09%	HYP	5.00%	ILV	5.00%	HCI	5.00%	INP	0.00%
ILA	3.77%	HYP	1.35%	ILV	0.56%	IMP	0.00%	HYP	0.00%	IPL	0.00%
ILV	0.00%	ILA	2.04%	IMP	0.00%	INL	0.00%	ILV	5.00%	ITE	5.00%
IMP	0.00%	ILV	0.42%	INL	0.00%	INP	0.00%	IMP	0.00%	JDG	0.00%
INL	0.00%	IMP	1.33%	INP	0.00%	IPL	0.00%	INL	0.00%	LBH	0.00%
INP	0.00%	INL	0.84%	IPL	0.00%	ITE	5.00%	INP	0.00%	LEW	0.00%
IPL	0.00%	INP	0.88%	ITE	5.00%	JDG	0.00%	IPL	0.00%	LON	0.00%
ITE	5.00%	IPL	0.59%	JDG	0.00%	LBH	0.00%	ITE	5.00%	MDC	0.00%
JDG	0.00%	ITE	1.63%	LAF	0.47%	LEW	0.00%	JDG	0.00%	MET	0.00%

2005/01/02		2005/07/03		2006/01/01		2006/07/02		2007/01/07		2007/07/01	
Share Code	%	Share Code	%	Share Code	%	Share Code	%	Share Code	%	Share Code	%
KGM	5.00%	JDG	1.02%	LBH	0.00%	LON	4.85%	LBH	0.00%	MPC	0.00%
LBH	0.00%	KGM	0.66%	LEW	0.00%	MDC	2.78%	LEW	0.00%	MRF	5.00%
LON	0.00%	LBH	0.38%	LON	5.00%	MET	0.00%	LON	0.59%	MSM	0.00%
MDC	0.00%	LON	0.37%	MDC	0.00%	MPC	0.00%	MDC	0.49%	MTN	0.00%
MET	0.00%	MDC	0.92%	MET	0.00%	MSM	0.00%	MET	0.00%	MTX	0.00%
MPC	0.00%	MET	1.62%	MPC	0.00%	MTN	0.00%	MPC	0.00%	MUR	5.00%
MSM	0.00%	MPC	0.78%	MSM	0.00%	MTX	4.53%	MSM	0.00%	MVG	0.00%
MTN	0.00%	MSM	1.05%	MTN	0.00%	MUR	2.10%	MTN	0.00%	MVL	0.00%
MUR	0.00%	MTA	2.06%	MTX	5.00%	MVG	0.00%	MTX	0.00%	NED	0.00%
MVL	0.00%	MTN	0.41%	MUR	0.00%	MVL	0.00%	MUR	5.00%	NHM	0.00%
NED	0.00%	MUR	0.44%	MVL	0.00%	NED	0.00%	MVG	0.00%	NPK	0.00%
NHM	0.00%	MVL	0.00%	NED	0.00%	NHM	5.00%	MVL	0.00%	NPN	0.00%
NPK	0.00%	NED	0.29%	NHM	5.00%	NPK	0.00%	NED	0.00%	NTC	0.54%
NPN	0.72%	NHM	1.05%	NPK	0.00%	NPN	0.00%	NHM	1.82%	OML	0.00%
NTC	0.00%	NPK	0.41%	NPN	0.00%	NTC	4.88%	NPK	0.00%	PAM	0.00%
OCE	0.00%	NPN	1.44%	NTC	0.00%	OML	0.00%	NPN	0.00%	PAP	0.00%
OML	0.00%	NTC	0.86%	OML	0.00%	OMN	0.00%	NTC	5.00%	PGR	0.00%
OMN	0.00%	OCE	0.19%	PAP	0.76%	PAP	0.00%	OML	0.00%	PIK	0.00%
PAM	0.00%	OML	0.70%	PIK	0.00%	PIK	0.00%	OMN	3.88%	PPC	0.00%
PAP	0.00%	OMN	0.95%	PPC	4.12%	PPC	2.63%	PAP	0.00%	PSG	0.00%
PIK	0.00%	PAP	1.51%	PSG	4.29%	PSG	0.38%	PGR	0.73%	PWK	0.00%
PPC	5.00%	PIK	0.69%	PWK	0.00%	PWK	0.00%	PIK	0.00%	RBW	0.00%
PWK	0.00%	PPC	1.37%	RAH	2.35%	RAH	4.97%	PPC	0.00%	RDF	0.00%
RAH	3.21%	PWK	1.01%	RBW	0.00%	RBW	0.00%	PSG	0.00%	RES	1.96%
RBW	0.00%	RAH	1.88%	RDF	5.00%	RDF	2.78%	PWK	0.00%	RLO	0.00%
RDF	0.73%	RBW	1.01%	RES	5.00%	RES	5.00%	RBW	4.75%	RMH	0.00%
RES	0.00%	RDF	1.59%	RLO	4.53%	RLO	3.93%	RDF	1.10%	SAB	5.00%
RLO	5.00%	RLO	1.32%	RMH	0.00%	RMH	0.00%	RES	5.00%	SAC	0.00%
RMH	2.80%	RMH	0.86%	SAB	0.00%	SAB	0.00%	RLO	3.71%	SAP	2.22%
SAB	0.90%	SAB	0.91%	SAC	0.00%	SAC	0.00%	RMH	0.00%	SBK	0.00%
SAC	0.00%	SAC	1.51%	SAP	0.00%	SAP	0.00%	SAB	0.00%	SHF	0.00%
SAP	0.00%	SAP	0.00%	SBK	0.00%	SBK	0.00%	SAP	4.35%	SHP	0.00%
SBK	0.00%	SBK	1.17%	SHF	0.00%	SHF	0.00%	SBK	0.00%	SIM	5.00%
SHF	0.00%	SHF	0.94%	SHP	0.00%	SHP	5.00%	SHF	0.00%	SLM	2.99%
SHP	0.00%	SHP	0.65%	SLM	0.00%	SIM	1.43%	SHP	0.00%	SNT	0.00%
SLM	0.00%	SLM	0.21%	SNT	0.00%	SLM	0.00%	SIM	5.00%	SNU	5.00%
SNT	0.00%	SNT	0.83%	SOL	0.00%	SNT	0.00%	SLM	0.00%	SOL	0.00%
SOL	1.64%	SOL	1.27%	SPG	0.00%	SOL	0.00%	SNT	0.00%	SPG	0.00%
SPG	0.00%	SPG	0.26%	SPP	0.00%	SPG	0.00%	SOL	0.00%	SPP	0.00%
SUI	0.00%	SUI	1.20%	SUI	0.00%	SPP	0.00%	SPG	0.00%	SUI	2.51%
SYC	5.00%	SYC	1.71%	SYC	5.00%	SUI	0.00%	SPP	0.00%	SYC	0.00%
TFG	0.00%	TFG	1.40%	TFG	0.00%	SYC	5.00%	SUI	0.09%	TFG	0.00%
TRE	5.00%	TRE	2.16%	TRE	4.05%	TFG	0.00%	SYC	0.00%	TRE	5.00%
TRU	0.00%	TRU	1.08%	TRU	0.00%	TRE	4.69%	TFG	0.00%	TRU	0.00%
TSX	0.00%	TSX	0.00%	VKE	3.76%	TRU	0.00%	TRE	4.73%	UUU	0.00%
WBO	5.00%	WBO	1.91%	WBO	0.00%	WBO	5.00%	TRU	0.00%	WBO	1.93%
WHL	3.30%	WHL	1.03%	WHL	0.00%	WHL	0.00%	WBO	0.00%	WEZ	5.00%
ZSA	5.00%	ZSA	1.07%	ZSA	0.00%	ZCI	2.76%	WHL	0.00%	WHL	0.00%

Appendix 3: Rebalance dates and portfolio composition – Jan 08 to Dec 09

2008/01/06		2008/07/06		2009/01/04		2009/07/05	
Share Code	%	Share Code	%	Share Code	%	Share Code	%
ABL	0.00%	ABL	0.00%	ABL	0.00%	ABL	0.00%
ACL	0.00%	ACL	5.00%	ACL	0.00%	ACL	0.00%
ACP	1.47%	AEG	0.00%	ACP	0.00%	ACP	5.00%
AEG	0.00%	AFE	0.00%	AEG	0.00%	AEG	0.00%
AFE	0.00%	AFX	0.00%	AFE	0.00%	AFE	0.00%
AFX	0.00%	AGL	0.00%	AFX	0.00%	AFX	0.00%
AGL	0.00%	ALT	0.00%	AGL	0.00%	AGL	0.00%
ALT	3.11%	AMS	0.00%	ALT	0.00%	ALT	0.00%
AMS	0.00%	ANG	0.00%	AMS	0.00%	AMS	0.00%
ANG	0.00%	APN	0.00%	ANG	0.00%	ANG	0.00%
APN	0.00%	AQP	1.09%	APN	0.00%	APN	5.00%
AQP	0.00%	ARI	5.00%	AQP	0.00%	AQP	0.00%
ARI	0.00%	ARQ	0.00%	ARI	0.00%	ARI	0.00%
ARL	5.00%	ASA	0.00%	ARL	0.00%	ARL	0.00%
ASA	0.00%	ASR	5.00%	ASA	0.00%	ASA	5.00%
ASR	5.00%	ATN	0.00%	ASR	5.00%	ASR	0.00%
ATN	0.00%	ATNP	0.00%	ATNP	0.00%	ATNP	0.00%
ATNP	3.87%	AVI	0.00%	AVI	5.00%	AVI	5.00%
AVI	0.00%	BIL	5.00%	BAW	0.00%	BAW	0.00%
BEL	5.00%	BVT	0.00%	BIL	0.00%	BIL	0.00%
BIL	0.00%	CAT	0.00%	BVT	0.01%	BLU	0.00%
BVT	0.00%	CLS	0.00%	CAT	0.00%	BVT	0.00%
CAT	0.00%	CSO	0.00%	CLH	1.92%	CAT	0.00%
CLS	0.00%	CZA	5.00%	CLS	3.51%	CLS	5.00%
CSO	0.00%	DDT	5.00%	CPL	2.98%	CSO	0.00%
DDT	5.00%	DST	0.00%	CSO	0.00%	CZA	0.00%
DST	5.00%	DSY	0.00%	DDT	0.00%	DDT	0.00%
DSY	0.00%	DTC	0.00%	DST	0.00%	DST	5.00%
DTC	0.00%	EHS	5.00%	DSY	3.79%	DSY	5.00%
EHS	5.00%	EMI	0.00%	EHS	0.00%	EHS	0.00%
EMI	0.00%	EXX	5.00%	EMI	1.69%	EMI	5.00%
FPT	0.00%	FPT	0.00%	EXX	0.00%	EXX	0.00%
FSR	0.00%	FSR	0.00%	FPT	0.00%	FPT	0.00%
GDF	5.00%	FUM	0.00%	FSR	0.00%	FSR	0.00%
GFI	0.00%	GBG	5.00%	FUM	0.00%	FUM	0.00%
GND	0.00%	GDF	0.00%	GDF	0.00%	GBG	0.00%
GRF	0.00%	GFI	0.00%	GFI	0.00%	GDF	0.00%
GRT	0.00%	GND	0.00%	GND	0.00%	GFI	0.00%
HAR	0.00%	GRF	0.00%	GRF	0.00%	GND	0.00%
HCI	5.00%	GRT	0.00%	GRT	2.66%	GRF	0.00%
HYP	0.00%	HAR	0.00%	HAR	5.00%	GRT	0.00%
ILV	4.90%	HCI	0.00%	HCI	0.00%	HAR	0.00%
IMP	0.00%	HYP	0.00%	HYP	1.60%	HCI	0.00%
INL	0.00%	ILV	5.00%	ILV	4.10%	HYP	0.00%
INP	0.00%	IMP	0.00%	IMP	0.00%	ILV	0.00%
IPL	0.00%	INL	0.00%	INL	0.00%	IMP	0.00%
JDG	0.00%	INP	0.00%	INP	0.00%	INL	0.00%
JSE	0.00%	IPL	0.00%	IPL	0.00%	INP	0.00%
LBH	0.00%	JDG	0.00%	JDG	0.00%	IPL	0.00%
LEW	0.00%	JSE	0.00%	JSE	0.00%	JDG	0.00%
LON	0.00%	KIO	5.00%	KIO	0.00%	JSE	0.00%
MDC	0.00%	LBH	3.91%	LBH	0.00%	KIO	0.00%

2008/01/06		2008/07/06		2009/01/04		2009/07/05	
Share Code	%	Share Code	%	Share Code	%	Share Code	%
MET	0.00%	LON	0.00%	LEW	2.27%	LBH	0.00%
MPC	0.00%	MDC	0.00%	LON	0.00%	LEW	5.00%
MRF	3.95%	MET	0.00%	MDC	1.41%	LON	0.00%
MSM	0.00%	MPC	0.00%	MET	0.00%	MDC	0.00%
MTN	3.44%	MRF	5.00%	MND	0.00%	MET	0.00%
MTX	0.00%	MSM	0.00%	MNP	0.00%	MND	0.00%
MUR	5.00%	MTN	5.00%	MPC	4.50%	MNP	0.00%
MVL	0.00%	MTX	0.00%	MSM	5.00%	MPC	5.00%
NED	0.00%	MUR	5.00%	MTN	3.90%	MSM	2.27%
NHM	0.00%	MVL	0.00%	MUR	0.00%	MTN	0.00%
NPK	0.00%	NED	0.00%	MVL	0.00%	MUR	0.00%
NPN	0.00%	NHM	0.00%	NED	0.00%	MVL	0.00%
NTC	0.00%	NPK	0.00%	NHM	0.00%	NED	0.00%
OAO	3.08%	NPN	0.00%	NPK	0.00%	NHM	0.00%
OML	0.00%	NTC	0.00%	NPN	1.64%	NPK	0.00%
PAM	0.00%	OAO	5.00%	NTC	0.00%	NPN	5.00%
PAP	0.00%	OML	0.00%	OAO	5.00%	NTC	5.00%
PGR	5.00%	OMN	5.00%	OML	0.00%	OAO	0.00%
PIK	0.38%	PAM	5.00%	PAM	0.00%	OML	0.00%
PPC	0.00%	PAP	0.00%	PAP	0.70%	PAP	0.00%
PSG	0.00%	PIK	0.00%	PIK	3.61%	PFG	0.00%
PWK	0.00%	PPC	0.00%	PPC	0.00%	PIK	5.00%
RBW	2.49%	PWK	0.00%	PWK	3.53%	PPC	0.00%
RDF	0.00%	RBW	0.00%	RBW	3.09%	PWK	5.00%
RES	5.00%	RBX	0.00%	RBX	0.00%	RBW	5.00%
RLO	0.00%	RDF	0.00%	RDF	0.00%	RBX	0.00%
RMH	0.00%	RES	0.00%	RES	1.30%	RDF	2.73%
SAB	4.85%	RLO	0.00%	RLO	0.00%	RES	5.00%
SAC	0.61%	RMH	0.00%	RMH	0.00%	RLO	0.00%
SAP	0.00%	SAB	0.00%	SAB	3.03%	RMH	0.00%
SBK	0.00%	SAC	0.00%	SAC	0.00%	SAB	0.00%
SHF	0.00%	SAP	0.00%	SAP	0.00%	SAC	0.00%
SHP	0.00%	SBK	0.00%	SBK	0.00%	SAP	0.00%
SIM	0.00%	SHF	0.00%	SHF	0.00%	SBK	0.00%
SLM	0.00%	SHP	5.00%	SHP	5.00%	SHF	0.00%
SNT	0.00%	SIM	0.00%	SLM	0.00%	SHP	5.00%
SNU	5.00%	SLM	0.00%	SNT	0.00%	SLM	0.00%
SOL	0.00%	SNT	0.00%	SOL	2.85%	SNT	0.00%
SPG	0.00%	SOL	5.00%	SPP	3.83%	SOL	0.00%
SPP	0.00%	SPP	0.00%	SUI	0.00%	SPP	0.00%
SUI	0.00%	SUI	0.00%	SYC	2.03%	SUI	0.00%
TFG	0.00%	TFG	0.00%	TFG	3.54%	TFG	5.00%
TRE	0.00%	TRE	0.00%	TON	0.00%	TON	0.00%
TRU	0.00%	TRU	0.00%	TRE	0.00%	TRE	0.00%
UUU	0.00%	UUU	0.00%	TRU	5.00%	TRU	5.00%
WBO	5.00%	WBO	0.00%	UUU	0.00%	UUU	0.00%
WEZ	2.85%	WEZ	0.00%	WBO	1.54%	WBO	0.00%
WHL	0.00%	WHL	0.00%	WHL	0.00%	WHL	0.00%

Appendix 4: Descriptive Statistics Report for overall EP performance

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Summary Section of Weekly_AR

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
417	7.354446E-04	0.0200635	9.825138E-04	-0.072274	0.0528238	0.1250978

Counts Section of Weekly_AR

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
417	417	0	417	0.3066804	0.1676839	0.1674583

Means Section of Weekly_AR

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	7.354446E-04	0.0014464	9.829906E-03	0.1281645	0.3066804	
Std Error	9.825138E-04				0.4097083	
95% LCL	-1.195866E-03	-0.0006138	8.512384E-03	8.000224E-03	-0.4986761	
95% UCL	2.666755E-03	0.0032827	1.135135E-02	-9.141473E-03	1.112037	
T-Value	0.7485336					
Prob Level	0.4545614					
Count	417		222	417		0

The geometric mean confidence interval assumes that the ln(y) are normally distributed.
The harmonic mean confidence interval assumes that the 1/y are normally distributed.

Variation Section of Weekly_AR

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	4.02544E-04	0.0200635	2.007556E-02	9.825138E-04	2.402545E-02	0.1250978
Std Error	3.319701E-05	1.169977E-03		5.729402E-05		
95% LCL	3.529869E-04	1.878794E-02		9.200496E-04		
95% UCL	4.633812E-04	2.152629E-02		1.054147E-03		

Skewness and Kurtosis Section of Weekly_AR

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	-0.2951021	3.836007	-0.2961685	0.8606458	27.28078	10.5115
Std Error	0.1533562	0.3372995			36.61577	

Trimmed Section of Weekly_AR

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	1.029858E-03	1.143362E-03	1.192742E-03	1.37102E-03	1.435737E-03	1.362059E-03
Trim-Std Dev	1.473912E-02	1.196612E-02	9.809284E-03	6.467469E-03	3.76562E-03	1.156054E-03
Count	375	334	292	209	125	42

Descriptive Statistics Report

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Mean-Deviation Section of Weekly_AR

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	1.521342E-02	1.520383E-02	4.015787E-04	-2.374806E-06	6.186153E-07
Std Error	5.921813E-04		3.31174E-05	1.34338E-06	1.147173E-07

Quartile Section of Weekly_AR

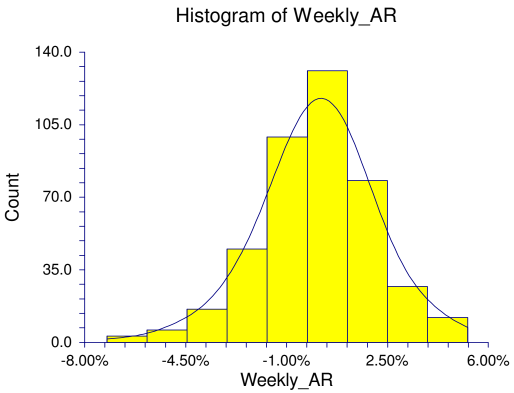
Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	-2.357608E-02	-0.0109226	0.0014464	1.310285E-02	2.472524E-02
95% LCL	-0.0285236	-0.0136986	-0.0006138	0.0104682	0.0225712
95% UCL	-0.0201851	-0.0088482	0.0032827	0.0150724	0.0282899

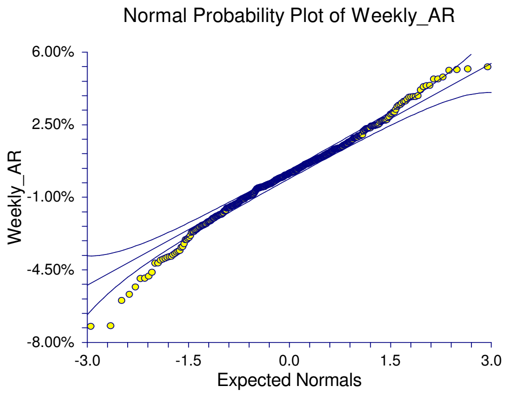
Normality Test Section of Weekly_AR

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.987474	1.182514E-03			Reject normality
Anderson-Darling	1.291298	2.36422E-03			Reject normality
Martinez-Iglewicz	1.081364		1.012543	1.02147	Reject normality
Kolmogorov-Smirnov	5.424463E-02		0.04	0.044	Reject normality
D'Agostino Skewness	-2.453629	1.414226E-02	1.645	1.960	Reject normality
D'Agostino Kurtosis	2.7658	0.005678	1.645	1.960	Reject normality

D'Agostino Omnibus	13.6700	0.001075	4.605	5.991	Reject normality

Plots Section of Weekly_AR





Percentile Section of Weekly_AR

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99	5.054303E-02	0.043735	0.0528238	95.86734
95	3.464536E-02	0.0273707	0.0385212	95.69461
90	2.472524E-02	0.0225712	0.0282899	95.02341
85	1.956655E-02	0.0167691	0.0233678	95.34289
80	1.564988E-02	0.0134698	0.0186336	95.01652
75	1.310285E-02	0.0104682	0.0150724	95.17757
70	1.020288E-02	0.0079333	0.0124045	95.12354
65	7.87479E-03	0.0059338	0.0099245	95.48793
60	0.0059192	0.0038148	0.0078456	95.44349
55	3.29053E-03	0.0016133	0.0058824	95.11132
50	0.0014464	-0.0006138	0.0032827	95.52063
45	-6.0797E-04	-0.00298	0.0014365	95.11132
40	-0.003052	-0.0049499	-0.0006882	95.44349
35	-4.96292E-03	-0.0078664	-0.0034173	95.37422
30	-8.11144E-03	-0.0104497	-0.005079	95.21055
25	-0.0109226	-0.0136986	-0.0088482	95.22726
20	-1.419156E-02	-0.0174928	-0.0115549	95.01652

15	-1.848966E-02	-0.0217895	-0.0151145	95.27576
10	-2.357608E-02	-0.0285236	-0.0201851	95.02341
5	-3.611904E-02	-0.0404246	-0.0285236	95.67654
1	-0.0561865	-0.072274	-0.0462408	95.86734

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of Weekly_AR

Depth	**Stem**	**Leaves**
Low	|	-72,-72,-59,-56,-53,-49,-49,-48
9	-4. |	6
12	-4* |	110
22	-3. |	9988877665
27	-3* |	43200
36	-2. |	998766655
55	-2* |	4443333322211110000
77	-1. |	9999888888887766665555
108	-1* |	4444444443333332222111111100000
145	. |	9999999999888888777666555555555555555
195	-0* |	44444444443333333333332222222211111111000000000000
(48)	0* |	000000000011111111111222222222223333334444444444
174	. |	555555555566666666777777777777888888888888999999
126	1* |	00000000111111222222333333333333334444
88	. |	55555555666667777888888889999
59	2* |	00112233333344444444
39	. |	556667777889
27	3* |	0012344
20	. |	566788888
11	4* |	1333
7	. |	667
High	|	51, 51, 51, 52

Unit = .001   Example: 1 |2 Represents 0.012

Appendix 5: Descriptive Statistics Report for Bull market conditions

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Summary Section of Bull_AR

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
209	9.602871E-04	1.606055E-02	1.110931E-03	-0.0492	0.0437	0.0929

Counts Section of Bull_AR

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
417	209	208	178	0.2007	5.384449E-02	5.365176E-02

Means Section of Bull_AR

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	9.602871E-04	0.001	8.367025E-03	-1.992131E-02	0.2007	0.0008
Std Error	1.110931E-03				0.2321846	
95% LCL	-1.229841E-03	-0.0008	6.858896E-03	1.347836E-02	-0.2570368	
95% UCL	3.150415E-03	0.0033	1.020676E-02	-5.727771E-03	0.6584368	
T-Value	0.8643983					
Prob Level	0.3883649					
Count	209		112	208		4

The geometric mean confidence interval assumes that the ln(y) are normally distributed.
The harmonic mean confidence interval assumes that the 1/y are normally distributed.

Variation Section of Bull_AR

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	2.579412E-04	1.606055E-02	1.607986E-02	1.110931E-03	0.0207	0.0929
Std Error	2.630521E-05	1.158154E-03		8.01112E-05		
95% LCL	2.147489E-04	1.465431E-02		1.01366E-03		
95% UCL	3.156895E-04	1.776765E-02		1.229014E-03		

Skewness and Kurtosis Section of Bull_AR

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	-0.1346256	3.173644	-0.1356007	0.2071378	16.72474	12.49234
Std Error	0.1633245	0.6315651			19.39854	

Trimmed Section of Bull_AR

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	1.047289E-03	1.157655E-03	1.247744E-03	1.438038E-03	1.299522E-03	1.232775E-03
Trim-Std Dev	1.244451E-02	1.019345E-02	8.517426E-03	5.523946E-03	3.218436E-03	9.357514E-04
Count	188	167	146	105	63	21

Mean-Deviation Section of Bull_AR

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	1.249253E-02	1.249234E-02	2.56707E-04	-5.537123E-07	2.091383E-07
Std Error	6.69482E-04		2.617934E-05	6.836711E-07	0

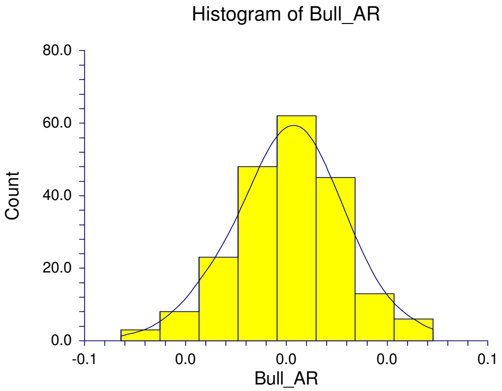
Quartile Section of Bull_AR

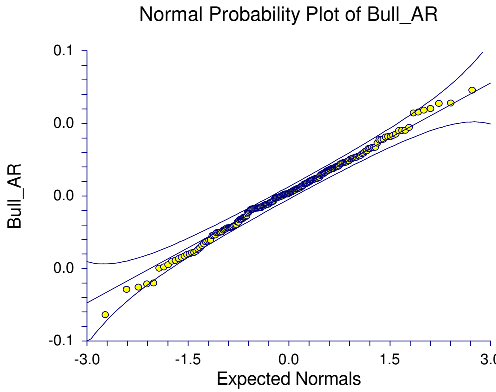
Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	-0.0205	-0.00915	0.001	0.01155	0.0201
95% LCL	-0.0249	-0.0132	-0.0008	0.0088	0.0168
95% UCL	-0.0153	-0.0052	0.0033	0.014	0.025

Normality Test Section of Bull_AR

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.9955762	0.8078011			Can't reject normality
Anderson-Darling	0.2934124	0.6019729			Can't reject normality
Martinez-Iglewicz	1.007683		1.026054	1.041743	Can't reject normality
Kolmogorov-Smirnov	5.209992E-02		0.056	0.061	Can't reject normality
D'Agostino Skewness	-0.8175808	0.4135966	1.645	1.960	Can't reject normality
D'Agostino Kurtosis	0.7319	0.464238	1.645	1.960	Can't reject normality
D'Agostino Omnibus	1.2041	0.547689	4.605	5.991	Can't reject normality

Plots Section of Bull_AR





Percentile Section of Bull_AR

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99	0.03838			
95	0.02695	0.0232	0.0354	96.22794
90	0.0201	0.0168	0.025	95.13414
85	0.01645	0.0139	0.02	95.78135
80	0.0139	0.0113	0.0165	95.38201
75	0.01155	0.0088	0.014	95.33627
70	0.0095	0.0066	0.012	95.04729
65	0.007	0.0042	0.0103	95.78012
60	0.005	0.0024	0.0073	95.21756
55	0.00295	0.0006	0.0057	95.46922
50	0.001	-0.0008	0.0033	95.48859
45	-0.0003	-0.0035	0.0017	95.64629
40	-0.0025	-0.0049	0.0004	95.21756
35	-0.0043	-0.0057	-0.0011	95.78012
30	-0.0054	-0.0097	-0.0038	95.04729
25	-0.00915	-0.0132	-0.0052	95.42996

20	-0.0129	-0.0153	-0.0089	95.12113
15	-0.0152	-0.0205	-0.0129	95.79411
10	-0.0205	-0.0249	-0.0153	95.13414
5	-0.02635	-0.0365	-0.0234	95.92852
1	-0.03861			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of Bull_AR

Depth	**Stem**	**Leaves**
Low	|	-49
5	-3. |	8766
5	-3* |	
12	-2. |	9987665
21	-2* |	444332210
33	-1. |	998886665555
49	-1* |	4443333322221000
69	. |	99988887665555555555
96	-0* |	444444333333222221100000000
(29)	0* |	00000000111112222223333334444
84	. |	555555666677777778899999
60	1* |	0000111112222333333444
38	. |	555556666778899
23	2* |	0001333444
13	. |	556778
7	3* |	44
5	. |	5688
High	|	43

Unit = .001   Example: 1 |2 Represents 0.012

Appendix 6: Descriptive Statistics Report for Bear Market Conditions

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Summary Section of Bear_AR

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
208	5.067308E-04	2.344132E-02	1.625363E-03	-0.0723	0.0528	0.1251

Counts Section of Bear_AR

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
417	208	209	180	0.1054	0.113799	0.1137456

Means Section of Bear_AR

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	5.067308E-04	0.002	0.0121288	-4.145319E-02	0.1054	0.002
Std Error	1.625363E-03				0.3380756	
95% LCL	-2.697658E-03	-0.002	1.007649E-02	3.404359E-02	-0.5611128	
95% UCL	3.711119E-03	0.0051	1.459912E-02	-1.288306E-02	0.7719128	
T-Value	0.3117646					
Prob Level	0.7555332					
Count	208		109	208		4

The geometric mean confidence interval assumes that the ln(y) are normally distributed.
The harmonic mean confidence interval assumes that the 1/y are normally distributed.

Variation Section of Bear_AR

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	5.494957E-04	2.344132E-02	2.346965E-02	1.625363E-03	0.02545	0.1251
Std Error	5.940177E-05	1.791853E-03		1.242426E-04		
95% LCL	4.572897E-04	2.138433E-02		1.482737E-03		
95% UCL	6.728624E-04	2.593959E-02		1.798587E-03		

Skewness and Kurtosis Section of Bear_AR

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	-0.3131312	3.430712	-0.3154104	0.4706583	46.25992	8.956731
Std Error	0.1634111	0.3278862			148.5462	

Trimmed Section of Bear_AR

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	9.047008E-04	1.154327E-03	1.195192E-03	1.298077E-03	1.599038E-03	1.561538E-03
Trim-Std Dev	1.780169E-02	1.406415E-02	1.161052E-02	7.544213E-03	4.475736E-03	1.691948E-03
Count	187	166	146	104	62	21

Mean-Deviation Section of Bear_AR

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	1.795064E-02	1.791346E-02	5.468539E-04	-4.004362E-06	1.025952E-06
Std Error	9.794936E-04		5.911619E-05	2.32819E-06	2.178573E-07

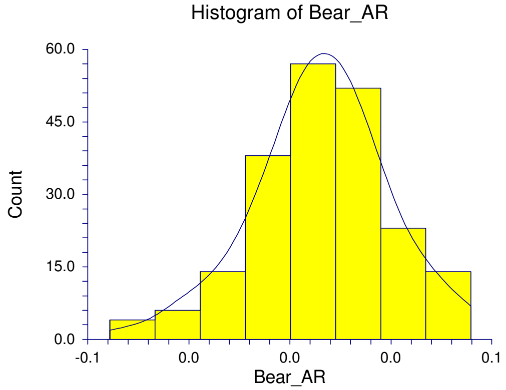
Quartile Section of Bear_AR

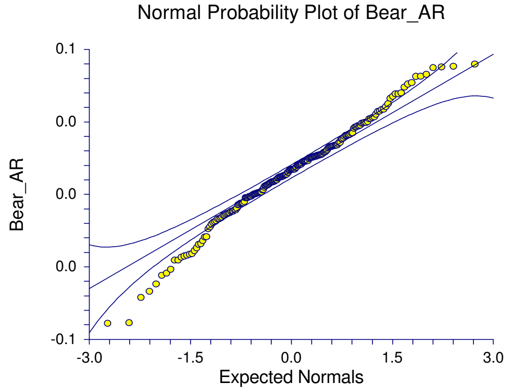
Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	-0.03078	-0.011675	0.002	0.013775	0.03002
95% LCL	-0.0394	-0.0182	-0.002	0.0102	0.0245
95% UCL	-0.0218	-0.0093	0.0051	0.019	0.0385

Normality Test Section of Bear_AR

Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0.9866335	4.746455E-02			Reject normality
Anderson-Darling	0.7017083	0.0669912			Can't reject normality
Martinez-Iglewicz	1.048524		1.026175	1.041925	Reject normality
Kolmogorov-Smirnov	5.127551E-02		0.056	0.061	Can't reject normality
D'Agostino Skewness	-1.865312	6.213772E-02	1.645	1.960	Can't reject normality
D'Agostino Kurtosis	1.3494	0.177207	1.645	1.960	Can't reject normality
D'Agostino Omnibus	5.3003	0.070641	4.605	5.991	Can't reject normality

Plots Section of Bear_AR





Percentile Section of Bear_AR

Percentile	Value	95% LCL	95% UCL	Exact Conf. Level
99	0.051773			
95	0.040485	0.0311	0.0479	96.23812
90	0.03002	0.0245	0.0385	95.18513
85	0.023985	0.0185	0.0287	95.76215
80	0.01872	0.0136	0.0243	95.40807
75	0.013775	0.0102	0.019	95.51076
70	0.01115	0.0083	0.0151	95.11878
65	0.008755	0.006	0.0127	95.05584
60	0.0066	0.0031	0.0091	95.25874
55	0.00438	0.0006	0.0078	95.66795
50	0.002	-0.002	0.0051	95.38598
45	-0.001195	-0.0044	0.0021	95.6198
40	-0.00378	-0.0079	-0.0005	95.25874
35	-0.0059	-0.0101	-0.003	95.05584
30	-0.00966	-0.0141	-0.0055	95.11878
25	-0.011675	-0.0182	-0.0093	95.51076
20	-0.01762	-0.0218	-0.0116	95.27778
15	-0.02126	-0.0306	-0.0175	95.89019

10	-0.03078	-0.0394	-0.0218	95.18513
5	-0.04117	-0.0568	-0.0358	96.03432
1	-0.070902			

Percentile Formula: Ave X(p[n+1])

Stem-Leaf Plot Section of Bear_AR

Depth	Stem	Leaves
Low	|	-72,-72,-59,-56,-53
11	-4 |	986110
22	-3 |	99987543200
34	-2 |	654332111100
60	-1 |	99988887765444443111111000
99	-0 |	999999988776555554443333333221111110000
(43)	0 |	0011222222234444445555666677777788888889999
66	1 |	00011223333333345566778888999
37	2 |	1223334444566778
21	3 |	00012367889
10	4 |	133677
4	5 |	111
High	|	52

Unit = .001   Example: 1 |2 Represents 0.012