Decision-making under uncertainty: Markowitz optimisation as a passive strategy on the JSE

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ABSTRACT

Noted economist and Nobel Prize winner, Harry Markowitz is often called the father of modern portfolio theory based on his 1952 article, *Portfolio Selection*. His innovative work provided a framework for investment managers and showed that it was possible to create and construct an optimal investment portfolio, offering the maximum possible expected return for a given level of risk. Markowitz showed that the risk of a security is not the risk of each security in isolation, but rather, the contribution of each security to the risk of the investment portfolio as a whole.

This study endeavours to apply modern portfolio theory to the JSE. More specifically, the aim of the study is to establish whether a passive trading strategy based on the theoretical underpinnings of Markowitz can outperform the market index, represented by the FTSE/JSE Top 40 TR, on a risk-adjusted basis over a period of 19.5 years. To accommodate both risk-averse and risk-neutral investors, two Markowitz portfolios are constructed, tested and compared to the market index.

The results from this study indicate that both of the Markowitz passively managed portfolios outperformed the market index by a significant margin. However, the portfolios are more volatile than the market, as subsequent analysis shows that the Markowitz portfolios unlock value over a longer time-period. The risk-adjusted outperformance does provide a strong case of momentum on the JSE, where securities that did well in a previous period continue to outperform in the next. Finally, the researcher found no conclusive evidence to factually state that the Markowitz portfolios are sufficiently diversified.

Keywords: JSE, portfolio selection, efficient frontier, modern portfolio theory, mean-variance optimisation, optimal portfolio, risk-adjusted return
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2015

“And whatever you do, whether in word or deed, do it all in the name of the Lord Jesus, giving thanks to God the Father through him.” (Colossians 3:17)
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CHAPTER ONE:
INTRODUCTION AND SCOPE OF THE STUDY

“The future is uncertain, so we can never know what will happen. Indeed, risk would not exist if we could correctly anticipate the future. But rather than reacting blindly to adverse – or even favourable – events, investors can prepare themselves for the future by imagining plausible outcomes.” (Bernstein, 2006:215)

1.1 Background to the study

Uncertainty is often closely linked to scarcity, the fundamental principle driving life on earth. There simply isn’t enough food, money, medical care and jobs to go around. The problem of scarce resources is the central topic in economics, and the reason for the emergence of the field of economics itself. In modern society, economics is mainly concerned with the optimal allocation of scarce resources in an attempt to maximise (or minimise) some function (Samouilhan, 2008:1).

Because of this scarcity, choices have to be made. If we choose one thing we must forego others, which under different circumstances we would not have relinquished (Robbins, 1932:15). In financial economics, these uncertain choices are mainly associated with the optimal allocation of wealth among available investment opportunities (Merton, 1983:105). These optimal allocations of wealth by investors inevitably occur in an environment that is riddled with uncertainty – an uncertainty that can never be completely resolved as nobody will ever have a complete knowledge of the future.

Risk, essentially, has to do with uncertainty. Low levels of uncertainty translate into low-risk and are associated with low potential returns. On the other hand, high levels of uncertainty translate into high-risk and are associated with higher potential returns. It is then safe to assume that the primary objective of any investor should be to maximise the return on their investment opportunities. A rational investor would certainly prefer higher returns on any investments to lower returns as well as lower risks to higher risks (Hargitay & Yu, 2003:4).
1.2 Risk-return relationship

The resultant risk-return relationship is at the very heart of financial theory. Many economic theories are based on the fact that investors are rational and risk averse; in other words, investors expect to be compensated for taking on more risk, the compensation being in the form of greater returns. This constant interaction between risk and return is called the risk-return trade-off (Rossi & Timmermann, 2010:1).

The risk-return trade-off is also the reason why over the medium- to long-run, equities (shares) provide greater expected returns when compared to a money market investment. In a money market investment, there is virtually no risk, but the expected return is much lower. The risk-return trade-off leads to an interesting question: What risk level is most appropriate? Risk tolerance differs between investors and depends on the investor’s goals, level of income, age and other priorities. Hence, investors need to arrive at their own individual risk-return trade-off that is unique to them.

It would seem that avoidance of all risk would lead to a safe and secure investment. This of course is partially true: an investment into a money market instrument, for example, contains little risk, but even money market instruments contain some risk. When African Bank declared bankruptcy in August 2014, the money market instruments that had exposure to fixed income securities issued by African Bank lost more than 5% in some cases. However, avoiding risks also means losing out on the potential gain that accepting the risky investment could have yielded. There are however some risks that are worth taking because the upside from taking these risks exceeds the possible costs. Optimal investment behaviour takes risks that are worthwhile (Engle, 2003:405). People will always try to optimise their behaviour, and in particular investors will optimise their investment portfolio with the end goal to maximise rewards and minimise risks (Engle, 2003:405).

1.3 Asset classes

An asset class is a specific category of assets or investments, such as cash, fixed interest, property, alternative investments and shares. These investments fall into two broad asset classes, growth and defensive. Figure 1-1 shows the particular risk and return characteristics.
Growth assets are designed to grow your investment. They include investments such as shares, alternative investments and property. They tend to carry higher levels of risk, yet have the potential to deliver higher returns over longer investment time frames. In general, growth assets are expected to provide returns in the form of capital growth. For example, as a shareholder, you may receive income in the form of a dividend on the shares you own. However, the majority of the return usually comes from changes in the value of the company over time, as determined by its share price.

Defensive assets include investments such as cash and fixed interest. They tend to carry lower risk levels and, therefore, are more likely to generate lower levels of return over the long term. Generally, defensive assets are expected to provide returns in the form of income.

Figure 1-1: Asset class risk and return characteristics

Source: (Pearce, 2015)
### 1.4 Asset class characteristics

Table 1-1 provides a full breakdown of the asset class characteristics, specific focus is placed on the drivers of return and the potential for the asset class to go up and down in value.

#### Table 1-1: Asset class characteristics

<table>
<thead>
<tr>
<th>Type of investment</th>
<th>Source of investment return</th>
<th>Potential to go up and down in value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Growth asset: Shares</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Securities that represent ownership in a company.</td>
<td>Returns come from increases or decreases in value.</td>
<td>Potentially earn the highest return over the long term. Value more likely to fluctuate in the short term. Considered a high-risk investment.</td>
</tr>
<tr>
<td></td>
<td>Returns also come from income from the company’s profits which are paid to shareholders as dividends.</td>
<td></td>
</tr>
<tr>
<td><strong>Growth asset: Alternative Investments</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infrastructure, such as roads and airports. Private equity investments</td>
<td>Returns come from increases or decreases in value.</td>
<td>Potentially earn more than property, fixed interest and cash over the long term. Value tends to fluctuate more than property, fixed interest and cash in the short term.</td>
</tr>
<tr>
<td></td>
<td>Returns also come from income.</td>
<td></td>
</tr>
</tbody>
</table>
Considered a medium to high risk investment.

**Growth asset: Property**

Returns come from increases or decreases in value.

Returns also come from income in the form of rent.

Returns from listed property are linked to movements in the value of the securities and income generated by the property management companies.

Potentially earn more than fixed interest and cash over the long term, but less than shares.

Value tends to fluctuate more than fixed interest and cash but not shares, over time.

**Defensive asset: Cash**

Returns come from interest paid on the amount invested.

Returns also come from increases or decreases in value of the underlying securities due to changing interest rates.

Chance of losing money on a cash investment considered remote over a one-year period, but possible.

Generally a stable investment that provides steady returns.

Value tends to fluctuate due to changing interest rates.
Returns tend to be lowest of all asset classes over time.

Short-term money market securities can increase or decrease in value over time, unlike money in bank deposits.

<table>
<thead>
<tr>
<th>Defensive asset: Fixed interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonds</td>
</tr>
<tr>
<td>Returns come from interest paid on the loan amount. (When buying fixed-interest securities, investors are “loaning” money to a corporation or government at an interest rate.) Returns also come from increases or decreases in value of the underlying securities due to changing interest rates.</td>
</tr>
<tr>
<td>Tend to provide better returns than cash over the long term, but lower returns than property and shares. Value tends to fluctuate more than cash but less than property and shares.</td>
</tr>
</tbody>
</table>

Source: (Pearce, 2015)

### 1.5 Risk management

Before the risk-return trade-off can be calculated, it is necessary to be able to measure risk. Exactly how risk is measured is a complicated issue and one of the most feared words in the investment world. However, risk is inseparable from return and, rather than being described as good or bad, it is simply necessary for investors to fully understand how to measure and manage risk. It then follows logically that measuring risk is a critical
first step towards managing it. In the investment world, risk means uncertainty and it refers to the possibility that the value of an investment will rise and fall or that an investment will return less than its anticipated return (Lasher, 2013:400).

The field of risk management deals with both diversifiable and no diversifiable risks. **Systematic risk** refers to the risk which affects the whole stock market and therefore it cannot be reduced or diversified away. For example any global turmoil will affect the whole stock market and not any single stock, similarly any change in the interest rates affect the whole market though some sectors are more affected than others. This type of risk is called non diversifiable risk because no amount of diversification can reduce this risk. **Unsystematic risk** is the extent of variability in the share or security’s return on account of factors which are unique to a company. For example it may be possible that management of a company may be poor, or there may be strike of workers which leads to losses. Since these factors affect only one company, this type of risk can be diversified away by investing in more than one company because each company is different and therefore this risk is also called diversifiable risk. These will be further explored in Chapter 2.

To make sense of the risk that is present in an investment, experts developed several ways to measure it. For most investors, risk equals volatility – meaning fluctuations in the price of an investment. The more the price fluctuates, the higher the volatility. Generally, the higher the volatility, the higher the risk; and, normally, the higher the probability for a higher return.

Standard deviation is probably used more often than any other risk measure to gauge an investments risk. Standard deviation is a statistical measurement that is expressed as a percentage and gives insight into the historical volatility of an investment. The smaller an investment's standard deviation, the less volatile (and hence risky) it is. The larger the standard deviation, the more spread those returns are and thus the riskier the investment is. The following example will provide a clear example: suppose security A has a 10% average return and a 10% standard deviation. Statistically speaking, and assuming a normal distribution of returns, about 68% of the security returns fall within plus or minus one standard deviation of the average. About 95% of returns will fall within plus or minus two standard deviations. In theory, that means about 68% of the time our example security will have returns between 0% and 20%. At a 95% level of confidence, the range
would be -10% to 30%. We would also expect over 99.9% of this security returns to fall within plus or minus three standard deviations, or between -20% and 40%.

1.6 Diversification

Over the longer term, one of the most efficient techniques to manage risk is through diversification. Diversification is a strategy that can be neatly summed up by the timeless saying "Don't put all your eggs in one basket". In this analogy, the "eggs" represent the individual investments of an investor, and the "basket" represents the total wealth or total portfolio of an investor. If the "basket of eggs" get spoiled for some reason, all the "eggs" could potentially be lost. Spreading the “eggs” around minimises the possibility that a single investment will unfavourably affect your overall investment portfolio.

However, the notion of not putting all of your “eggs” in one basket fails to provide insight into how an investor should go about diversifying their portfolio. Although the concept of diversification has existed for hundreds of years, what many investors miss is a clear understanding of how they should approach the diversification process. However, the act of diversifying a portfolio is much more than simply adding more investments. There is a "right kind" of diversification that provides the "right reason" for adding additional investments to a portfolio. The "right kind" of diversification requires investors to own investments within a portfolio that don't behave alike (Francis & Archer, 1979:43).

This leads us to the concept of correlation. The key to efficient diversification involves the statistical concept of correlation. Correlation measures the degree to which two securities move in unison. Correlation moves on a continuum between -1 and 1. The maximum correlation is 1, and indicates that two securities move in exactly the same direction, if the one security goes up the other security moves in exactly the same direction. A +5% move in one security will be matched by an opposite move of exactly +5% in the other security. On the other end of the continuum, a correlation of -1 indicates that the securities move in exactly the opposite direction. A -5% move in one security will be matched by an opposite move of exactly -5% in the other security (Sanger, 2014:1). A correlation of -1 will lead to a portfolio that contains zero risk, however, in real life, it is virtually impossible to find securities that are perfectly negatively correlated. That said, an investor should always aim to have securities in a portfolio that are as negatively correlated to each other as possible.
It was not until 1952 that Harry Markowitz published a formal model of portfolio selection expressing diversification principles. Markowitz acknowledged that investors should diversify individual securities in a portfolio, but he went one step further and recommended that investors should be concerned about the diversification of the entire portfolio (Markowitz, 1952:77). If investors were attempting to diversify their portfolio by comparing the correlation between the securities, the investor should not just compare the correlation between security A and B but should also compare the effect that a new security, C, will have on the correlation between security A and B. While this approach certainly diversified company specific risks, other risks, including those that would affect the market as a whole, were not addressed. In other words, Markowitz showed that having a diversified portfolio is not just about picking which securities to include but about choosing the right combination of securities (Markowitz, 1952:77).

The above model of diversification has led to one of the most important and influential economic theories in modern finance. Modern Portfolio Theory (hereafter referred to as MPT) primary goal is to assemble “optimal” portfolios through the identification of an acceptable level of risk (measured by standard deviation) and then find a portfolio with the maximum expected return for that level of risk. The concept is achieved by investing in a variety of different portfolios that change differently in relation to each other; they should thus have a low correlation to each other.

### 1.7 Introduction to the problem statement

On the JSE alone, there are over 400 securities to choose from, all with different risk and return characteristics. This figure does not include the entire investable universe and excludes the following: direct property investments, fixed income securities, derivatives and Exchange Traded Funds (hereafter referred to as an ETF). With so many investments to choose from the average investor may be overwhelmed and intimidated by sheer choice. Before the investor chooses an investment, several things therefore need to be looked at. These include: How has the security performed historically? What are the costs associated with the security? What are the regulatory issues surrounding the security? How risky is the investment?

One of the biggest challenges that the investor will face is determining how well their portfolio is performing. The primary solution to this problem is to find a benchmark against
which the investor can evaluate the portfolio’s performance (Elton and Gruber, 1999:266). A benchmark is often represented by a market index and provides a starting point for an investor to construct a portfolio and directs how that portfolio should be managed from the perspectives of both risk and return. This benchmark index will allow the investor to check several important measures and answer several key questions: How volatile the investment was, whether the investment outperformed the benchmark, and whether the benchmark was appropriate? Outperforming a benchmark is often more difficult than one would assume and several researchers have dedicated papers to this topic. In the South African context it has been shown that relatively few active portfolio managers are able to consistently outperform the market (as represented by the FTSE/JSE All Share Index J203) (Oldham & Kroeger, 2005:81).

Research done by the Association for Savings and Investment South Africa (ASISA) indicates that for the 20-year period ending 30 June 2014, on average, 82% of active portfolio managers who manage general equity portfolios failed to beat their respective benchmark (Figure 1-2). Most of the general equity portfolios are managed against the FTSE/JSE All Share Index (J203). As an average over the 20 years, only 18% of portfolio managers managed to beat the benchmark. Of the 18% that have beaten the index, it is virtually impossible to accurately and consistently predict the portfolio managers who will outperform the index in the future. Even though a large part of pension fund money is invested into these actively managed share portfolios, it would seem that by merely buying into the FTSE/JSE All Share Index (J203) this will provide the investor with a portfolio that beats 82% of the competition.
Figure 1-2: Active management outperformance

Source: (Brown, 2014:4)

Investment strategies used by portfolio managers to manage investor’s capital can broadly be divided into either active or passive management. An actively managed portfolio is exactly that: actively managed by a portfolio manager who usually tries to outperform a specific benchmark (Gentile, 2013:116). Portfolio managers following an active investment strategy use various methods to outperform a given market index or benchmark. They conduct detailed research on companies and share prices and compare the current value of those shares to that of the market. The majority of this analysis includes evaluating and forecasting a company’s past, current and future earnings capability.

In contrast, a passive investment strategy refers to when investors buy a portfolio that mimics the performance of a reference index. Passive investment strategies make no attempt to distinguish attractive from unattractive securities, or to forecast company earnings or prices (Laopodis, 2012:38). The most commonly used passive investment
strategy is investing into an ETF. An ETF mimics the performance of a given market index and provides investors with the returns, positive or negative, of that specific market index. There is no attempt to try and outperform the index, the aim being to provide an investor with a return that matches the reference index.

Applying a Markowitz optimisation to a portfolio can in many ways be seen as a passive investment strategy, as the investor invests into the portfolio in accordance with a certain mandate. The mandate provides the “rules and regulations” that will guide the actions of the portfolio manager; all decisions of the portfolio manager must adhere to the mandate. The main advantages of a passive investment strategy are to minimise fees, increase diversification, and avoid potential incorrect decision making and consequences of failing to correctly forecast the future (Bodie, et al., 2001:197). For investors, the costs of passive investing will generally be lower than the costs of active investing. The success of following a passive investment strategy is largely reliant upon the presence of efficient markets and, therefore, the Efficient Market Hypothesis (hereafter referred to as EMH). The EMH is one of the most important theories in finance, and there are perhaps equally as many people who are against it as those who support it.

Beginning with the work by Fama (1970), the EMH states that when markets are efficient, security prices adjust so quickly to new information released to the market that no opportunities exist for investors to take advantage of information that is not already known. Information includes not only what is currently known about a security, but also future expectations on earnings or dividend payments. EMH acknowledges that unexpected data, or data that surprises investors, will create a profit opportunity in the very short run, but the data will be absorbed very quickly into the market. It is therefore impossible to beat the markets over time because securities are always priced correctly based on all available information. In essence, the EMH states that because information on security prices is freely and publically available, no investor should be able to consistently and predictably outperform the market.

1.8 Problem statement

The problem that faces the active portfolio manager is that the EMH dictates that no excess profits can be made over the long-run by rebalancing a portfolio of financial instruments on a regular basis.
Given this problem, the following research question can be asked: Can a passive trading strategy based on the Markowitz mean-variance optimal portfolio construction outperform the FTSE/JSE Top 40 TR ZAR (J200T) on a risk-adjusted basis over a period of 19.5 years?

1.9 Aims of the study

The aims of the study are threefold:

First, in conducting research into MPT, the researcher will try and evaluate whether the application of MPT in modern times is still as relevant as it was more than 50 years ago. Second, to examine the differences in risk-return characteristics between the FTSE/JSE Top 40 TR ZAR (J200T) with the newly identified optimal investment portfolios. Thirdly, to determine whether the Markowitz optimal portfolios are sufficiently diversified enough to help the investor create a low risk portfolio, which will provide more reliable and more persistent returns.

In order to provide reliable results to support the aims of the study, the following portfolios will be constructed:

- Portfolio 1: Port1_Max_Sharpe_Max_10: No short selling allowed with a maximum of 10% invested into any one share.
- Portfolio 2: Port2_Max_Sharpe_No_Max: No short selling allowed with no maximum amount that can be invested into any one share.

1.10 Chapter outline

The preliminary chapter provided the background, rationale and objectives for the study, and addressed the significant methodological and data issues surrounding the study. A brief discussion of the forthcoming chapters is outlined below.

Chapter Two provides a literature review of the uncertainty associated with investment decision making. MPT is discussed from its humble beginnings up to its present use. The focus is especially placed on (Markowitz, 1952; 1956; 1959). This is followed by a review of the assumptions underlying MPT, with particular focus on efficient markets. After discussing MPT and market efficiency in detail, the study gives an overview of market
efficiency in the South African setting. The chapter concludes with a discussion of active and passive management and a description of several risk-return measures.

Chapter Three contains the reasoning behind the research methods that have been used in the study. This is followed by a full description of how the empirical data was collected, the search criteria used in the accumulation of data, and the time horizon that was used in construction of the optimal portfolios. The chapter concludes with a full description of the model parameters and steps used in the construction of the optimal portfolios.

Chapter Four presents the findings from the research methods presented in the previous chapters. The chapter includes descriptive statistics and the results from the analyses on the optimal portfolios against the benchmark index. The chapter concludes with an analysis of risk, return, risk-adjusted performance metrics and full details on the diversification benefits (if any) of the optimal portfolios.

Chapter Five concludes by referring to the problem statement and aim of this study. Each of the research aims are discussed separately and a full overview is done on whether the study was successful in addressing the problem statement. Finally, recommendations are provided for further research.
CHAPTER TWO:
LITERATURE REVIEW

“If you obsess over whether you are making the right decision, you are basically assuming that the universe will reward you for one thing and punish you for another. The universe has no fixed agenda. Once you make any decision, it works around that decision. There is no right or wrong, only a series of possibilities that shift with each thought, feeling, and action that you experience.” (Chopra, 2005:270)

2.1 Decision making under risk and uncertainty

It can hardly be argued that decisions affect our lives; as we go about our daily business we constantly make decisions to act in certain ways. Making decisions has become so ingrained that we tend to make routine decisions without even knowing that we are actually making them. Literature on the subject of decision making is broad and there are many definitions, interpretations, as well as ways of studying the phenomena. Most of the definitions have common elements to them. Bitarafan and Ataei (2004:493) for example define decision making as a process by which a preferred alternative is chosen from among a set of alternatives based on input information and certain criteria, while Cimren, et al., (2004:196) describe decision making as a process of sufficiently reducing uncertainty and doubt among alternatives, allowing for the opportunity to make an optimum choice among all the available alternatives. The latter description indicates that one of the major challenges of decision making is uncertainty, and that the goal of decision making is therefore to reduce this uncertainty (Hodgkinson & Starbuck, 2008:234).

From the definition, we can conclude that making an informed decision depends not only on the amount of information that is available to the decision maker but also on the quality of the available information. An informed decision is one where a reasoned choice is made by a reasonable person using relevant information about the advantages and disadvantages of all the available alternatives (Thagard, 2001:355). It is evident that a model was needed to further expand on the quality and the amount of information available to the decision maker. This led Raiffa (1968:13) to develop a three-tiered classification of decision making based on the amount of knowledge and information
possessed by the decision maker. These classifications are: decision making under pure uncertainty; decision making under certainty; and decision making under risk.

Under the first classification, decision making under pure uncertainty, the decision maker has no information available, not even about the expected outcome of the decision. There are no estimates of the probabilities for the occurrence of the different outcomes. The decision maker can use any personal knowledge about past experiences to assign subjective probabilities to the unknown outcomes (Taghavifard, et al., 2009:4).

Under the second classification, decision making under certainty, all information on which decisions are based is available and all variables and their values are known with certainty. In this instance, the decision maker will choose the outcome with the highest expected payoff (Taghavifard, et al., 2009:5).

Under the third classification, decision making under risk, the word risk implies the uncertainty associated with the information that is available and an inability of the decision maker to fully control the outcome. Conditions of risk occur when a decision maker must make a decision for which the outcome is uncertain (Taghavifard, et al., 2009:5). Under conditions of risk and uncertainty associated with the outcome, the decision maker can make a list of all possible outcomes and assign probabilities to the various uncertain outcomes. One of the models proposed under a situation of risk is optimisation. Optimisation is defined as a model of statistical decision theory and entails the process of searching through all possible outcomes and alternatives, evaluating all of them in terms of the decision criteria in order to determine the course of action that gives the highest and/or best outcome (Kavun, et al., 2013:23).

It is clear that the investment decision making process involves considerable complexity and uncertainty. Complexity is reflected by the number of securities and asset classes that are available to the investor. Uncertainty on the other hand is inherent in all decision making but is particularly pertinent to the investment decision maker where the implications of their decisions are often very significant. Understanding financial markets and basic investing principles will give investors the fundamental understanding from where they can enhance and make rational investment decisions.
2.2 Efficient capital markets

The EMH is one of the most researched topics in finance literature. The EMH states that at any given time, security prices (shares, bonds and other securities) fully reflect all available information. The implications of this simple statement are truly profound (Fama, 1965:34). Many investors buy and sell securities (stocks in particular) in order to make a profit. Securities are thus bought under the assumption that the security is worth more than the price paid for said security, and that the price of the security will increase in the future.

Many investors believe that they have the necessary skills to choose the securities that will provide a greater percentage increase than other securities; effectively the investor believes that their selection of securities will outperform a random selection of securities. These investors actively manage every detail about a security and use a variety of techniques to assist them in identifying mispriced securities, most of which involve forecasting return data by employing sophisticated valuation techniques (Clarke, et al., 2001:126). However, if the EMH hypothesis holds true, it means that trying to identify undervalued or mispriced securities in an attempt to outperform the market will effectively be a game of chance rather than skill (Tariq Zafar, 2012:37). Arguably, no other economic theory has had a greater impact or led to more intense debate on economic and investment theory than EMH (Arffa, 2001:127). Before examining the EMH in greater detail, however, it is necessary to consider some of the fundamental assumptions related to this theory and the factors that impede market efficiency (Firth, 1986:2):

- There must be many investors who make rational decisions and who act upon new information as it becomes available. In general, the greater the number of active market participants that analyse a security, the greater the degree of efficiency in the market. Overly strong restrictions that impede investors from investing in certain markets, or certain securities, impede market efficiency.

- Irrational decisions made by investors are unrelated and cancel one another out, thus having no net effect on the price of a security, making the market rational.

- New information becomes available randomly and must be independent of past information. The availability of accurate and timely information regarding companies
contributes to market efficiency. It is just as important that all investors have fair and equal opportunity to act on this information.

- There are no taxes or transaction costs.

Given these assumptions it should be clear that the EMH does not reward the study of past price movement as past movement in the price of a security cannot be used to predict future price movements (Fama, 1965:55). The past and the present are completely independent and have no relationship; in essence, the movement in security prices is at best unpredictable and it is impossible to know whether the next move in the price of a security will be up or down, or by how much it will rise or fall, based on information about the security’s past price movements (Bhatt, 2014:102).

The idea that security prices tend to follow a random and unpredictable pattern or "walk" over a period of time can be traced back to the 1900s, when French mathematician Louis Bachelier (1900) bought out his PhD dissertation entitled: The theory of speculation. The opening paragraph states that "past, present and even discounted future events are reflected in the market price, but often show no apparent relation to price changes" (Bachelier, 1900:17). The view that security prices follow a random and unpredictable pattern is supported by many market researchers. Malkiel argues that securities are priced so efficiently that no investor can exploit mispriced securities with any consistency. He goes so far as to say that “a blindfolded chimpanzee throwing darts at The Wall Street Journal can select a portfolio that performs as well as those managed by the experts”. (Malkiel, 2003:60). Although many economists, academics and researchers have contributed to the establishment and development of the EMH, Eugene Fama is considered its main contributor. It was Fama who coined the term "efficient markets" and summarised EMH by the saying, "prices fully reflect all available information" Fama (1970:383). Fama identified three forms of market efficiency: strong form EMH, semi-strong form EMH, and weak form EMH.

Weak form EMH assumes that the current price of a security already incorporates all historical data, return data, trading volume data or other market generated information. Historical security data are arguably the most public as well as the most freely available pieces of information. Thus, no investor should not be able to consistently profit from using information that “everybody else knows” (Clarke, et al., 2001:128). Therefore,
technical (trend) analysis, an investment technique that uses historical data about securities in order to predict the future path of a security or the market, is useless (Yalchin, 2010:25).

*Semi-strong form EMH* assumes that security prices adjust rapidly to all publicly available information. Public information includes not only historical security prices, but also data that is reported in company financials, financial statements and annual reports. The semi-strong form encapsulates the weak form EMH; in other words if a market is seen as a semi-strong efficient market, then the market is also seen as a weak form efficient. If markets are indeed semi-strong efficient, and investors base their decisions on public information, then earning a consistent and profitable return should be impossible (Clarke, *et al.*, 2001:128).

*Strong form EMH* assumes that security prices fully reflect all historical data, public and private information. The strong form EMH implies that investors who have access to inside information will not be able to use the information to make a profit, as no investor would be able to beat the speed in which new information is reflected into the price (Roberts, 1967). The strong form EMH assumes a perfect market where no investor has an edge over any other investor, hence excess returns are impossible to achieve consistently.

It is important to note that markets cannot strictly be classified as efficient or inefficient. Market efficiency should instead be viewed as falling on a continuum between efficient and inefficient. A relatively efficient market will reflect and absorb new information more quickly and accurately than a relatively inefficient market.

### 2.3 Efficient capital markets anomalies

Like most hypotheses in finance and economics, the evidence on the EMH is mixed. Some studies have supported EMH, concluding that financial markets are efficient in some regard, while other studies have revealed some anomalies related to the EMH. According to Tversky and Kahneman (1986:252), “an anomaly is a deviation from the presently accepted paradigms that is too widespread to be ignored, too systematic to be dismissed as random error, and too fundamental to be accommodated by relaxing the normative system”.

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There is no doubt that market anomalies exist; even Fama (1991), in his paper, *Efficient Capital Markets: II*, accepted their existence. Fama states that most of these anomalies can be explained as temporary effects while others are the result of different underlying statistical methodologies used by market researchers. However, although some anomalies fade over time, some seem to persist. These anomalies can be identified under a few main effects:

**Small firm effect:** a major study on US shares showed that small capitalisation securities (small cap shares) delivered higher returns than larger market capitalisation securities (large cap shares). Banz (1981:3) analysed the New York Stock Exchange (hereafter referred to as the NYSE) in the period 1936–1975 and found that the smallest 20% of the companies earned a risk-adjusted return that is 0.4% higher per month than the remaining companies. The small firm effect is supported by Reinganum (1983), who analysed the size effect in a shorter, but broader sample of 566 NYSE and AMEX (American Stock Exchange) companies over the period 1975–1977 and found that the smallest 10% of the companies outperformed the largest 10% by 1.6% per month. However, more recently, Brown, *et al.*, (1983) re-examined the size effect using the Reinganum data set of 566 companies, but conducted the study over a longer time period, 1967–1979. They found that the size effect is unstable over time and reversed in the period 1967–1975.

Further research into the area indicates that most of the difference in return between the small and large cap securities occurred in the first two weeks of January (Malkiel, 2003:64). This anomaly became known as the *turn-of-the-year effect*. Gultekin and Gultekin (1983:479) looked at the seasonal pattern in 16 countries and found that January returns were exceptionally large in 15 of them. Interestingly, they found that the January returns in Belgium, Netherlands and Italy exceed the average returns for the rest of the entire year (February to December).

*Earnings announcements* can also have major effects on security prices. Earnings expectations and future earnings are usually based on analyst reports. If the actual earnings are different from the earnings expectations, then this negative earnings surprise can have a large effect on the price of a security. Ball and Brown (1968) were the first to observe and study this anomaly. They discovered that for a significant period after a positive unexpected earnings announcement that security returns showed positive momentum, while negative unexpected earnings announcements were followed by a
prolonged period of negative momentum in share return. The phenomenon was later given the name of Post-Earnings Announcement Drift (PEAD). A study by Foster, et al., (1984:580) showed that the more dramatic the earnings surprise, the more dramatic and long-lasting the effect on the price of the security. Positive earnings surprises caused the price of a security to rise for up to two months after the announcement. Negative earnings surprises led to a substantial loss of value in the prices of the affected security.

2.4 Behavioural finance

The above anomalies led many researchers and market participants to question the validity of EMH and in the 1990s a new theory emerged that questioned the existence of EMH. The field of behavioural finance (hereafter referred to as BF) developed as a counter argument to EMH and takes issue with two crucial implications of the EMH: Firstly, EMH states that the majority of investors are rational, and as rational investors they make rational decisions based on available information. BF, on the other hand, proposes that investors are human and, as humans, investors are not always rational. Secondly, under EMH, the market as a whole may overreact or underreact to information (unexpected earnings for example), allowing astute investors to temporarily take advantage of the mispricing, but in the end the market as a whole, and the market price, is always right. Proponents of BF, or behaviourists as they are often referred to, believe that numerous factors, irrational as well as rational, drive investor behaviour. One of the best examples of why people can’t act rationally comes from Prechter (2001:121), who concluded that the mind of the rational individual cannot act completely randomly and objectively, since it would require individuals to have no opinions to start with. He concludes by saying that the main reason for this is that individuals are too strongly affected by other individuals in their surroundings. A few such irrational behaviours are as follows:

Overconfidence, being defined as the tendency of investors to overestimate and be too confident about their knowledge, skills and abilities (Konstantinidis, et al., 2012:20). One of the best examples of overconfidence occurs when a novice investor decides to enter the securities market, invests into a few securities, and if these securities perform well, the investor will in future overestimate his ability based on the previous favourable experience.
Regret aversion is an emotional bias where investors tend to avoid making decisions because of the potential negative outcome that might flow from making the decision in the first place; as a result the investor will postpone buying or selling securities so as not to incur a loss (Konstantinidis, et al., 2012:20).

Herding, as seen when investors have a tendency to follow or join larger groups, and consequently develop herd behaviour in making decisions. Herding often occurs because of social pressure and leads the investor to blindly accept the majority view of a group (Prechter, 2001:123).

The most notable critic of behavioural finance is Eugene Fama, the founder of EMH. Fama suggests that even though there are some anomalies that cannot be explained by modern financial theory, market efficiency should not be totally abandoned in favour of BF. In fact, he notes that many of the anomalies found in conventional theories could be considered shorter-term chance events that are eventually corrected over time. In his 1998 paper, entitled Market Efficiency, Long-Term Returns and Behavioural Finance, Fama argues that many of the findings in BF appear to contradict each other, and that all in all, BF itself appears to be a collection of anomalies that can be explained by market efficiency (Fama, 1998:287).

2.5 Adaptive market hypothesis

Financial and investment practitioners agree that the classic definition of EMH may often fall short of explaining certain aspects of finance and investment. Despite a large body of research on EMH, there is no unified view of whether markets are efficient or not. The core issue with EMH is that the theory seems somewhat static to explain the irrational investor and market behaviour that was found in the anomalies presented earlier. In addition, the impact of major negative investment experiences has, over the last two to three decades, led investors to re-evaluate the EMH approach. BF, on the other hand, analyses the thought and decision making processes of investors and shows that individual investors are all different and are influenced by varying emotional and psychological factors. These unpredictable emotional responses cause investors to behave in irrational ways (Taffler, 2014:1). What is evident is that none of the above theories are correct 100% of the time and yet both EMH and BF have proved correct at certain times.
An alternative and promising approach to EMH and BF was developed by Andrew Lo (2004; 2005). The Adaptive Market Hypothesis (hereafter referred to as AMH) may be the theory to reconcile and solve the issues pertinent to both EMH and BF. According to Lo, AMH has several important implications that differentiate it from both EMH and BF.

The first differentiating factor describes that even though a relationship between risk and return may exist, it is unlikely to be stable over time. This relationship will be shaped by the participants in the ecosystem and their past experiences. For example: investors who have only experienced positive markets and were not exposed to the Financial Crisis of 2007-2008 may demand a lower premium for bearing risk. Secondly, Lo remarks that the market efficiency is not an all-or-nothing condition, but a continuum. Opportunities will appear from time to time in different time scales. However, as more participants enter the market, competition increases and opportunities are exploited and disappear. Nevertheless, new opportunities are also created since species (investors) die out, while others are born and institutions and business cycles change. Market efficiency can thus be seen as cyclical: there are times of market inefficiency and times of market efficiency. For a market to become efficient, it must first be inefficient and vice versa. Thirdly, investment strategies, including quantitative, fundamental and technically-based strategies, will perform well in certain environments and poorly in others. Therefore, investment strategies must be formulated with market condition changes in mind, and should adapt accordingly. Lastly, the primary objective of risk-taking is survival. Lo sees profit and utility maximisation as secondary objectives. Innovation is instead seen as the key to survival. While the EMH suggests that investors should earn more returns simply by taking more risk, the AMH implies that the risk-reward relationship varies over time. Therefore, as environments change, investors who are quickest to adapt will be the ones to reap the most consistent rewards.

Both EMH and BF have been studied in great detail by investment and finance professionals from both a developed and developing market point of view, but a new wave of finance professional are now flocking to the theory developed by Lo. The next section looks specifically at the literature of market efficiency on the JSE.
2.6 Efficient capital markets: research on the JSE

Under the EMH a market can be classified as efficient when security prices incorporate all the available information. Furthermore, the flow of information must not be impeded or obstructed in any way; information must be freely and easily available to all end users (individual investors and portfolio managers). In order to facilitate an efficient and real time flow of information from the listed companies directly to the end users, the JSE established the Stock Exchange News Service (hereafter referred to as SENS). This gives all end users access to real time company information. The JSE recognises the SENS as the only medium to release public company information.

Many studies have been performed to test the JSE for market efficiency. Earlier studies of the JSE's market efficiency are largely inconclusive. Thompson and Ward's 1995 paper, *The Johannesburg Stock Exchange as an efficient market*, reviews the literature on the efficiency of the JSE, finding that even though there have been many studies on the JSE and its relative efficiency, these studies differ in terms of methodology, time periods, samples and conclusions. In their words, “the evidence on the efficiency of the JSE is at best mixed, particularly regarding weak and semi-strong form efficiency” (Thompson & Ward, 1995). The mixed findings of efficiency on the JSE are supported by the literature. Earlier studies conducted by Philpott and Firer (1994) and Glass and Smit (1995) found that the JSE is not efficient in the semi-strong form. Interestingly enough, the tipping point of market efficiency came about in 2002. Studies conducted after 2002 tend to detect more efficiency than the earlier studies. Jefferis and Smith (2004) found that the JSE’s large capitalisation indices showed no predictability in returns. They concluded that the larger capitalisation indices exhibited a random walk and are weak form efficient, whereas the smaller indices are not. Overall, it seems that the JSE’s market efficiency has been increasing and this is perhaps attributed to the incorporation of SENS in 2002.

2.7 Active investment management

Active investors believe that markets are informationally inefficient, and that there are always some securities that are under-priced or mispriced, enabling them to buy (or sell) these securities at a profit. Active investors practice market timing to profit from temporary market inefficiencies. Both market timing and stock selection is achieved by devoting a
large amount of time and resources towards trying to outperform the buy and hold strategy. Active investors will go through financial statements, visit the company and its competitors, study all the latest economic and company-specific releases and try to predict a company’s past, current and future earnings capability. In exchange for the research that goes into trying to find the best securities, the active manager levies a fee in return for his skill. Investors choose to invest their money in actively managed portfolios in the hope that the portfolio manager’s skill will provide them with superior returns. Active fund performance is measured against a benchmark, in order to assess whether the portfolio is providing its investors with superior returns (Sensoy, 2009:27).

For the investor who invests in an actively managed portfolio, it is important to compare the performance of the portfolio manager against the benchmark or market index in an attempt to evaluate whether the portfolio manager looking after the portfolio can provide sufficient returns to offset the additional fee that the manager levies on the portfolio. Estimates of the cost of active management differ from country to country. Recent estimates suggest the cost of active portfolio management to be near 70 basis points per year (0.70%); the study was conducted in the US (Fama & French, 2008). The same cost would be substantially higher for an emerging country like South Africa.

In addition to the costs that the investor should take into account, an investor should also be familiar with the persistence of returns. Simply stated: whether the active manager can consistently outperform the index on a regular long-term basis? The outperformance portion when compared to an index can be referred to as alpha. Some researchers have concluded that outperformance against an index or benchmark (persistence of outperformance) is short-lived, inconsistent and is more a function of luck than stock picking skill on the part of the active manager (Carhart, 1997; Bollen & Busse, 2005).

Active portfolio managers will use a variety of techniques to determine whether the intrinsic value (true security value determined through analysis and forecasting) is different from the market value (current price) of a security. If the value determined by the portfolio manager (intrinsic value) is higher than the current market price, the security is said to be undervalued and the manager might purchase the security.

The most typically used active investment strategies are fundamental in nature. Active portfolio managers use a variety of analytical measures to determine if there is a
meaningful difference between the market value and the intrinsic value of a security. In addition to a wide variety of analytical measures, active managers divide themselves into several different “styles”. Value investing, growth investing and momentum trading are just a few of the “styles” within the active investment framework, the most prominent being value and growth investing.

**Value investing** is the strategy of buying securities that appear undervalued relative to some fundamental measure. Many of these securities have the following characteristics:

- securities with low price-to-book-values tend to outperform securities with high price-to-book-values;
- securities purchased at low price-earnings ratios offer better long-term performance than securities with higher price-earnings ratios, especially when compared with companies that show good prospects for future earnings growth; and
- Historically, securities that exhibit higher dividend yields that outperformed securities with a lower dividend yield. This is a popular measure among investors who are interested in dividend income.

These securities are often associated with companies operating in an established industry where there is strong competition and companies that are experiencing difficult operating conditions. Value investors typically disagree with the market price (ruling price) of a company stock and believe that through their analysis they would be able to determine the "true value" of the company's stock. The end objective is to find companies with a solid balance sheet and a good track record that are going through a rough patch.

Value investing and its guidelines were first popularised in the 1930s by David Dodd and Benjamin Graham (1934) in their classic book entitled, *Security Analysis*. Benjamin Graham (1959) later wrote *The Intelligent Investor*, and together, these books are considered the bibles of value investing. It is worth noting that not all value investors are the same, as some value investors focus on securities that offer deep value, as in securities selling at steep discounts to their true value. Others look for opportunistic value, namely securities that while not extremely cheap, nonetheless appear to be bargains.

**Growth investing** entails the strategy of buying securities that are believed to have substantial growth potential and/or above average earnings potential. In contrast, many growth securities may appear to be expensive when valued at current levels, but growth
investors believe that these securities can still be bought with the prospect of substantial future growth. The securities often exhibit high price-to-book value, price-to-earnings, price-to-sales and price-to-cash flow ratios. However, these securities have higher than average cash on hand to guide them through potential rough times. The growth investing style is generally considered to be more aggressive than a value investing style.

A large body of research indicates that over the long term (periods > 7 years), value investing tends to outperform growth investing, but over the short term (periods < 7 years), there are certain sub-periods during which growth investing performs outperforms value investing.

2.8 Passive investment management

Where active investment managers use their skill and knowledge in an attempt to identify cheap or undervalued securities, passive investment strategies makes no attempt to forecast, or categorise securities as cheap or undervalued.

Passive investing ranks among the most successful innovations of modern finance. At the core of passive investing is the realization of Sharpe (1991) that active investing is a zero-sum game before transaction costs and a negative-sum game after investment costs are included. Passive investors believe in the EMH and that prices are always right; the passive investor has no view on whether a security is cheap or undervalued. Passive investing or indexing, as it is more commonly referred to, refers to buying a portfolio of securities that mimics the performance of a given market index. It is important to consider that passive investing looks to match, not beat, the return of a particular index. This is accomplished through buying and holding all of the securities that comprise the particular market index. If market efficiency is upheld it is impossible to consistently beat a market index or identify those money managers who will. Instead, an investor should invest passively, to get the necessary exposure to a broad range of securities. The two main benefits and some of the reasons why many investors prefer to use a passive investment strategy are summarised as follows:

Firstly, lots of research into portfolio performance shows that most actively managed portfolios will not outperform their respective benchmark. There will be a small selection of active managers who outperform the index but it is virtually impossible to predict who those managers will be. Over the period 1986–2002, the S&P 500 Index (a broad US
index consisting of the largest 500 companies) beat roughly 90% of active managers. Active portfolio managers who managed to beat the S&P 500 during the first 10-year period were not the same people who outperformed the index during the next 10-year period (Malkiel, 2007:11). The odds of correctly identifying and predicating who those managers will be ahead of time is nearly impossible.

Secondly, minimising and controlling trading and investment-related costs is crucial to achieving long-term investment success. Costs, unlike market performance, are one of the few areas that investors can control. One of the main advantages of passive strategies is the fact that they are very cost effective, as they don’t need to pay for expensive research.

Passive management is gaining market share, especially among portfolio managers – and for good reason. Positive long-term results have preferred the use of a passive investing strategy, most notably among large capitalisation securities. What’s more, investors have been flooded with advice by the media to invest passively after watching active investment managers perform poorly over the last decade. At the same time, there may be an important role for active management as well. The varying efficiency of markets means that securities prices are sometimes mispriced and active managers are perfectly situated to take advantage of the mispricing once the opportunity arises.

In summary, the active versus passive debate does not provide the investor with a clear-cut answer that would eliminate either strategies. As illustrated, there are just too many variables on both sides that raise questions while offering no concrete answers. This has led many market commentators to recommend an investment strategy that uses elements of both active and passive investment strategies.

2.9 The myth of passive investment management

The researcher would like to point out that even though the active vs passive debate carries a lot of weight in modern day finance there are some market commentators that theorise that all investors employ a form of active investment management. According to Roche (2014) one of the biggest misconceptions about passive investing is that it is inherently inactive. But this doesn’t reflect the full circle of transactions that occur when an investor buys or sells an index fund. For instance, when an ETF is trading there is always a market price for the ETF (the price you see) as well as an intraday indicative
value of the index the ETF tracks (the price the authorized participants see). If the market price were to deviate from the intraday indicative value then the market makers would either buy/sell the ETF or buy/sell the underlying securities. So, while there doesn’t appear to be much activity on the surface, the very act of buying an index could actually force some active management in the underlying securities markets.

Ferri (2010:12) goes as far as to say “there’s no such thing as passive investing. It’s true. Passive investing in its purest form doesn’t exist. Only lesser degrees of active management exist.” Ferri goes on explaining that any index must be continuously maintained by real people who face difficult issues when trying to track an index. The managers must make hundreds of active decisions each day concerning when to trade, what to trade, what to do with new cash, how to raise cash when needed, and whether to use futures, swaps or other derivatives.

In light of the above, the investment approach followed by the researcher could be seen as a passive investment strategy where the investment portfolio are been actively rebalanced and re-evaluated. Chapter three provides more in depth information on the rebalancing period.

2.10 Modern portfolio theory

Arguably the most popular passive investing strategy in the world, Harry Markowitz’s Modern Portfolio Theory, is largely based on the concepts of EMH with underpinnings of passive investing. Perhaps the most important aspect of the Markowitz model was the realisation that the risk-return aspect of a portfolio does not entirely depend on the risk-return characteristics of the underlying securities; but just as important, if not more so, was the correlation between securities (Meggison, 1996:325). Markowitz realised that efficient diversification could only be achieved if newly considered securities were judged not only on their correlation to the portfolio as a whole, but also to each and every security in the portfolio. The main conclusion of MPT is that investors should not only hold a range of securities but should also focus on how the individual securities are related to one another. According to Mangram (2013:61), Markowitz built MPT on the following key assumptions:
There are no trading- or transaction-related costs involved in buying or selling securities. In addition, the investor doesn’t have to pay any tax on holding the securities.

Investors are risk averse and rational; and, being rational, investors seek to maximise returns, while minimising risk;

Markets are efficient;

An investor can borrow any amount of capital at a risk-free rate, and investing this potentially unlimited amount of money into a security will not affect the price of the security or the market;

There is a positive relationship between risk and return over the long and short term, in other words, long- and short-term investors view risk over the investment time horizon; and

All security analysis is based on a single period.

2.11 Portfolio management: return and risk

To manage a portfolio, the portfolio manager of a portfolio is concerned with two fundamental concepts, return and risk.

Return: An investor invests either in their own capacity or in a portfolio through a professional money manager in order to receive a return on their investment. Return is seen as the compensation the investor receives for accepting a certain level of risk (Samouilhan, 2008:4). The expected return on a portfolio is the weighted average of the expected rates of return for the individual securities in the portfolio. The weights are proportional to the total value of the individual securities in the portfolio. Return of a portfolio is mathematically expressed as:

\[ E(R) = \sum_{i=1}^{n} W_i R_i \]

where:

\( W_i \) is the weight of an individual security in the portfolio, and

\( R_i \) is the expected rate of return for asset i.
Risk: in portfolio management, risk is seen as the volatility of future expected returns; more specifically, it is the possibility that the return that an investor expects is significantly different to the actual returns (Friedman, 1982:27). One of the best ways to measure risk is to measure the variability of the return from the expected value. The higher the variability in returns, the higher the risk. The lower the variability, the lower the risk. Standard deviation is denoted with the lower case sigma, and is often referred to as the volatility of a portfolio. A higher standard deviation translates into a greater volatility in returns, while a lower standard deviation translates into more predictable, less volatile returns. Standard deviation of a portfolio is mathematically expressed as:

\[ \sigma = \sqrt{\sum_{i=1}^{n} W_i^2 \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} W_i W_j \text{Cov}_{ij}} \]

where:

- \( \sigma \) is the standard deviation of the portfolio,
- \( W_i \) is the weight of an individual security in the portfolio,
- \( \sigma_i \) is the volatility of security \( i \), and
- \( \text{Cov}_{ij} \) is the covariance matrix of securities of \( i \) and \( j \).

It is important that risk and return be considered together and not in isolation. Even though most investors want high return at low risk, this is not achievable or a sustainable strategy in the long-run.

According to Mangram (2013:61), the risk of a security under the assumption of MPT can be analysed on a *stand-alone basis* (the security is considered on its own, separate from the rest of the securities in the portfolio) or on a *portfolio basis* (the security forms part of a combination of all the securities in the portfolio).
2.12 Portfolio Risk

In the context of risk on a portfolio basis, the total risk of a portfolio can be divided into two basic components: systematic risk and unsystematic risk.

Systematic risk is also known as undiversifiable or market risk, and is a form of risk that affects all comparable investments that are available in the market place. Systematic risk affects not just a part of the market, but the market as a whole. Systematic risk is typically associated with large-scale political and economic events. Systematic risk captures a portfolio's sensitivity to these global events (Ogilvie, 2009:190). Examples of such events include: recession or expansion in global economic markets, interest rates changes, volatility of exchange rates, wars and inflation. Systematic risk is also described as the "domino effect" where "bad news" about the market spreads from one company to another or, in many cases, the "bad news" spills over and spreads from one country to another country.

Unsystematic risk is also known as non-market risk, and is the part of total portfolio risk that is unique to a specific security or industry. Unsystematic risk is often referred to as company-specific risk. Examples of unsystematic risk could include labour and management unrest, management change, product recall, regulatory action or any other factors specific to the company. Unsystematic risk is easily controllable by an investor and may be eliminated by having exposure to a variety of securities in a portfolio. The basic reasoning is that the factors that are affecting one security (unsystematic risk associated with that security) will not necessarily affect other securities in the same manner. While diversification across industries or having exposure to a global selection of securities will eliminate most, if not all, of the unsystematic risk (Ross, et al., 1993:381).

A well-diversified portfolio will therefore contain very little unsystematic risk, but no portfolio can escape all risk. Many studies have been done to determine the amount of securities that are needed to effectively provide diversification of a portfolio. Wagner and Lau (1971:51) conclude that most of the diversification is achieved with fifteen securities, while Evans and Archer (1968:767) maintain that there is no economic justification for increasing portfolio sizes beyond ten or so securities. However, Statman (1987:362) argues that a well-diversified portfolio should include between thirty and forty securities. That said, in practice, returns on different securities are correlated to some degree and
regardless of how many securities are included in the portfolio, there will always be an element of unsystematic risk.

2.13 Methods of establishing diversification

According to Santarelli and Tran (2013), there are various ways in which a portfolio may be diversified. The most basic form of diversification is through holding different asset classes. The broad asset classes are property, fixed income securities (bonds) and cash. History has shown that many of the aforementioned asset classes, specifically bonds and equity (shares), behave differently under different market cycles and the correlation between the two asset classes have been low, adding to the diversification of the entire portfolio. For example: if interest rates change, bonds will behave differently to equities. Diversification can also be achieved by gaining exposure to different market sectors. Exposure to a variety of sectors within a portfolio – financial, industrial and real estate, would therefore diversify a portfolio. Exposure to securities that are located internationally will lead to further diversification benefits. The main purpose of having exposure to securities from different countries is to reduce the portfolio to risks that are inherent to a country; i.e. country-specific risks. Lastly, having a portfolio that is exposed to various investment styles will ensure that the investor is not overly exposed to a certain "style" of management.

2.14 Risk-adjusted performance measures

The diversification effect that comes from investing in different countries, different market sectors and exposing one’s portfolio to different investment “styles” can result in both an increase in return and a reduction in volatility. In other words, having a diversified portfolio helps to improve the risk-adjusted performance of a portfolio. Risk-adjusted performance measures give an indication of whether the investor was sufficiently rewarded for the extra risk taken. The Sharpe Ratio is the most commonly used.

2.14.1 Sharpe Ratio

The most commonly used measure of risk-adjusted performance is the Sharpe Ratio (Lhabitant, 2004:31). The Sharpe Ratio measures the average return of a portfolio in excess of the risk-free rate per unit of risk. Standard deviation is used as a measure of risk in the Sharpe Ratio. The Sharpe Ratio can be expressed as follows:
\[
\theta = \frac{E(R) - RfR}{\sigma_p}
\]

where:

\( \theta \) is the Sharpe Ratio,

\( E(R) \) is the expected return of the portfolio,

\( RfR \) is the risk-free rate, and

\( \sigma \) is the standard deviation of the portfolio returns.

When analysing the Sharpe Ratio, the higher the value, the better the portfolio. A higher Sharpe Ratio indicates that the investor is compensated for the extra risk he has taken on. When analysing the Sharpe ratio, the higher the value, the better the portfolio. A higher Sharpe ratio indicate that the investor is compensated for the extra risk he has taken on.

The Alexander Forbes Short Term Fixed Interest (STeFI) Composite index is a proprietary index that measures the performance of Short Term Fixed Interest or money market investment instruments in South Africa. It is a benchmark index constructed by Alexander Forbes, calculated and published daily by the South African Futures Exchange (hereafter referred to as SAFEX), and has become the industry benchmark for cash equivalent investments (up to 12 months). It is comprised of:

- 15% of the STeFI Call Deposit Index which is based on an Interbank Call rate i.e. SARB-SABOR;
- 30% of the STeFI 3 month NCD Index which is based on 3 month NCD instruments measured at SAFEX rates;
- 35% of the STeFI 6 month NCD Index which is based on 6 month NCD instruments measured at SAFEX rates; and
- 20% of the STeFI 12 month NCD Index which is based on 12 month NCD instruments measured at SAFEX rates.
Money-market instruments are considered to be almost risk-free because of the high security and low variability associated with these instruments. Hence, a money market index was chosen as a proxy for the risk-free asset. As explained above, the STeFI Composite Index was chosen as an appropriate money-market index. This is supported by Reddy and Thomson (2011:47).

2.15 Efficient frontier

It has previously been established that the rational investor will take on more risk if the returns are expected to go up. There are an endless number of possible permutations available to the investor that satisfy those requirements. The efficient frontier symbolises the sequence of “optimal” portfolios resulting from the collection of all possible combinations of securities available. The optimal or most “efficient” combination of securities falls along the efficient frontier. Figure 2-1 shows that the efficient frontier uses two measures – expected return of a portfolio of securities and the associated risk of the portfolio – in construction of the efficient frontier; standard deviation is used as an indication of the amount of risk in the portfolio. Portfolios situated along the efficient frontier line (red dots) represent the most “optimal” portfolio. No portfolios can be constructed in the region above the efficient frontier, while all portfolios below the efficient frontier are suboptimal. Thus, a rational investor will only hold a portfolio on the efficient frontier (Kaura, 2005:14).
Figure 2 shows that as portfolios move further away from the efficient frontier, their risk and return characteristics change, leading to a high risk portfolio with low expected returns. The portfolio represented by the blue dot (portfolio A) is not an “optimal” portfolio; for the same level of risk, the investor can achieve a better return (portfolio B). In other words, by holding a different portfolio, made up of a different combination of securities, and without adding any more risk to the portfolio, the investor can expect “extra” performance, without any added risk.

Each dot represents a portfolio with a mix of different securities. The dots or portfolios closest to the efficient frontier are expected to show the best return based on the amount of risk.
The above representation (Figure 2-2) of the efficient frontier provides an easy to understand framework of how the efficient frontier works. In the real world, the red dots represent 1000s of portfolio each with their own risk-return characteristics. What is evident from the illustration is that the portfolios that make the efficient frontier are those that are most diversified. Less diversified portfolios tend to be below the efficient frontier line. It is also important to note that there are many “optimal” portfolios along the efficient frontier, each representing an “optimal” portfolio. Each individual investor will have a combination of risk-return characteristics that are unique to that investor, and while the selection of that unique “optimal” portfolio is not the topic of study, it is possible to determine the location of such a portfolio and build a portfolio specifically customised to the individual investor.
CHAPTER THREE: RESEARCH METHODOLOGY AND APPROACH

3.1 Research method

Without effective and appropriate research methods, it is unlikely that reliable and quality information will be gathered and presented. The two most widely used methods to obtain the necessary information are either a qualitative or quantitative method. Both methods ultimately have the same purpose, and that is to create a better understanding of a phenomenon and how it will affect the study. The chosen method should be based on the theory, objectives and purpose of the research under consideration.

The quantitative research method is used to summarise, arrange and transform information into numbers in order to make a meaningful assumption or prediction and reach a conclusion. Quantitative research makes use of questionnaires, surveys and experiments to gather data that is presented in a numerical form, which allows the data to be characterised by the use of statistical analysis (Hittleman & Simon, 1997:31). The quantitative research method is very structured and gives the researcher a straightforward result. The analysis and results can be extrapolated and applied as a measure of the whole population if done in a proper manner.

Qualitative research, on the other hand, is interested in gaining a deeper understanding; in other words, qualitative research is about understanding how people make sense of the environment and the world (Merriam & Tisdell, 2015:15). This type of research focusses specifically on the “human” side of an issue. Attention is paid to beliefs, opinions, emotions and relationships of individuals. Methods used for qualitative research include: interviews, observations and focus groups.

The focus of this study is on the valuation, application and testing of Modern Portfolio Theory (MPT). Research in the field of finance and investment uses historical data, mathematical formulas and statistical models to explain relationships between variables. The most valid research method to use is a quantitative research method.
3.2 Inductive vs Deductive

To further investigate and ultimately understand a research topic or problem, the researcher has to decide which approach to use when attempting to analyse and draw conclusions about the research problem. There are two approaches that can be used: either a deductive or inductive approach.

In an inductive approach to research, the researcher has an idea to study something more in depth. The researcher begins by collecting data that is relevant and applicable to the topic of interest (Jebreen, 2012:162). Once a substantial amount of data is collected through historical data, mathematical formulas and statistical models, the researcher will look for patterns in the data, working to develop a theory that could explain the findings that were uncovered in the previous step. Essentially, inductive reasoning is about the collection of data, and analysing whether any meaningful patterns or meaning can be extracted from the data. In other words, researchers start with a theory that they find compelling and interesting, develop a hypothesis on existing data and then test the implications through additional data and statistics (Gray, 2013:17).

The research approach that will be employed in this study is deductive, which means that the researcher will use existing theory and shared principles as a starting point. The literature review that was carried out in Chapter Two found that many other studies with a similar subject matter have used a deductive approach.

3.3 Data and literature sources

After deducting the research methodology, the question of which data sources to be used remains. INET BFA is used by many researchers and is considered to be one of the most reliable providers of financial data feeds, financial analysis tools and financial statistics. INET BFA was therefore used as source to gather numerical data of shares together with FTSE/JSE Top 40 TR ZAR index data.

3.4 Population of relevance

The population of relevance in this study are all the shares listed on the FTSE/JSE Top 40 TR ZAR index. Only the Top 40 was considered and not all the shares listed on the JSE. This was done in an effort to reduce the computational intricacies of the model; also, including all the shares listed on the JSE would have exposed the model to potentially
small and illiquid shares (Bird & Casavecchia, 2007). The Top 40 Index represents the 40 largest companies that are constituents of the FTSE/JSE All Share Index (J203), ranked by market capitalisation. The number of constituents can however exceed 40. Over the 19.5-year period under consideration (1 July 1995 – 31 Dec 2014), there have been 80 shares that were part of the Top 40.

3.5 Sampling method and size

The sample that was drawn from the population differs somewhat from the Top 40. The selection of the constituents of the Top 40 index is mainly based on market capitalisations, however, market capitalisation is not the only criteria. Other selection criteria include: rules of eligibility, free float and liquidity screening. The selection and creation of the Top 40 constituents falls beyond the scope of this study. The quarterly review of the Top 40 constituents takes place in March, June, September and December. The data that is used for initial review purposes is the full market capitalisation as at the close of business on the Monday four weeks prior to the review date. In order to replicate the Top 40, the author created a "Top 40" through the use of only market capitalisation. The sample included at any time the largest 40 shares ranked by market capitalisation.

Dividends constitute a noteworthy percentage of the return an investor receives and therefore dividends are included in returns by using the dividend payment amount and dividend payment date. Share buybacks are not adjusted for on the grounds that these are a form of capital reduction, which only affects those shareholders that exit the company (Muller & Ward, 2013).

Data was collected for the period 1 July 1995 to 31 December 2014. This was deemed sufficient to cover the recent drastic volatilities in the global economy. The longer time period allowed for a fairer view of the development of the Top 40. The 19.5-year period under review covers the recent extremely positive share returns but also included the Global Financial Crisis of 2007–2008 and the recession in 1998 and 2002.

Some quantitative studies that predominantly use historical information may suffer from a type of selection bias known as survivorship bias. This bias is present in studies that only list shares currently in existence, which means that those shares that have either delisted due to liquidation, bad performance, or failing to comply with regulations are not included in the historical data. As a consequence, the results obtained from the study
may not accurately reflect the true picture. Survivor bias was minimised by including newly listed shares into the analysis; if a particular share’s market capitalisation was not within the Top 40 market capitalisation when the efficient frontier was calculated, the share was not available to be chosen, and was appropriately excluded from the sample. Table 3-1 lists all 80 shares that were part of the two Markowitz portfolios at any given time.

**Table 3-1: Markowitz portfolios share universe**

<table>
<thead>
<tr>
<th>Intu Properties Plc</th>
<th>Arcelormittal Sa Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mtn Group Ltd</td>
<td>Tiger Brands Ltd</td>
</tr>
<tr>
<td>Lonmin Plc</td>
<td>African Oxygen Ltd</td>
</tr>
<tr>
<td>Naspers Ltd</td>
<td>Standard Bank Group Ltd</td>
</tr>
<tr>
<td>Shoprite Holdings Ltd</td>
<td>Rmb Holdings Ltd</td>
</tr>
<tr>
<td>Steinhoff Int Hldgs Ltd</td>
<td>Anglo American Plat Ltd</td>
</tr>
<tr>
<td>Ppc Ltd</td>
<td>Gold Fields Ltd</td>
</tr>
<tr>
<td>Imperial Hldgs Ltd</td>
<td>Telkom SA Soc Ltd</td>
</tr>
<tr>
<td>Growthpoint Prop Ltd</td>
<td>African Rainbow Min Ltd</td>
</tr>
<tr>
<td>Compagnie Fin Richemont</td>
<td>Bidvest Ltd</td>
</tr>
<tr>
<td>Netcare Ltd</td>
<td>Sanlam Ltd</td>
</tr>
<tr>
<td>Impala Platinum Hldgs Ltd</td>
<td>Mmi Holdings Ltd</td>
</tr>
<tr>
<td>Anglogold Ashanti Ltd</td>
<td>Pick N Pay Stores Ltd</td>
</tr>
<tr>
<td>Barclays Africa Grp Ltd</td>
<td>Avi Ltd</td>
</tr>
<tr>
<td>Woolworths Holdings Ltd</td>
<td>Investec Ltd</td>
</tr>
<tr>
<td>SAB Miller Plc</td>
<td>Barloworld Ltd</td>
</tr>
<tr>
<td>Sasol Limited</td>
<td>Discovery Ltd</td>
</tr>
<tr>
<td>British American Tobacco Plc</td>
<td>Remgro Ltd</td>
</tr>
<tr>
<td>Aspen Pharmacare Hldgs Ltd</td>
<td>Vodacom Group Ltd</td>
</tr>
<tr>
<td>Caxton Ctp Publish Print</td>
<td>Capital &amp; Counties Prop</td>
</tr>
<tr>
<td>Assore Ltd</td>
<td>Mr Price Group Ltd</td>
</tr>
<tr>
<td>African Bank Inv Ltd</td>
<td>Investec Plc</td>
</tr>
<tr>
<td>Harmony Gm Co Ltd</td>
<td>Mediclinic Ltd</td>
</tr>
<tr>
<td>Nampak Ltd</td>
<td>Exxaro Resources Ltd</td>
</tr>
<tr>
<td>Nedbank Group Ltd</td>
<td>Truworths Ltd</td>
</tr>
<tr>
<td>Massmart Hldgs Ltd</td>
<td>Datatec Ltd</td>
</tr>
<tr>
<td>Company Name</td>
<td>Company Name</td>
</tr>
<tr>
<td>------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>Bhp Billiton Plc</td>
<td>The Foschini Group Ltd</td>
</tr>
<tr>
<td>Firststrand Ltd</td>
<td>DRD Gold Ltd</td>
</tr>
<tr>
<td>Tongaat Hulett Ltd</td>
<td>Super Group Ltd</td>
</tr>
<tr>
<td>Murray &amp; Roberts Hldgs</td>
<td>Northam Platinum Ltd</td>
</tr>
<tr>
<td>Santam Limited</td>
<td>Rand Merchant Insurance Hldgs</td>
</tr>
<tr>
<td>Old Mutual Plc</td>
<td>Delta Emd Ltd</td>
</tr>
<tr>
<td>Reinet Investments S.C.A.</td>
<td>AECI Limited</td>
</tr>
<tr>
<td>Liberty Hldgs Ltd</td>
<td>Anglo American Plc</td>
</tr>
<tr>
<td>Sappi Ltd</td>
<td>Aveng Group Ltd</td>
</tr>
<tr>
<td>Trencor Ltd</td>
<td>Sun International Ltd</td>
</tr>
<tr>
<td>Mondi Plc</td>
<td>Distell Group Ltd</td>
</tr>
<tr>
<td>Kumba Iron Ore Ltd</td>
<td>Brait</td>
</tr>
<tr>
<td>Reunert Ltd</td>
<td>Hosken Cons Inv Ltd</td>
</tr>
<tr>
<td>Life Healthcare Grp Hldgs Ltd</td>
<td>Aquarius Platinum Ltd</td>
</tr>
</tbody>
</table>

### 3.6 Data collection process

The data extracted from INET BFA contains historical share market records. The specific data points that were collected include:

- Share name
- Ticker
- Date
- Weekly closing share price
- Dividend payment amount
- Market capitalisation, and
- FTSE/JSE Top 40 TR ZAR index weekly closing price
Table 3-2 identifies the search criteria that were used in INET BFA:

<table>
<thead>
<tr>
<th>Security types</th>
<th>Equities, ordinary shares, standard ordinary shares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange</td>
<td>JSE</td>
</tr>
<tr>
<td>Listing status</td>
<td>Listed</td>
</tr>
<tr>
<td>Presentation</td>
<td>Time series</td>
</tr>
<tr>
<td>Observation</td>
<td>Weekly</td>
</tr>
<tr>
<td>Date</td>
<td>01 July 1994 until 31 December 2014</td>
</tr>
</tbody>
</table>

After the data was collected, it was cleaned to identify and remove any irregularities. Thereafter, the data was organised and used to create the portfolios required.

3.7 Transaction cost

The researcher has already established the assumptions underlying MPT. One of the most debated of these assumptions is the assumption of non-existence of transaction costs. In reality, investors in the financial markets know that transaction costs not only exist but can have a meaningful effect on investment returns. There are different transaction costs across different investment securities. Fixed income securities have very low transaction costs, while trading in shares attract high transaction costs.

In order for the results of this study to replicate the potential return that an investor can expect to earn in a realistic environment, transaction costs were included. At each rebalancing period (26 weeks throughout the study), a 1.5% transaction fee was levied against the portfolio. Not taking into account compounding, the transaction costs represented 3% per year. Including transaction costs also meant addressing many of the shortcomings in previous studies into MPT. Most notably, the study by Du Plessis and Ward (2009).

3.8 The Portfolio

The shares included in the two "optimal" portfolios are, as mentioned earlier, the 80 shares that were part of the Top 40 over the 19.5-year period under consideration. To construct these portfolios, expected returns and standard deviations were estimated for each share. Theoretically, these estimations of expected returns and standard deviations
should be calculated by setting up a probability distribution of the data, and attaching or associating a probability with each security (Markowitz, et al., 2000). However, in practice, employing such a method is not possible. The more practical method to acquire the estimates is to assume that the future returns that are associated with each share will be indicative of the returns that an investor can expect to receive in the future. Therefore, the researcher used past returns to calculate the expected returns and used those returns to calculate the standard deviation and variance of each share.

The period that was used for converting and calculating the average share return, variance and standard deviation was set at 26 weeks throughout. This is in line with the period that was used by du Plessis and Ward (2009). The recalculation of the statistics was therefore performed every 26 weeks.

3.9 Data issues

As with all time-series studies an important choice regarding the frequency of the data must be made. This study uses weekly returns in all the estimations as it was judged that this would provide the best trade-off between data and information. Using data any finer than weekly, for example by employing daily data, would be too “noisy” to accurately infer information. Coarser data, such as monthly data, was judged as potentially problematic as it could exclude valuable information concerning the intimate relationships under review.

3.10 Portfolio construction

As with all time-series studies, an important choice regarding the frequency of the data must be made. This study uses weekly returns in all the estimations as it was judged that this would provide the best trade-off between data and information. Using data any finer than weekly, for example by employing daily data, would be too “noisy” to accurately infer information. Coarser data, such as monthly data, was judged as potentially problematic as it could exclude valuable information concerning the intimate relationships under review.

3.11 Portfolio construction

The following two optimisation portfolios were constructed:
- Portfolio 1: No short selling allowed with a maximum of 10% invested into any one share.

- Portfolio 2: No short selling allowed with no maximum amount that can be invested into any one share.

Microsoft Excel and INET BFA were the tools used for gathering, transforming and calculating the returns from the raw data. The main statistical tool that was used to present the research findings was Morningstar Direct (Morningstar, 2015).

**Step 1**: To analyse return and risk characteristics of the shares over the period, the weekly mean return and standard deviation are calculated. Dividend information is incorporated with the weekly closing price. The weekly return on each share is calculated as follows:

\[
R_{it} = \frac{P_{it}}{P_{it-1}} - 1
\]

where:

- \(R_{it}\) is the weekly return on share i at time t,
- \(P_{it}\) is the adjusted weekly closing price of share i at time t, and
- \(P_{it-1}\) is the adjusted weekly closing price of share i at time t-1.

**Step 2**: The expected return on each share is calculated as follows:

\[
E (R_i) = \frac{\sum_{i=1}^{n} R_i}{N}
\]

where:

- \(R_i\) is the return on share i, and
- \(N\) is the number of periods, 26 weeks.
**Step 3:** A single asset or portfolio of securities is considered to be efficient if no other asset or portfolio of assets offers higher expected returns with the same or lower risk. The risk on each share is calculated as follows:

\[
\sigma_i = \sqrt{\frac{\sum_{i=1}^{n}(R_i - E(R_i))^2}{N}}
\]

where:

- \( R_i \) is the return on share \( i \),
- \( N \) is the number of periods, 26 weeks, and
- \( E(R_i) \) is the expected rate of return on share \( i \).

**Step 4:** The expected return for a portfolio, made up by multiple shares, can be calculated using the following formula:

\[
E(R_p) = \sum_{i=1}^{n} X_i E(R_i)
\]

where:

- \( X_i \) is the fraction of investment in share \( i \), and
- \( E(R_i) \) is the expected rate of return on share \( i \).

**Step 5:** The risk of a portfolio can be written as:

\[
\sigma_p^2 = \sqrt{\sum_{i=1}^{n} (X_i^2 \sigma_i^2) + \sum_{i=1}^{n} \sum_{j=1}^{n} (X_i X_j \sigma_{ij})}
\]

where:

- \( X_i \) and \( X_j \) is the fraction of investment in share \( i \) and \( j \),
\( \sigma_i \) and \( \sigma_j \) is the variance of share i and j, and
\( \sigma_{ij} \) is the covariance between securities i and j.

**Step 6:** Beside the risk on each share, the Markowitz optimisation is also taking the correlation coefficient between the shares into account. By so doing it will be possible to diversify the portfolio and thereby bring down the risk of the entire portfolio. The covariance between securities i and j can be written as:
\[
\sigma_{ij} = \sigma_i \sigma_j \rho_{ij}
\]
where:
\( \rho_{ij} \) is the correlation coefficient between share i and j, and
\( \sigma_i \) and \( \sigma_j \) is the standard deviation of share i and j.

**Step 7:** The efficient frontier is the optimal portfolio combination of the included shares, which provides the lowest possible risk for a given expected return. The way the efficient frontier was created, and thereby the portfolios, was to choose a static standard deviation for the two portfolios, and then use Microsoft Excel Solver® to find the maximum expected return for the given standard deviation. The Sharpe Ratio was optimised:
\[
\theta = \frac{E(R) - R_f R}{\sigma_p}
\]
where:
\( \theta \) is the Sharpe Ratio,
\( E(R) \) is the expected return of the portfolio,
\( R_f R \) is the risk-free rate, and
\( \sigma_p \) is the standard deviation of the portfolio returns.
Step 8: Microsoft Excel Solver® needs to fulfil some specific conditions when solving for the optimisation problem. These are:

\[
\text{Condition 1: } \sum_{i=1}^{n} X_i = 1
\]

Condition 1 ensures that the sum of the different share weights in the portfolio at any given time adds up to 100%.

\[
\text{Condition 2: } X_i \geq 0, \text{ for } i = 1,2,3,4 \ldots n
\]

Condition 2 states that the weight of a share cannot be negative, which eliminates the possibility of short selling any of the shares. The researcher has chosen not to include short selling, partly because there are very specific rules about short selling certain shares and due to the unreliable expected returns.

\[
\text{Condition 3: } X_i \leq 10\%, \text{ for } i = 1,2,3,4 \ldots n
\]

Condition 3 ensures that none of the shares in Portfolio 1 have a weight higher than 10%. This rule was made to ensure that the investor has some diversification benefits in the portfolio. Under this condition the researcher is more interested in a broad diversification than a potential high risk-adjusted return that an unconstrained portfolio (Portfolio 2) can offer.

\[
\text{Condition 4: } X_i \leq 100\%, \text{ for } i = 1,2,3,4 \ldots n
\]

Condition 4 gives Portfolio 2 the ability to invest up to 100% into any given share at any given time. This rule was made to gain insight into the highest potential risk-adjusted return that an unconstrained strategy might achieve.
3.12 Tests of normality

Before it is possible to present the Markowitz portfolios, it is important to verify that the returns of the selected shares are normally distributed. The reason for this is that the use of variance and mean returns when applying the Markowitz's portfolio theory cannot be used with accuracy unless the sample is normally distributed. Kurtosis and Skewness measure the shape of the distribution and are used to verify whether sample data is normally distributed or not. Skewness is a measure of how symmetrical the data is around the mean returns; a number of 3 indicates that the distribution is normally distributed. Kurtosis is a measure of whether the data is more peaked or flat relative to a normal distribution. Data that perfectly follows a normal distribution has a kurtosis value of 3 and a skewness of 0 (Pyzdek, 2001).

Figure 3-1 shows the skewness and kurtosis of both Portfolio 1 and 2. The portfolios has the following characteristics:

- Portfolio 1 has a skewness of -0.30 and kurtosis of 3.48, and
- Portfolio 2 has a skewness of -0.21 and kurtosis of 3.27.

Even though the returns do not follow a normal distribution, the researcher will still try to apply Markowitz's theory when creating the “optimal” portfolios. In order to conduct the study, the researcher assumes that the returns are close to normally distributed. It is important to note that the reason these portfolios fail the normality test is not so much because of the skewness, which is close to a normal distribution, but that the kurtosis is larger than what is expected of normally distributed data. The proper treatment of data that is asymmetric and not normally distributed is beyond the scope of the study, but it is important to bear in mind that the data is not symmetric.
Figure 3-1: Test for normality
CHAPTER FOUR:
EMPIRICAL FINDINGS AND ANALYSIS

"Most institutional and individual investors will find the best way to own common stock is through an index fund that charges minimal fees. Those following this path are sure to beat the net results [after fees and expenses] delivered by the great majority of investment professionals." (Buffett, 1996)

4.1 Introduction

At the end of an investment period it is important to conduct a performance evaluation to see how well the chosen investment strategy has done. In this chapter the researcher presents and discusses the empirical findings obtained from the statistical analysis. The results are presented in a way that makes comparison with the benchmark easy. The chapter is broken down into the following subsections: Section 1, the portfolios are compared to the benchmark index from a purely performance perspective. Factors such as investment growth, annualised return, excess return, and best and worst month analysis are presented. Section 2: the researcher presents the analysis from a volatility (riskiness) perspective. Factors such as standard deviation and maximum drawdown (hereafter referred to as MDD) are presented. Section 3: the risk-adjusted performance of the portfolios and the benchmark is presented. Lastly: the researcher takes a closer look at the diversification benefits (if any) of holding either of the two portfolios.

4.2 Portfolio and benchmark definition

The following two optimisation portfolios and the market index are used throughout the chapter. Wherever possible reference will be made to these.

- Portfolio 1: Port1_Max_Sharpe_Max_10: No short selling allowed with a maximum of 10% invested into any one share. The portfolio represents a passive investment portfolio constructed under the Markowitz mean-variance framework. The portfolio is in all cases represented by the colour blue.

- Portfolio 2: Port2_Max_Sharpe_No_Max: No short selling allowed with no maximum amount that can be invested into any one share. The portfolio represents a passive
investment portfolio constructed under the Markowitz mean-variance framework. The portfolio is in all cases represented by the colour green.

- Market/benchmark index: *FTSE/JSE Top 40 TR ZAR*: Top 40 Total Return Index with dividends included and reinvested. The index/market index is in all cases represented by the colour pink.

### 4.3 Section 1: Performance evaluation

#### 4.3.1 Cumulative investment growth

Figure 4-1 illustrates the performance of a R100 investment into the two portfolios against a R100 investment into the Top 40. The initial investment was made on 1 June 1995 and liquidated on 31 December 2014. The following observations are most prevalent: *Firstly*, the market index as represented by the Top 40 turned an initial R100 investment into R1,579.50 over the 19.5-year period under observation. *Secondly*, Portfolio 1 turned an initial R100 investment into R11,368.60 over the 19.5-year period under observation. *Lastly*, Portfolio 2 turned an initial R100 investment into R24,109.30 over the 19.5-year period under observation. This excellent performance is attributed to the fact that the portfolio had no restrictions as to the weight of the underlying constituents.
Based on the above graphical analysis (Figure 4-1), the Markowitz portfolio has outperformed the market by a substantial margin. Because of the long time period associated with the top graph it is difficult to see the peak and troughs of the Top 40 and the two portfolios.

Figure 4-2 presents the investment growth with a logarithmic scaling, which enables a clearer picture of the portfolios.
Figure 4-3 illustrates the annualised growth over several periods, with the following observations being most prevalent: 

**Firstly:** Portfolio 2 offered the investor annualised growth of 32.48% over the entire holding period. 

**Secondly:** Portfolio 1, offered the investor a return of 27.47% since inception. 

**Lastly:** the Top 40 index only returned 15.27%. By holding either one of the Markowitz portfolios the investor has seen substantial growth.

Figure 4-3 takes no cognisance of risk; risk-adjusted return of the portfolios is discussed later in the chapter. It is interesting to observe that over the longer time periods (periods > 15 years) the Markowitz portfolios achieved significant outperformance when compared to the Top 40. However, the picture looks slightly different over the shorter time periods (periods < 15 years) where the outperformance margin is much smaller, and over 7 years the Top 40 outperforms the two Markowitz portfolios. In general, the Markowitz portfolios achieve significant outperformance when compared to the Top 40.
4.3.3 Excess return

Figure 4-4 shows the excess return (alpha), over and above the Top 40 that the Markowitz portfolios achieved over the holding period. Portfolio 1 achieved returns of 612.10% in excess of the benchmark, while Portfolio 2 achieved excess returns of 1,410.15%.

The results and the effectiveness of using a passive investment strategy, supported and constructed under the guidelines of MPT, are supported by du Plessis and Ward (2009) who had very similar results. Their study was conducted over the period between 27 June 1997 and 31 December 2007 – a period of 10.5 years. Even though their study differs in length (19.5 years compared to 19.5 years), their results showed significant outperformance against the Top 40. Below is a summary and description of the results obtained by du Plessis and Ward (2009):
- Portfolio 1: Short selling allowed, and no other restrictions. R100 investment grew into R2,390 over the 10.5-year period under observation. Cumulative investment growth of 2,390%.

- Portfolio 2: Short selling allowed with a minimum of -10% and a maximum of +10% invested in any one share. R100 investment grew into R477 over the 10.5-year period under observation. Cumulative investment growth of 477%.

- Portfolio 3: No short selling and no other restrictions. R100 investment into the portfolio at the inception date grew into R1,736 over the 10.5-year period under observation. Cumulative investment growth of 1,736%.

- Portfolio 4: No short selling allowed with a maximum of 10% invested in any one share. R100 investment grew into R1,058 over the 10.5-year period under observation. Cumulative investment growth of 1,058%.

- The benchmark index was the FTSE/JSE Top 40 ZAR; R100 investment into the Top 40 grew into R417 over the 10.5-year period under observation. Cumulative investment growth of 417%.
Even though the study done by Du Plessis and Ward (2009) is different from a number of perspectives, the results show that a Markowitz optimal portfolio can achieve significant outperformance.

4.3.4 Best and worst month

The best and worse month graphical analysis (Figure 4-5) presents the best and worst month of the two Markowitz portfolios and the benchmark. It is interesting to note that the worst month analysis on the portfolios and the benchmark have been very similar, over periods of less than seven years, with the worst month performances only showing slight differences. Over the periods of greater than seven years the two Markowitz portfolio have been more volatile than the benchmark. A very similar result is obtained from the best month analysis: over the shorter term the results have been mixed, with marginal differences between the Markowitz portfolios and the benchmark. It is only over the longer periods that the strength of the Markowitz portfolios come to fruition.
Section 2: Risk evaluation

In the next section, the portfolios are compared to each other and are analysed based on the risk that each investment has associated with it. Standard deviation and MDD are used to represent the risk.

4.4.1 Standard deviation

Figure 4-6 illustrates the standard deviation associated with each of the investments; a lower standard deviation indicates that the investment has low historical volatility. With this information an investor can judge the range of return that a portfolio is likely to generate in the future. The following observations are most prevalent: Firstly: Portfolio 1 has the lowest standard deviation in four of the seven periods included (over 3, 5, 7 and 15 years). Secondly, the Top 40 had the lowest standard deviation for the rest of the 3 periods (over 1, 10 and 19.5 years). Lastly: Portfolio 3, which can have a potential weighting of 100% exposure to one security, is the riskiest of the three portfolios.
4.4.2 Maximum Drawdown

MDD is an indicator of downside risk over a specific period of time. MDD measures the largest single drop from peak to bottom in the value of a portfolio (before a new peak is achieved). In other words, it is the worst (maximum) peak to trough loss. MDD also indicates how quickly an investment has made back its losses. The steeper the slope of the line, the quicker the investment made back its losses.

From the below graph (Figure 4-7) the following observations can be made. Firstly, during the recession in 1996–1997 the two portfolios and the market lost about 40% of their value and the losses were made up fairly quickly. Secondly, during the recession in 2002, the Top 40 lost close to 35% of its value while the Markowitz portfolios only lost about 13% of their value. Lastly, during the Financial Crisis of 2007–2008, Portfolio 1 lost close to 50% of its value, Portfolio 2 lost 43% and the market as represented by the Top 40 index lost roughly 42%.
Figure 4-7: Maximum drawdown

Figure 4-7 highlights an interesting point: during the 19.5-year period under review, the greatest loss in the portfolios and the market index occurred during the Financial Crisis of 2007–2008. During the crisis, the market and the two Markowitz portfolios were in drawdown for nine months, meaning that on a month-on-month basis they returned a negative return. However, when the market finally turned, it took the market only 22 months to make up all the losses that were incurred during the Global Financial Crisis of 2007 - 2008. This is in stark contrast to the 40 and 51 months that it took to recover the losses in Portfolio 1 and 2.

4.5 Section 3: Risk-adjusted return

While MDD is a crude measure of risk, it does indicate the greatest loss that a portfolio experienced over a certain time period. A better way to look at risk is to combine the risk of a portfolio with the return that each unit of risk contributed to the performance of a portfolio. The Sharpe Ratio is the most widely used metric to show risk-adjusted return.
4.5.1 Sharpe Ratio

As indicated in the graph below (Figure 4-8), both Markowitz portfolios returned superior risk-adjusted performance over all the periods except over a seven-year period. Data on the risk-free rate was not available for a period greater than ten years.

![Sharpe Ratio Graph](image)

Figure 4-8: Sharpe ratio

4.6 Diversification

Literature on the subject of diversification is vast and there is no definitive answer on how many securities must be included for a portfolio to be considered diversified. Wagner and Lau (1971:51) concluded that most of the diversification is achieved with 15 securities, while Evans and Archer (1968:767) maintain that there is no economic justification for increasing portfolio sizes beyond 10 or so securities. However, Statman (1987:362) argues that a well-diversified portfolio should include between 30 and 40 securities.

The answer to what constitutes a diversified portfolio is highly dependent upon factors that are unique to each investor. Only when those factors are understood and quantified
can we get a clearer answer. Some of these factors include: risk tolerance, willingness to take risks and investment horizon (planned holding period), which are considered as the most important.

![Graph showing diversification and number of holdings](image)

**Figure 4-9:** Number of holdings in portfolio 1

Figure 4-9 shows that Portfolio 1 had an average of 14 securities over the holding period of 19.5 years, never had less than 11 holdings and had a maximum of 35 holdings in 2011. The portfolio is considered to be insufficiently diversified. The restrictions placed on the portfolio meant that the portfolio would at all times have at least 10 holdings.

Figure 4-10 shows that Portfolio 2 had an average of 9 securities over the holding period of 19.5 years, never had less than 4 holdings and had a maximum of 36 holdings in 2011. The portfolio is considered to be insufficiently diversified. The restrictions placed on the portfolio meant that the portfolio could theoretically have a minimum of 1 holding (making up 100% of the portfolio) and a maximum of 40 holdings (maximum selectable universe).
4.7 Concluding analysis

The statistical analysis that was done using 19.5 years of historical data shows that a passive investment strategy based on the Markowitz optimal portfolio theory outperforms the benchmark, as represented by the FTSE/JSE Top 40 TR ZAR. The researcher would like to highlight the following points:

- The Markowitz portfolios achieved a risk-adjusted return consistently better than the benchmark; however, it must be noted that the portfolios have been more volatile.

- The Markowitz portfolios really start to shine over the longer time period (periods > 7 years). This means that the portfolios are only suitable to investors who have an investment horizon greater than 7 years. The swings in monthly performance highlight that the portfolios are suited to an investor who does not mind short-term volatility.

Figure 4-10: Number of holdings in portfolio 2
• The Markowitz portfolios recovered losses incurred over a much longer time period than the market; the reason for this is unclear and more research needs to be done in order to gain greater insight.

• The diversification benefit from using a Markowitz portfolio remains open to debate; even though the holdings of both portfolios are in excess of 10 holdings, many market commentators would argue that there is no diversification benefit obtained from only 10 shares.

• The Markowitz portfolios presented in this study are not complete solutions for an investor; while the results have been outstanding, there is a need for an investor, as part of his total portfolio, to have exposure to property, fixed income securities and commodities, as having exposure to these alternative asset classes will add to the diversification of the total portfolio.
CHAPTER FIVE: CONCLUSION

"The investor with a portfolio of sound stocks should expect their prices to fluctuate and should neither be concerned by sizable declines nor become excited by sizable advances. He should always remember that market quotations are there for his convenience, either to be taken advantage of or to be ignored." (Graham, 1949)

5.1 Introduction

The researcher will evaluate and compare the statistical analysis to the problem statement and will evaluate whether the research question and research aims have been adequately addressed and answered. Finally, the researcher concludes with a closing discussion and suggestions are made for future research.

5.2 Problem statement: review

Can a passive trading strategy based on the Markowitz mean-variance optimal portfolio construction outperform the FTSE/JSE Top 40 TR ZAR (J200T) on a risk-adjusted basis over a period of 19.5 years?

The results presented in Chapter Four have conclusively shown that a passive investment strategy based on the Markowitz optimal portfolio theory consistently outperformed the FTSE/JSE Top 40 TR ZAR (J200T). The researcher identified weaknesses and recommendations from previous studies (similar studies have excluded both dividends and transaction cost, and similar studies have suggested a large sample) and made provision for these in this study. To improve the reliability of the study, the researcher tested the problem statement against two portfolios, including dividend receipts and transaction costs, and broadened the sample data to include the complete history of the FTSE/JSE Top 40 TR ZAR (J200T). The results show that even under the constraints of no short selling and/or no more than 10% invested into any single share, the passive investment strategy works.

5.3 Research aims: review

In conducting research into MPT, the researcher will try and evaluate whether the application of MPT in modern times is still as relevant as it was more than 50 years ago.
The study reviewed the foundation of MPT from the early beginnings and showed how MPT theory has evolved over time; opinions from opposition theories were also presented and evaluated. To conclude, even though the groundwork of MPT theory is over 50 years old, it is still relevant and applicable in modern times.

To examine the differences in risk-return characteristics between the FTSE/JSE Top 40 TR ZAR (J200T) with the newly identified optimal investment portfolios.

The researcher compared both Markowitz portfolios against the FTSE/JSE Top 40 TR ZAR (J200T); a full analysis was done on performance, risk and risk-adjusted return. The researcher has shown that an optimal portfolio can be constructed to find the perfect balance between maximising return and minimising risk.

To determine whether the Markowitz optimal portfolios are sufficiently diversified enough to help the investor create a low risk portfolio, which will provide more reliable and more persistent returns.

The researcher has presented the holdings over the 19.5-year period; while some market commentators might perceive the Markowitz portfolio to be diversified, other may disagree. The researcher cannot factually conclude that the presented portfolios are adequately diversified.

5.4 Conclusion

The simulations and optimisations done on both of the Markowitz passive strategies using 19.5-years of data from INET BFA show that a passive strategy based on the Markowitz optimal portfolio theory consistently outperformed the market, as represented by the FTSE/JSE Top 40 TR ZAR. To further validate the strategy, both Markowitz portfolios earned superior risk-adjusted returns over all the investment periods except one.

It is however difficult to choose outright a best performing portfolio based on risk-adjusted performance. Portfolio 1 and 2 provided excess performance, superior risk-adjusted performance and protected the investor to some degree on the downside. There were periods where Portfolio 1 was better than Portfolio 2 and vice versa. In the end the choice of an optimal portfolio will come down to the individual investor. Portfolio 1, from a risk-averse investor’s standpoint, will be the better investment because of the limitations
placed on the portfolio. By limiting exposure to 10% in any share, the investor will have at least 10 holdings in his portfolio.

The results of this study imply that there is a momentum effect on the JSE. This is supported by Snyman (2011), who found a definite relationship between momentum and future expected returns on the JSE. Furthermore, it was found that momentum is a common attribute amongst top performing shares on the JSE. Snyman also noted that the returns obtained from the highest decile (top 10% of the JSE) can be applied as a viable momentum-based investment strategy to attain abnormally high returns. Similar studies proved that shares which out-performed in a prior period will continue to out-perform in the next (Fraser & Page, 2000).

The success of the two passive investment strategies does lead to a few interesting questions and discussion points. In South Africa the use of active investment management is still preferred to its passive counterpart, whereas in the rest of the world many large investment managers and individual investors have realised the benefits of passive investment strategies. However, the use of passive investment funds has somehow not taken off locally.

5.5 Suggestions for further research

The outcome of the study has been extremely interesting and the results have exceeded expectations. Further research using more shares and inclusion of more onerous constraints would enhance the quality of this study. In addition, information on share splits and bundling/unbundling of companies would enhance the accuracy of the return data. Future research would also benefit from the inclusion of different asset classes, especially property, commodities and fixed income securities.

Lastly, since the mean-variance portfolio model suggested by Harry Markowitz relies on expected returns, standard deviations, variance and correlation between shares, it will be valuable to find a more precise way to predict how returns on shares will be in the future. The use of an adaptive algorithm model, such as the Kalman filter, might improve the methodology and future predictability of returns.


http://www.etfsara.co.za/presentations/PensionFunds_Windhoek_MikeB_4Sept2014.pdf Date of access: August 2015.


http://www.berkshirehathaway.com/letters/1996.html Date of access: 30 August 2015.


