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Combining Markowitz's selection model with different investment styles

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Abstract

Portfolio selection has been a well-researched topic since the mid 1950's. Researchers such as Harry Markowitz obtained the Noble Prize for his work on portfolio selection. His model, which is underpinned by the concept that the market is efficient, has been the cornerstone of many investment strategies over the years.

Recently, however, many authors have claimed that the markets are inefficient, and that one cannot rely on a model that assumes a linear and static relationship between risk and reward, making the Markowitz Portfolio Selection Model (MPSM) obsolete.

Literature suggests that much of this inefficiency is created through the use of different styles; that is, styles in which shares are grouped together based on certain fundamental characteristics, to inform the investment strategies of investors.

Therefore, this study endeavours to supplement the MPSM with different investment styles. Firstly, testing whether the risk adjustment afforded by the MPSM is positively influenced by the different investment styles. Secondly, to determine which style achieves the highest returns over the selected period.

Monthly total return data from the JSE was used and portfolio rebalancing took place every six months for a period of 10 years. The share weightings of the portfolios were informed by risk adjusted style based predicted returns. The performance of these portfolios was subsequently compared.

Results indicated that style influenced portfolios outperform the non-style influenced MPSM, with some styles providing greater returns than others over the period selected.

Keywords

Markowitz, Style investing, Risk adjusted, Portfolio selection, Sharpe Ratio, EMT

Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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List of Abbreviations

AMT	Adaptive Market Theory
BV/MV	Book Value to Market Value of Equity
CAL	Capital Allocation Line
CAPM	Capital Asset Pricing Model
CTR	Calculated Total Return
EF	Efficient Frontier
EFT	Exchange Traded Funds
EMT	Efficient Market Theory
EV/EBITDA	Enterprise Value to Earnings Before Interest, Tax, Depreciation and Amortisation
JSE	Johannesburg Stock Exchange
MC	Management Cost/Fee
MPSM	Markowitz Portfolio Selection Model
MPT	Modern Portfolio Theory
MV	Mean Variance
PE	Price Earnings
PGD	Portfolio Generation Date
RA	Risk Adjustment
TC	Transaction Cost
TRI	Total Return Index
VBA	Visual Basic for Applications

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Chapter 1: Introduction

In this chapter an introduction to the study will be provided, as will the rationale for the study and what impact it will have on the business and academic environment. The chapter will explain why combining investment styles with the Markowitz Portfolio Selection Model (MPSM) will be considered, and reference will be made to some crucial literature which helped to inform the decision.

The origins and fundamentals underpinning the MPSM are well known, as are the seminal works of Markowitz (1952) and Sharpe (1963). Their research was reduced to the idea of providing a risk adjustment process to portfolio selection, in which shares are selected into a portfolio not only based on their performance, but also their lack of volatility or risk. Thus, the concept of risk adjusted returns are presented.

However, since these two authors published their research, a plethora of subsequent studies have been conducted, both supporting and disproving the concepts surrounding the MPSM and adjusted returns.

Most notably, the Efficient Market Theory (EMT) was put forward by Fama (1970), who found that an efficient market price will fully reflect all the available information within the market, i.e. the price in the market will be accurate and equal to the intrinsic value contained within the share. This will ultimately ensure that no share is mispriced, because if the value of the share shifts, the market will react appropriately and the share price will quickly adjust to the new and correct value.

However, as many authors would suggest, this is not the case, and the market operates inefficiently resulting in the mispricing of shares. Lo (2012) suggested that since the 2008 financial crisis, the Efficient Market Theory has been replaced by a more adaptive model, adding that theories such as EMT are based on assumptions concerning risk and reward, such as the relationship being linear and static across time.

Moreover, due to the instability observed within markets recently, Lo (2012) stated that the linear relationship expected between risk and reward is no longer valid, which results in the risk-adjusted returns obtained through the MPSM being fundamentally inaccurate and irrelevant.

It is also noted in the literature that some of the inefficiency present within the market is due to the use of style investment strategies. The grouping of shares based on certain characteristics, such as size, book to market value, cash flow to price and/or liquidity can inform a style strategy. As a result, other fundamentals are not considered when applying a style strategy, and mispricing of shares may occur due to this.

This is supported by Bird, He, Thosar and Woolley (2005), who found that "an increasing proportion of investment funds have been managed following styles, such as index and momentum investing, where information and fair pricing are largely irrelevant to the decision process" (p. 383). Furthermore, Hoffman stated that the presence of this evidence contradicts the EMT, which is in line with a similar conclusion made by Graham and Uliana (2001).

As noted above, various investment styles exist, each with their own benefits and drawbacks. For example, positive price momentum shares were noted in a study by Jegadeesh and Titman (1993) to outperform historically weak performers. Furthermore, Barroso and Santa-Clara (2015) found that momentum strategies outperform other styles. However, the crash risk associated with momentum is also relevant, with Bird et al. (2005) stating that momentum investing has been found, in some instances, to lead to the over valuation of shares, i.e. investors keep buying shares that are performing well causing the share prices to overshoot fair value. Thus, the momentum strategy might lead to price bubbles being formed, resulting in significant crashes. However, if combined with a risk adjustment process, this risk might be negated.

This study examines the efficacy of combining the MPSM with the predictive insights that different investment styles have shown to provide (Wang, Brooks, Lu, & Holzhauer, 2014). The intention is to derive a portfolio which generates higher returns than the Index (Top 40 Index (J200)), but with lower risk characteristics. This research concept is in line with studies by Wang et al. (2014), Muller and Ward (2013) and Moerloose and Giot (2011), who have all shown that positive returns can be generated by using style-based investment strategies.

More specifically, Muller and Ward (2013) found that momentum, value, liquidity and cash flow were the most effective styles to utilise when adopting a style-based investment strategy. These are also some of the styles that will be incorporated into this study. Furthermore, Du Plessis and Ward (2009) have demonstrated the advantages to

risk-adjusted returns from the application of the MPSM, and thus the rationale for combining these two strategies is evident.

As alluded to, this study also attempted to partially build on the work of, amongst others, Du Plessis and Ward (2009), who applied the MPSM to the JSE and further suggested that, "…the inclusion of more onerous constraints as well as alternative approaches to estimating future returns (such as analyst consensus earnings forecasts) might improve the methodology" (p. 45).

In terms of the contribution to industry, the proposed model for this study, created by combining different style-based investment strategies with the MPSM, could be used as an investment strategy applied by fund managers, so as to obtain an above Index return at the lowest possible risk. Moreover, the insights derived from knowing which style outperforms the others, as well as if the non-style influenced MPSM outperforms the style influenced portfolios, are valuable. This could lead to a possible inference that the market is inefficient, and that investing cornerstones such as the MPSM, EMT and the Capital Asset Pricing Model (which will be discussed in the following section) are obsolete.

Furthermore, considering that Williams, Mooney and Marriage (2016) reported in the *Financial Times* that an annual charge of 1.59% is applied over a three-year period for the management of a fund, the benefit of managing an investment fund providing above Index returns is clear. By implication, should this model prove to be a viable one, both the fund manager and investor will reap the benefits, which further enhances the rationale and motivation for this research.

Another aspect that will also be tested for, although not optimised, is the transaction cost effect and the level of diversification. Both these aspects have significant real-world effects on the rebalancing of the portfolios and subsequently the returns generated. Specifically, the addition of the transaction costs to the methodology will increase the practicality of the study, and is something that has not been significantly explored in the literature or similar studies.

Chapter 2: Literature review

2.1 Introduction

In the previous chapter an introduction to this study was provided, as well as the rationale for the research. In addition, the impact that the study will have on the business and academic environment was discussed, with specific reference to why combining investment styles with the MPSM would be considered by the researcher.

In this section, the main components of the study will be defined and discussed. Firstly, the theoretical base of the MPSM will be explained, including the background, theory and elements that contribute to the model. Attention will also be paid to the shortcomings of the MPSM, arguing why this model is still relevant and which factors might compensate for these shortcomings. Secondly, the Efficient Market Theory (EMT) will be discussed, including how it relates to the MPSM. The question of whether the EMT still applies in today's dynamic markets will be considered, as well as what bearing this has on the successful application of the MPSM. Furthermore, the effect that style investing has on the EMT will be discussed in detail. Thereafter, investment styles will be assessed, focusing on how these will be used to predict returns and also noting some positive and negative aspects of the different styles. The effect of combining these two approaches will also be explored, and finally, the inherent inadequacies of the investment styles and the MSPS will be deliberated on, with specific reference to how these two concepts might complement each other.

2.2 Markowitz Portfolio Selection Model (MPSM)

Harry Markowitz advocated for the idea of a linear relationship between risk and return, suggesting that a share with a higher variance/risk would inherently result in a higher return. In order to reduce the risk portion applicable, diversification is thus required. In 1952, Markowitz published a landmark paper, *Portfolio Selection* (Markowitz, 1952), in which he proposed the idea of diversifying a portfolio in order to lower the cumulative risk associated with this portfolio (Rubinstein, 2017). He noted that the sum of the risks associated with a certain number of shares is lower than the shares individually. As an example, some shares within a sufficiently diversified portfolio would positively correlate with market movements, whilst other shares would have a negative correlation, providing some hedging if the market fell significantly.

Besides supporting diversification, Markowitz's work, together with William Sharpe's asset pricing theory, led to the development of what is commonly known today as Modern Portfolio Theory (MPT) (Mangram, 2013). This theory, by using estimates of the returns, covariances and volatilities of a set of shares, along with certain constraints applied (such as not shorting any stocks), allows for the optimisation of a portfolio, which results in risk-adjusted returns (Fabozzi, Gupta, & Markowitz, 2002). Even though this method is relatively simple, it is still the cornerstone of finance for many fund managers (Ledoit & Wolf, 2014).

The risk-adjusted returns would represent points on an Efficient Frontier (EF), which is formed by a line of efficient portfolios on a risk vs. return graph. Every underlining point below the EF represents various portfolios, each with a different risk/return ratio due to the proportion of the shares which constitute the specific portfolios. The frontier would result in the highest return given a specific level of risk or the lowest risk for a specific level of return (Fabozzi et al., 2002; Karandikar & Sinha, 2012).

In addition, the MPSM is also known as the mean-variance (MV) model (Wan Mohd, Mohamad, & Mohamed, 2013). Wan Mohd et al. (2013) noted that one problem with the use of the MV model is the fact that it relies on the returns of the assets being normally distributed. This issue was supported by Liu, Zhang, and Wen (2014), as well as Harris, Coskun Küçüközmen and Yilmaz (2004), who stated that most asset returns are skewed and not normally distributed. Levy and Levy (2004) added to this sentiment by stating that for long investment horizons, returns are generally positively skewed.

Furthermore, Wan Mohd et al. (2013) noted that another assumption made by those who apply the MV model is that the future returns will follow the historic return trends of the individual shares, but this is not always the case. To compensate for the shortcomings noted above, this study proposes the use of the possible predictive capabilities of different investment styles. The return forecast accuracy would then not rely on an estimation of future returns from the MV model alone, but rather a style influenced approach. This would possibly enhance the "probabilistic estimations" of the future returns, as mentioned by Sharpe (1963).

Some research has noted that the risk aversion afforded by the MPSM is not necessarily a trait welcomed by all investors, however. Levy and Levy (2004) commented that individuals are risk-seeking in order to gain significant returns, despite substantial losses potentially being incurred. Nevertheless, the authors promoted the use of the MPSM as

a diversification algorithm, i.e. by combining the MPSM and different investment styles, not only does it enable risk aversion, but it may also facilitate significant returns.

Furthermore, numerous other studies used the work of Markowitz as a platform to continue refining the portfolio selection process. Sharpe (1963) aimed to simplify the portfolio selection model proposed by Markowitz, stating that he endeavoured to determine a set of efficient portfolios. He added that Markowitz had a three-step process to portfolio selection, namely, "(1) making probabilistic estimates of the future performances of securities, (2) analysing those estimates to determine an efficient set of portfolios and (3) selecting from that set the portfolios best suited to the investor's preferences" (p. 277). Sharpe's work led to the development of the Sharpe ratio, which reduced computational effort involved with the MPSM and simplified it. Other contributions by Sharpe include the creation of the single factor model and the Capital Asset Pricing Model (CAPM) (Du Plessis & Ward, 2009).

The Sharpe ratio, which was designed to simplify the use of the MPSM, indicates the slope of the Capital Allocation Line (CAL) and was presented in the following formula:

$$Sp = \frac{(E(r_p) - r_f)}{\sigma_p}$$

Where:

Sp = Sharpe ratio of portfolio "p"

$\mathrm{E}(\mathrm{r_p})$ = Expected returns of portfolio "p"

r_f = Return of the risk-free asset

And σ_p = the standard deviation of the returns of portfolio "p"

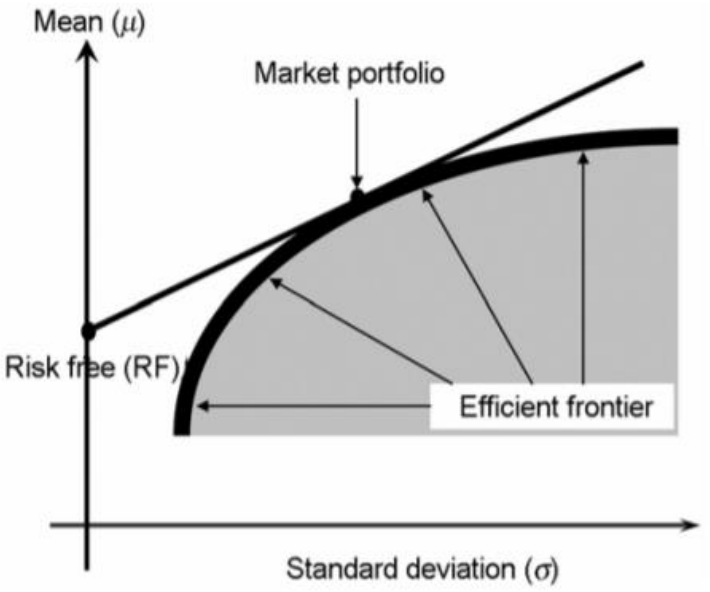
(Du Plessis & Ward, 2009, p. 42)

Small, Duncan and Small (2013) noted that the Sharpe ratio indicates the expected return per unit of risk, thus indicting a risk-adjusted return value.

Graphically, the CAL would stem from the return value of a risk-free asset - such as a government bond - as a starting point, and would extend towards the EF, passing the frontier at a single point of contact. The most efficient portfolio on the EF would be present at the point of contact between the CAL and EF. A graphical representation of these two important concepts is displayed in Figure 1 below. The calculated Sharpe ratio would indicate the slope of the CAL, thus the higher the Sharpe ratio number, the greater the slope and the higher the risk-adjusted return. By optimising the Sharpe ratio through

the adjustment of the proportions of underlying shares within a portfolio, the optimum risk-adjusted return can be achieved, subject to the constraints imposed on the portfolio (i.e. no short selling and no share's proportion being above 10% of the entire portfolio).

Figure 1: Efficient Frontier and Capital Allocation Line



Source: Karandikar and Sinha (2012, p. 667)

Thus far, the theory supporting the MPSM has been noted, as well the computational 'shortcuts' proposed by Sharpe (1963), which were used in this study. The subsequent sections will provide insight into Market Efficiency, Style Investment Strategies, and their application to the MPSM and this study.

2.3 Market Efficiency

Market efficiency indicates that a price in the market for a specific share is based on all the relevant information available. Additionally, risk and return have an equilibrium relationship which drives prices, and the two concepts of market efficiency and equilibrium pricing cannot be separated (Fama & Litterman, 2012).

In seminal work by Fama (1970), it was noted that an efficient market price will fully reflect all the available information within the market. Fama continued by stating that this would be an ideal market, in which prices would provide accurate signals for resource allocation. Rösch, Subrahmanyam and van Dijk (2017) noted that an efficient market is one that is high quality and relatively free from frictions, asserting that the prices in this

market would accurately reflect the fundamentals of the specific shares, i.e. “assets with identical cash flows sell for the same price” (Rösch et al., 2017, p. 1151). This underlining theory is called the Efficient Market Theory (EMT). Furthermore, Fama (1991) noted that two versions of this theory exist, i.e. the strong form in which the cost associated with getting the prices to reflect the information is zero, and the weak form which was noted to be more economically sensible, reflecting the information via the prices as long as the marginal benefit of acting on the information does not surpass the marginal costs associated.

Additionally, it is assumed when applying asset pricing models that markets are efficient. For instance, it may be expected that if a certain share has a higher risk (measured by the variance in price from the mean) associated with it, that the subsequent return should be higher as well. This is a fundamental concept on which models such as the CAPM and MPSM are based, as noted by Grable (2013). To this point, and as described previously, the portfolios generated on the EF will result in the highest return given a specific level of risk, or the lowest risk for a specific level of return.

However, certain researchers such as Lo (2012) have suggested that since the 2008 financial crisis, the Efficient Market Theory (EMT) has been replaced by a more adaptive model (Adaptive Market Theory or AMT), due to these traditional paradigms not being able to explain the reasoning behind how and why the crisis occurred.

Lo (2012) continued by stating that theories such as EMT, and by association MPSM and CAPM, are based on certain assumptions concerning risk and reward, which informs their usefulness and accuracy. These include:

- “The relationship is linear.
- The relationship is static across time and circumstances.
- The relationship’s parameters can be accurately estimated.
- Investors have rational expectations.
- Asset returns are stationary (i.e., their joint distribution is constant over time).
- Markets are efficient” (Lo, 2012, p. 18).

Moreover, authors such as Lo (2012) noted that the assumptions underpinning the EMT are not relevant anymore, and that due to the instability observed within markets, the linear relationship expected between risk and reward is no longer valid. This results in the risk-adjusted returns provided by the MPSM being fundamentally inaccurate and

irrelevant. However, Johnstone (2015) found this to only be partly true, arguing that market efficiency is still pertinent, with markets reacting to information disclosed by organisations efficiently. Also, these markets react positively to positive information and negatively towards negative information. More importantly, Johnstone found that if the information available is comprehensive enough, it may reduce the perceived risks associated with a specific share, resulting in an increased risk premium for that share, that is there will be a higher expected return for a share with a lower perceived risk.

Yet Markowitz (2014) argued that although certain circumstances enhance the use of the MPSM, they do not disqualify the use if not present. He described these as “not necessary conditions” (p. 346). Furthermore, Statman (2013) noted that traditional approaches such as the MPSM, still provide the best combinations of risk vs. return, even though the returns might be negative in very negative conditions such as the financial crisis.

Nevertheless, it seems the odds are against MPSM when it comes to style investment and the inefficiencies it creates. A study by Bird et al. (2005) tested the effect that style investing, such as momentum investing, has on the efficiency of a simulated market. They found that “an increasing proportion of investment funds have been managed following styles, such as index and momentum investing, where information and fair pricing are largely irrelevant to the decision process” (p. 383). This indicates that due to the use of style investment strategies, market efficiency has been reduced. This was confirmed by Hoffman (2012), who noted that evidence suggests that the returns generated in portfolios which are formed by using specific groupings or styles of shares cannot be explained by market risk alone; these were acknowledged as stock return anomalies. Furthermore, Hoffman stated that the presence of this evidence contradicts the EMT which is in line with a similar conclusion made by Graham and Uliana (2001).

Most significantly, while conducting a study on size, price-to-earnings and betas on the JSE, Van Rensburg and Robertson (2003) found that betas (which indicate market risk) were negatively correlated with the returns generated when using style investment strategies. Thus, not only does risk not have a linear relationship with return, it has an inverse relationship.

For this study, style investment strategies were combined with the MPSM. The notion was that the combination would reduce the effect of the market inefficiencies created by style investing and other aforementioned factors, such as market instability, thus

improving the relevance and usefulness of the risk adjust returns generated by the MPSM.

2.4 Style investing

The grouping of shares based on certain characteristics, such as size, book to market value, cash flow to price and/or liquidity, occurs frequently as investors try to simplify the decision-making process around investing (Wahal & Yavuz, 2013). An investment style is thus based on these groupings, and in some cases the ranking within these groupings (e.g. investing in the top 10 largest companies by market cap on the JSE). In a study by Chan, Chen and Lakonishok (2002) on mutual funds' investment styles, the authors noted that due to the large number of assets that fund managers control these days, style investing has intensified. They added that equity funds grew exponentially from $240 billion in 1990 to $4 trillion in 1999, indicating the need for fund managers not only to "make sense" of the market by using distinctive styles/share groupings, but also to avoid risk by selecting styles that other fund managers would select as well, thereby bolstering the appeal of the underlying shares.

However, style investing is not free from risk; in certain circumstances a crash risk is highly probable. Chue, Wang and Xu (2015) conducted a study in which they tested whether the crash risk associated with style investing can be mitigated through international diversification. In their study, they observed whether portfolios constrained by value, size and momentum characteristics are prone to crashes, if diversified in the G7 countries (USA, UK, Germany, Italy, France, Japan and Canada). Their study found that value and size investment styles were not prone to severe crashes, however momentum was.

In relation to this study, it should be noted that the combination of a mean-variance model such as the MPSM and different investment styles is not a novel concept. In their study, Hjalmarsson and Manchev (2012) tested mean-variance optimisation when the underlying shares within portfolios were constrained by the different types of investment styles. In their study, they used two investment styles: momentum and value. Hjalmarsson and Manchev found that robust performance is attained when the portfolio weights are stratified using the underlying investment styles, and even more so when different styles are combined. However, they noted that the performance obtained might not be as a result of the optimisation process, but rather due to the diversification

obtained by using different investment styles. This research study sought to expand the number of styles to be tested in order to build on, amongst others, the research done by Hjalmarsson and Manchev (2012).

2.5 Momentum

Momentum as an investment style is derived from the assumption that past performance predicts future returns. Therefore, if the momentum effect is correct and present, the historical performance of a share could be forecasted into the future as the 'momentum' of the share. Jegadeesh and Titman (1993) found that stocks which historically performed well (winners) outperformed historically weak performers (losers) by as much as 1.49% per month. Furthermore, Barroso and Santa-Clara (2015) noted that momentum strategies outperformed value and size based strategies, while Fraser and Page (2000) noted the predictive benefit of a momentum strategy, finding that this strategy allows accurate return forecasting one month into the future.

Accordingly, Jegadeesh and Titman (2001) stated that many fund managers also believe that a momentum strategy yields higher than normal profits when applied (as evident above). To this point, Menchero, Wang and Orr (2012, p. 35) found in their study that "24 out of the 25 style momentum strategies examined in this study generate positive returns, 10 of which are statistically significant at 1% or 5%." Additionally, they noted that using the trend established over the past six months and holding (if the trend was positive), the share for the next six months was the most profitable of the 25 strategies tested. Similar to this, Muller and Ward (2013) found that retaining a share with a positive momentum effect for three months after purchase produced the highest return.

Another momentum strategy was described by Yu (2012), who noted that share momentum calculated as the ratio between the current price and the 52-week high of the share is most profitable when applied as a momentum investment strategy. Thus, selecting shares which are closest to their 52-week high would result in that share continuing with its growth trend and providing significant profits once sold.

Furthermore, in a study by Grundy and Martin (2001), the authors noted that if a momentum strategy is risk-adjusted, as the MPSM would provide, the returns generated are remarkably stable. However, they also noted that this strategy produces even greater returns when shorting certain shares (with negative momentums). A critical point made by Grundy and Martin (2001), was the concession that a full understanding of the source

of a momentum strategy's risk-adjusted profitability remains an open question. Some researchers, such as Moskowitz and Grinblatt (1999), attributed the profits generated using a momentum strategy to industry momentum. However, Grundy and Martin (1999) noted that although significant, industry momentum alone does not explain the profits generated through the use of momentum strategies. This being said, this study did not try to answer this specific question, but rather to benefit from the positive risk-adjusted returns generated.

Considering all the positive traits of momentum as an investment strategy, it is important to note the negative effects inherent with this strategy as well. As noted by Bird et al. (2005), momentum investing has been found, in some instances, to lead to the over valuation of shares, i.e. investors keep buying shares that are performing well causing the share prices to overshoot fair value, leading to price bubbles as noted in the IT sector in the late 1990s.

Furthermore, Daniel and Moskowitz (2016) noted that the track record of momentum investing providing positive returns and high Sharpe ratios was disrupted by occasional crashes. In their study, the authors investigated the predictability of momentum crashes and found that in stable market environments, price momentum is strong. However, they also noted that in panicked market circumstances and periods of high price volatility, "past losers" shares sometimes rebound, and due to the momentum strategy mandating the sorting of these shares, losses are suffered as the momentum strategy crashes.

Significantly, Daniel and Moskowitz (2016) found that by using a dynamic method of weighing the momentum shares within a portfolio by using bear market indicators and mean/variance estimations, the Sharpe ratios of these portfolios were doubled. Similarly, Barroso and Santa-Clara (2015) scaled their exposure to momentum risk through the use of the strategy's past return variances, thus supporting the value of combining the MPSM with a momentum investment style, in order to compensate for momentum risk by providing risk-adjusted returns.

2.6 Value

To describe value shares, the definition proposed by Asness, Frazzini, Israel and Moskowitz (2015) can be partly applied. They noted that value is the buying of shares that are perceived to be cheap, and shorting shares that are perceived to be expensive, with the resulting premium achieved being the value premium. In line with this, Fraser

and Page (2000) noted that a value strategy aims to buy shares that are perceived to be under-valued in order to obtain superior returns.

Chan and Lakonishok (2004) noted that the value premium exists due to ingrained patterns of investor behaviour, adding that because these behavioural traits are set to continue into the future, value investing is set to provide good returns in the long run. In order to determine whether a share has value or a value premium, there are three major indicators to observe and analyse:

- Shares with a low price-earnings ratio.
- A low market value to book value ratio.
- Low price to cash flow ratio (Otuteye & Siddiquee, 2014).

Furthermore, Chan and Lakonishok (2004) noted that academic literature mainly refers to book value to market value of equity (BV/MV) when identifying value shares. This method of identification was also supported by Fraser and Page (2000).

Menchero et al. (2012) noted that there is a firm belief among financial practitioners that value shares outperform growth shares. This was supported by Graham and Uliana (2001) in their study of the value-growth phenomena on the JSE, when they found that post 1992, growth shares were outperformed by value shares. Furthermore, Otuteye and Siddiquee (2014) stated that there is a large amount of evidence indicating that value investing as an investment strategy outperforms all other investment styles currently in use. Additionally, Fraser and Page (2000), in their study of value shares on the JSE, found that value strategies based on BV/MV enable the prediction of returns one month into the future, which allows increased exposure to those stocks set to improve in the coming month.

However, caution must be applied, as certain shares that might seem to be value shares due to them being undervalued in the marketplace might be well priced for a good reason. As noted by Otuteye and Siddiquee (2014), “Value Traps” exist where low priced shares are depressed due to the company being in financial distress and at the point of failure. Some of this risk should, however, be mitigated by the fact that only the shares within the Top 40 Index (J200) on the JSE (indicating that they are substantially sized and robust businesses) were used in this study, thus finding an undervalued share in this Index should be exactly that, and not a failing company.

2.7 Liquidity

The more often a stock is traded, the more liquid that share is considered to be. Stock turnover is thus a good measure of liquidity, and liquidity is noted to be negatively correlated with the long term positive returns of shares. Thus, if a share is less liquid, it has a higher probability of providing a positive return in the long term (Ibbotson, Chen, Kim, & Hu, 2013). This was also supported by Payne, Rutherford and Sadler (2016), who noted that there is a positive relationship between low enterprise value and high liquidity. Again, this indicates that less liquid shares would be expected to perform better than more liquid shares.

Reasons as to why less liquid shares provide better returns was provided by Idzorek, Xiong and Ibbotson (2012, p. 38), when they noted that:

> "The generally accepted rationale for a liquidity premium is that all else equal, investors prefer greater liquidity; thus, in order to induce investors to hold less liquid assets, they must have the expectation (but not the guarantee) of a return premium."

However, a concern was noted in that with less liquid shares being given preference due to the liquidity premium present, the trading of these shares in order to effectively include (buy) and exclude (sell) them from a portfolio might be a constraint. The fact that these shares might not trade as easily as their more liquid counterparts adds to the trading costs involved with the rebalancing of portfolios. This notion was supported by Ibbotson et al. (2013), when they noted that, "Less liquidity comes with costs: It takes longer to trade less liquid stocks, and the transaction costs tend to be higher" (p. 41).

Building on the above discussion, Cao, Chen, Liang and Lo (2013) conducted a study to determine whether hedge fund managers specifically time the market based on liquidity. They found that these managers adjust their equity exposure in order to have more (less) exposure when the market conduction are more (less) liquid, thus indicating the value of trading in liquid shares, especially for funds with very dynamic portfolio adjustments and regular rebalancing. Furthermore, Cao et al. (2013) found that hedge funds that achieved high market liquidity timing attained 4% - 5.5% higher returns per annum than the funds that did not time their exposure based on liquidity.

It should be noted, however, that due to the fact that this study used the JSE's J200 shares as the sample pool, the concerns noted above would not necessarily be valid as

the Top 40 shares on the JSE would be well traded. That is not to say that these shares would not have different liquidity levels, as they would, however the difference would only be marginal. Yet, if this same study would be applied to an out of sample population of shares, such as all the shares traded on the JSE, this would include shares with very low liquidity. The impact of this would be significant and would thus need to be compensated for.

2.8 Cash Flow/Price

The importance of sufficient cash flow is a known reality in the business environment in which organisations operate today. Cash flow is the lifeblood of any business, and the amount of cash flow, or lack thereof, may indicate the general 'health' of an organisation.

The above-mentioned appears to be the case with companies listed on the JSE as well. Muller and Ward (2013) found that using cash flow/price as an investment style produced a 10.1% premium per annum above the benchmark used in their study, which was the JSE All Share Index over the same period. However, some may argue that excess cash should be paid out as dividends (Conover, Jensen, & Simpson, 2016), thus increasing the dividend yield and so the total return of the share.

This study used total return data as well as cash flow/price ratios when predicting the returns generated by a specific share. In this way, the research theoretically obtained the best of both between regular and significant dividend payments and positive and substantial cash flows, vs. the price per share.

2.9 Size

As mentioned in previous sections of this thesis, the size of an organisation, or in other terms the market capitalisation (market map) of a company on the stock exchange, indicates stability and resilience to adverse market conditions. However, the literature suggests that a size effect exists and that smaller companies outperform larger ones due this effect (Strugnell, Gilbert, & Kruger, 2011). This was supported by Van Rensburg and Robertson (2003), who concluded that small sized companies earned higher returns and had a lower beta than large companies. Thus, it may be inferred that even within an Index such as the J200, the smaller shares - by capitalisation - would outperform the larger shares, even if only marginally.

However, some research has also noted that the market favours different size types at different periods (Menchero et al., 2012). This indicates that small firms might be popular at a certain point in time, but as the popularity of these smaller shares becomes greater, their share prices would increase. This leads to an overvaluation of the smaller firms, at which point investors might move back to other size stratifications. This uncertain benefit proposed by the size effect to one specific size grouping of shares was confirmed by Muller and Ward (2013), when they found no significant difference in returns among 300 shares grouped into size specific portfolios (descending) of 10 shares each.

Considering the information above, evidence for and against the size effect exists. However, due to there being no clear consensus found, the size investment style was tested in this research by allocating a higher return to the smallest market cap shares.

2.10 Summary of literature review

This section has discussed the theoretical base of the MPSM, including frameworks that were based on the theoretical platform provided by Markowitz (1952), as well as the practical application of the model and computational shortcuts. The shortcomings of this model, as well as the shortcomings of the EMT which underpins this model, were also described. This indicates the need for an amendment, adjustment and/or supplementation of the EMT, and subsequently the MPSM, to ensure the continued usability of these concepts in a modern, dynamic and irrational market.

Furthermore, different investment styles were assessed, focusing on how they affect market efficiency and how they will be used to predict returns and support, and/or enhance the MPSM. Each style was evaluated, noting the positive and negative aspects of each, as well as how some of them have been applied in studies similar to this one.

Lastly, to conclude this chapter, the combination of the MPSM and different investment styles has been noted. The strengths and weaknesses of each of the different investment approaches (style and MPSM) were demonstrated, with some evidence being found to indicate the complementary nature of the two. The benefits of having potential returns generated by different investment styles risk-adjusted are thus clear, which sets the foundation of this study.

Chapter 3: Hypotheses

In the previous chapter, the use and theoretical background of the MSPM were discussed. The principle that the market is not efficient and investors are not rational was explored, and the applicability and effectiveness of the MPSM as a passive investment strategy was called into question.

It was noted that some of the market inefficiency is caused by style investment strategies that have been growing in popularity. This growth in popularity is not only due to investors trying to simplify investment strategy, but also the above average returns generated by using investment styles as an investment strategy (Barroso & Santa-Clara, 2015; Cao et al., 2013; Graham & Uliana, 2001; Jegadeesh & Titman, 1993; Menchero et al., 2012; Muller & Ward, 2013).

The combination of the MPSM and the style investment strategies are proposed to provide enhanced and risk-adjusted returns, thus the following hypothesis was set:

3.1 Hypothesis 1

H0 (null): Investment styles do not enhance the risk-adjusted returns generated by applying the MPSM.

However, the question of which style combined with the MPSM provides the highest return may also be posed. Evidence would suggest that these styles do result in different returns, thus a second hypothesis was set:

3.2 Hypothesis 2

H0 (null): Different investment styles provide different risk-adjusted returns when applied with the MPSM.

In the following chapter, the research method will be detailed. In addition, a guide to how the above-mentioned hypotheses were tested and the results are presented.

Chapter 4: Research Method

4.1 Introduction

Within this section, the various study method design choices are noted and justified. As far as possible the method choices were based on literature, however certain approaches are new due to the nature of the study and the hypotheses set. The research method has been designed to ensure that the hypotheses are clearly and comprehensively tested.

4.2 Choice of methodology

This research study is quantitative in nature as it concerns the quantities or amounts of the variables of interest and not the qualities or characteristics of these variables (Leedy & Ormrod, 2010, p. 94). Furthermore, due to this study being only quantitative, the study is a mono method study.

4.3 Population

The population of this study consisted of Top 40 Index (J200) companies on the JSE, for a ten-year period from 1 January 2006 – 1 January 2016. Shares that were listed or delisted in that period were included or excluded from the population to prevent survivor bias. This is in line with a similar approach followed by Muller and Ward (2010). Out of sample data were also used to obtain a six-month lead-in period in order to calculate the covariance, ‘six-month return’ and momentum of the shares within the J200 as at the start date of 1 January 2006.

4.4 Unit of analysis

The unit of analysis for this research study was individual shares within the J200 on the JSE over the ten-year period. This characterisation was in line with the definition noted by Welman, Kruger and Mitchell (2005).

4.5 Sampling method and size

For this study, the sampling method consisted of non-probability quota sampling. Blanche, Durrheim and Painter (2012) noted that non-probability sampling is sampling that does not use randomness as a selection criterion. Similar to Du Plessis and Ward (2009), the sample of this study consisted of companies listed on the J200 Index. The sample was retrieved from Thomson Reuters (2017) and INET (2017).

Furthermore, support data such as the constituents within the J200 for a specific period were downloaded and recorded. This constituted quota sampling, as sampling occurred until the J200 Index's shares in the given month were selected over the ten-year period.

4.6 Data gathering process

Secondary data, in the form of monthly closing prices, returns and dividend payments over the ten-year period for the Top 40 shares, were extracted. The total return for a specific share over a specific period was calculated by first determining the price return over the period. The following formula was used:

$$PR_p = Ln\left(\frac{SP_p}{SP_{P-1}}\right)$$

Where:

PR_p = Price Return for the period

Ln = Natural Log

SP_p = Current Share Price

SP_{P-1} = Share Price from previous period

Secondly, the dividend payments were included into the price return. All dividends were considered reinvested at the share price at date of payment. The resulting figure was named the Calculated Total Return (CTR).

In order to ensure data quality, the CTR was compared to the Total Return Index (TRI) retrieved from Thomson Reuters (2017) over the same period. Due to the fact that the TRI does not include delisted shares and some survivor bias exists, only the available shares were compared. Suspected outliers in the CTR were replaced with values from the TRI, and the resulting blended total return data set was considered to be more

accurate and reliable than the two sources separately. Subsequently, two equally weighted portfolios containing the same 15 shares were generated from the CTR and the TRI. The reason for this was that if the return data from both the subsets are similar or the same, the returns generated from the two equally weighted portfolios shall be the same or similar. This similarity is easily observed graphically and by means of a relative line, which is the result from dividing one portfolio's return by the other and plotting it over the period in question. The returns generated from these two portfolios will be noted and compared in the next chapter.

In addition, the following information concerning the different style types were sourced from Thomson Reuters (2017) and INET (2017):

- **Value style –** The result obtained by dividing the market price per share by the book equity value per share was used to determine the value of a share at a specific period of time. The lower the resulting ratio value, the more value the share was considered to have.

- **Liquidity style** – The value traded of a specific share within a month, divided by the market capitalisation of the share, was used to determine its liquidity. The higher the resulting figure, the higher the liquidity was considered to be, however lower liquidity provides better returns. For this reason this style would be inversely ranked, which is in line with the findings of Muller and Ward (2013).

- **Cash Flow style** – The cash flow of the company in question, divided by the price of the share, was used to determine the cash flow of the share. The higher the ratio value, the higher the cash flow of the share was considered to be.

- **Market Capitalisation style** – The share price multiplied by the number of shares issued resulted in the market cap of the share. The higher the value, the larger the share's market cap.

- **Momentum style** – The average return for the past six months was used to determine the momentum of the shares. This was in line with the positive returns generated by the method when tested by Menchero et al. (2012).

Data sets were exported to Microsoft Excel, with some formatting taking place to convert the data and labels from the various formats into workable matrices. However, while formatting the dataset mentioned above, certain information had to be considered. Name changes and acquisitions were adjusted for with certain returns and ratios applied to share codes, which became redundant due to these events. An example of this is the name change of Mittal Steel South Africa to ArcelorMittal South Africa Limited (ACL).

Figure 2: ACL historic name change

NAME CHANGES	
Date	Organization Name
01-Oct-2006	ArcelorMittal South Africa Limited
09-Jun-1989	Mittal Steel South Africa

Source: Thomson Reuters (2017)

The share information for ACL preceding 1 October 2006 thus applied to Mittal Steel SA, and was used as such.

4.7 Analysis approach

Analysis of the data obtained was done using Microsoft Excel (Excel). Any visualisation of the results was processed by the same programme. In addition, programme add-ons such as Solver and JSE bulletin were used to optimise and reformat the various data sources and portfolios' share proportions, respectively.

As noted later in the section, portfolios were generated using the different style investment strategies to inform future return predictions. These predictions then formed part of the MPSM, where the returns were risk-adjusted in order to select the "best" shares, which would constitute the portfolio for the next six months. These portfolios were rebalanced every six months in line with a study conducted by Du Plessis and Ward (2009). In addition, the rebalancing period was influenced by the effect of the transaction costs associated with the rebalancing. The principle of transaction costs is detailed in later sections of this study.

The returns generated by using the various styles in conjunction with the MPSM, as well as the returns generated by the MPSM without style influence, were then compared. More detail concerning the analysis conducted follows in the next section.

4.8 Calculation, formatting and manipulation of subsets

Once all the data sets were collected and formatted, the analysis was initiated. Due to the fact that the portfolios generated in this study were rebalanced every six months, the covariance was calculated over the same number of months. A preceding period of six months of total return data was used to calculate the covariance of the shares listed on the J200 Index on a specific date (portfolio generation date or PGD). The covariance was calculated using the following formula within Excel:

=Resize(mCovariance($ATRJ200_{P\text{-}6m}$))

Where:
$ATRJ200_{P\text{-}6m}$ = the array of total monthly returns for shares within the J200, during a period of six months preceding the portfolio generation date.

The “mCovariance” function provided a method to relate one share’s returns within the array to all the other eligible shares’ returns within the prescribed six-month period. This function is presented below:

Figure 3: mCovariance, VBA code

```
Public Function mCovariance(data As Range)
    ' Array formula
    ' Covariance matrix
    ' Columns of variables' data
    Dim i As Long
    Dim j As Long
    Dim matrix() As Double

    ReDim matrix(1 To data.Rows.Count, 1 To data.Rows.Count)

    For i = 1 To data.Rows.Count
        For j = 1 To data.Rows.Count
            matrix(i, j) = Application.WorksheetFunction.Covar(data.Rows(i), _
                                                data.Rows(j))
        Next j
    Next i

    mCovariance = matrix
End Function
```

Source: Muller (2017)

Shares within the J200 that did not have a full six months’ worth of returns were excluded from the portfolio. The covariance of each share indicated the relationship of each share’s returns relative to the market’s (other J200 shares within a specific array) returns. The covariance matrices were labelled for use in the MPSM on each specific portfolio

generation date. A share's covariance vs. the market indicates the volatility of the share's return. Thus, as per the MPSM, the volatility indicated the risk of the share.

The style ratios were converted into functions that could be used in the MPSM (a forecasted return). This was done be ranking the shares according to their respective ratios from the highest to the lowest. An expected return based on a study commissioned by Peregrine Securities (Flint, Seymour, & Chikurunhe, 2016), as well as a study conducted by Muller and Ward (2013) in which they critically examined different investment styles on the JSE, was then applied. The expected returns used are listed below:

Table 1: Expected returns per style

Style	Highest return	Style	Lowest return
High Value	24.9%	Low Value	13%
Low Liquidity	22.9%	High Liquidity	13.1%
High Cash Flow	24.5%	Low Cash Flow	13.1%
Low Market Cap	4.61%	High Market Cap	-7.63%
High Momentum	26.1%	Low Momentum	6.4%

Source: Flint, Seymour and Chikurunhe (2016, p. 10), Muller and Ward (2013, p. 81)

It is important to note that the Low Market Cap return range is based on excess and deficit returns, while the other style ranges are based on actual returns achieved. This does not limit its usability, but it is important to provide clarity between the different sources used.

The expected returns for each style were distributed across the eligible shares, with the highest style-ranking share receiving the highest expected return value, and the lowest style-ranking share receiving the lowest return value. The shares in between the lowest and highest ranking would receive a return fraction proportional to their ranking.

Thus, the higher the ratio amount, the higher the ranking and the larger the fraction of the expected return allocated. Therefore, a higher ratio was interpreted by the model as a higher forecasted return for that period. Furthermore, it can be stated that in these circumstances, the more a share conforms to a specific style, the higher its expected return would be.

However, due to lower returns being inherent to higher liquidity, as suggested by Ibbotson, Chen, Kim and Hu (2013), this ratio was ranked inversely, with the highest ratio amount obtaining the lowest return and the lowest obtaining the full expected return. The shares in between were again allocated a fractional return based on their ranking.

Market capitalisation data, although not a ratio, were ranked, and an expected return was added similar to the process followed above. The smallest market cap share was allocated with the highest return, in line with the research findings of Strugnell et al. (2011) and Van Rensburg and Robertson (2003).

Furthermore, with regards to the non-style influenced MPMS, as proposed by its alternative name, the mean variance model; the mean return for the past six months was used as the predicted return for the period to come.

In Table 2 below, an example of this rank and return allocation for the Value style is displayed.

Table 2: Value style - rank and return allocation

	Share code	Value	Rank	Expected return
High	AGL	0,76	1,00	24,90%
24,90%	BVT	0,79	2,00	24,59%
Low	REI	0,89	3,00	24,29%
13,00%	ITU	0,90	4,00	23,98%
	GRT	1,15	5,00	23,68%
	BIL	1,31	6,00	23,37%
	ANG	1,32	7,00	23,07%
	OML	1,34	8,00	22,76%
	INL	1,38	9,00	22,46%
	INP	1,45	10,00	22,15%
	AMS	1,45	11,00	21,85%
	CCO	1,45	12,00	21,54%
	SHF	1,60	13,00	21,24%
	SOL	1,65	14,00	20,93%
	NED	1,68	15,00	20,63%
	SBK	1,80	16,00	20,32%
	BGA	1,87	17,00	20,02%
	REM	1,91	18,00	19,71%
	KIO	2,33	19,00	19,41%
	MNP	2,70	20,00	19,10%
	RMH	2,85	21,00	18,80%
	CFR	2,87	22,00	18,49%
	SLM	2,89	23,00	18,19%
	MTN	3,24	24,00	17,88%
	FSR	3,37	25,00	17,58%

Share code	Value	Rank	Expected return
DSY	3,62	26,00	17,27%
MND	3,63	27,00	16,97%
SAB	3,66	28,00	16,66%
TBS	3,79	29,00	16,36%
RMI	3,87	30,00	16,05%
SHP	5,08	31,00	15,75%
NTC	5,34	32,00	15,44%
APN	5,34	33,00	15,14%
WHL	6,54	34,00	14,83%
NPN	8,84	35,00	14,53%
VOD	9,59	36,00	14,22%
BTI	11,55	37,00	13,92%
MDC	13,18	38,00	13,61%
MPC	13,18	38,00	13,61%

4.9 Generation of portfolios and calculation of returns

Once each style's return forecasts (every six months) and the covariance matrices were populated, portfolios were generated. These portfolios were re-adjusted every six months for a period of ten years. Thus, 20 portfolio adjustments were made for each style, and the returns were calculated after each rebalancing and accumulated over the period of ten years.

One set of portfolios was generated with a maximum allowable weighting per share of 5%, and a second set of portfolios at 10%. This was done to indicate the effect that would be present if fewer, larger weightings were used (less diversification) or more, smaller weightings were used (more diversification).

Furthermore, transaction costs (TC) were deducted when re-adjusting the portfolios at an average rate of 2% of the value traded, accounting for the brokerage, taxes and market impact costs. Due to the transaction costs and to keep the portfolio selection model as practical and implementable as possible, readjustment took place every six months; reducing the readjustment period would have increased the effect that the transaction costs had. Considering that a portfolio would need to have to return at least 2% every six months in order to account for the transaction costs applicable (if the full value of the portfolio trades), a three-month rebalancing period or shorter was rejected.

Studies conducted by Hjalmarsson and Manchev (2012), Elze (2012) as well as Van Rensburg and Robertson (2003) did not account for any transaction costs, however considering the impact that an average transaction cost of 2% of the amount traded

during rebalancing would have on the performance of a portfolio, the inclusion of transaction costs was deemed to be necessary in order to ensure actual market replicability. This was supported by Asness, Moskowitz and Pedersen (2013, p. 976), who stated that:

"Korajczyk and Sadka (2004) and Lesmond, Schill and Zhou (2004) argue that the real world returns and capacity of equity momentum strategies are considerably lower than the theoretical results would imply. Their conclusions are based on aggregate trade data and theoretical models of transactions costs."

In order to determine which shares from the J200 would be included into the portfolios at a specific PGD, the style influenced predicted returns were risk-adjusted and the shares with the highest risk-adjusted returns were proportionally weighted into the portfolio. To facilitate the selection process, the Sharpe ratio was used:

$$Sp = \frac{(E(r_p) - r_f)}{\sigma_p}$$

Where:

Sp = Sharpe ratio of portfolio "p"

$\mathrm{E}(\mathrm{r_p})$ = Expected/predicted returns of portfolio "p"

r_f = Return of the risk-free asset

And σ_p = the standard deviation of the returns of portfolio "p"

Source: Du Plessis And Ward (2009, p. 42)

The risk-free rate for the period was subtracted from the portfolio's predicted return, and then divided by the standard deviation of the selected portfolio. The standard deviation was derived and calculated using the covariance array for the specific six-month period, factored by the share proportions within the portfolio. Thus, lower volatility shares would adjust (decrease) the predicted return less than highly volatile shares.

The proportions of the shares within a specific portfolio were determined by using the Solver function in Excel. The following parameters were coded into Visual Basic for Applications (VBA) in order to facilitate the application of the Solver function across multiple periods and portfolios:

Figure 4: SolverMarco, VBA code

```
Sub SolverMacro1()
'
' SolverMacro1 Macro
' Macro recorded by Shaun Smith
'
    SolverReset
    SolverOk SetCell:="$AY$3", MaxMinVal:=1, ValueOf:="0", ByChange:="W1_"
    SolverAdd CellRef:="W1_", Relation:=3, FormulaText:="Lower"
    SolverAdd CellRef:="W1_", Relation:=1, FormulaText:="Upper"
    SolverAdd CellRef:="$AU$3", Relation:=2, FormulaText:="100%"
    SolverOptions MaxTime:=0, Iterations:=0, Precision:=0.000001, Convergence:= _
        0.0001, StepThru:=False, Scaling:=True, AssumeNonNeg:=False, Derivatives:=1
    SolverOptions PopulationSize:=100, RandomSeed:=0, MutationRate:=0.075, Multistart _
        :=False, RequireBounds:=True, MaxSubproblems:=0, MaxIntegerSols:=0, _
        IntTolerance:=1, SolveWithout:=False, MaxTimeNoImp:=30
    SolverSolve
End Sub
```

By setting the Solver function to optimise the Sharpe ratio by changing the proportions of shares within the portfolio, the most efficient portfolio for a specific period was selected. This was due to the Sharpe ratio using the return forecast and covariance matrix (standard deviation) information factored by the share proportions to determine the risk-adjusted return of the portfolio. The highest return at the lowest level of volatility (risk) would provide an efficient portfolio.

The returns generated by these portfolios were then calculated using the total returns data for each six-month period in question. Once calculated, these portfolio returns (unitised) were graphically represented against each other (difference in styles) and against the MPSM's returns (without style influence). This was to determine whether a significant difference exists in the returns achieved over the ten-year period.

Furthermore, as benchmarks, the returns for the risk-free rate (at 8.5% per annum, reinvested biannually), J200 Total Return Index, an equal weighted portfolio and market cap weighted portfolio were included into the graphical representations. The J200 Total Return Index was presented without and with a management fee (MC) of 0.5% per annum, applied semi-annually. Due to the practical nature of this study a management fee relative to a Top 40 ETF (exchange traded fund) was deemed necessary.

In some cases, portfolios were also generated with the risk adjustment portion, which the MPSM provides, removed. This was done to indicate the influence the risk adjustment process has on portfolio generation and the subsequent returns. The returns generated by these means were also graphically represented.

4.10 Summary of Research Method

In this chapter, the method implemented to test the hypotheses selected has been detailed. The quantitative nature of this study, using secondary data from various platforms and data sources in order to construct efficient portfolios over a ten-year period, was noted. Specific reference was made to similar studies with alignment and misalignment in methodology noted. Important considerations and method parameters were discussed and defended, such as the rebalancing of the portfolios every six months and the subtraction of transaction costs against the portfolio returns generated. Graphical representation was noted as the indicator of the difference in portfolio returns between the different investment styles as well as the non-style influence MSPM.

In the following chapters, the results obtained from this method will be presented, discussed and eventually concluded on.

Chapter 5: Results

In the previous chapter the research method was detailed, discussed and defended. In this chapter, the results achieved from applying the research method will be presented. Certain results relative to the method will also be presented, supporting the decisions made. Most of the results in this section are graphical, as it is deemed the clearest and most concise way to communicate the results achieved.

Benchmark portfolios such as the Top 40 Index (J200) total return, equal weighted and market cap weighted portfolios are included in the various graphs in order to relate them to the achieved style influenced and no style influenced returns. Furthermore, the risk-free rate of 8.5% per annum reinvested semi-annually was also included.

5.1 Top 40 (J200) constituents

As stated in the previous chapter, certain shares entered or exited the J200 Index during the time period tested. In addition, certain shares were listed, delisted and renamed during this period, thus all these movements had to be considered and adjusted for.

Controlling for all the factors listed above, a total of 78 shares were eligible in the Index over the ten-year period. These shares are listed below:

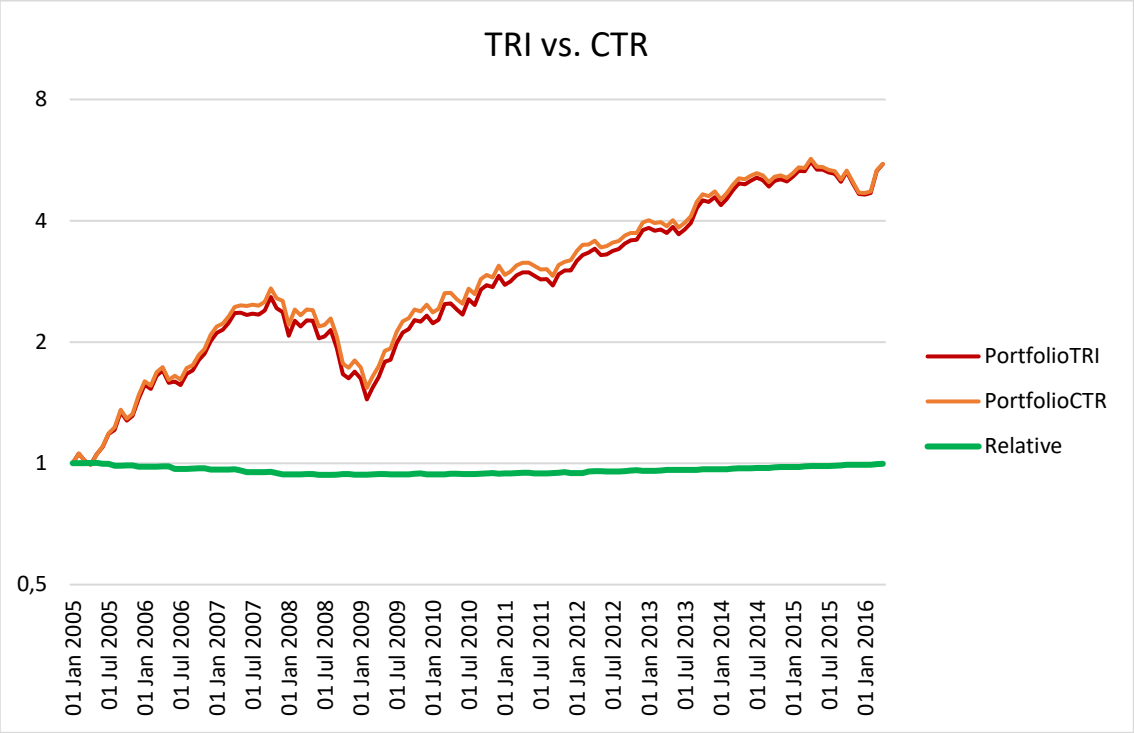
Table 3: Eligible shares over the ten-year period

Code	Name	Code	Name	Code	Name	Code	Name
ASA	Absa Bank Ltd	DSY	Discovery Ltd	MSM	Massmart Holdings Ltd	REI	Reinet Investments S.C.A
ABL	African Bank Inv Ltd	ECO	Edgars Consolidated Stores Ltd	MEI	Mediclinic Int Plc	REM	Remgro Ltd
ARI	African Rainbow Min Ltd	EXX	Exxaro Resources Ltd	MDC	Mediclinic International Ltd	RLO	Reunert Ltd
AMS	Anglo American Plat Ltd	FSR	Firstrand Ltd	MLA	Mittal Steel Sa	RCH	Richemont Sa
AGL	Anglo American Plc	FFA	Fortress Inc Fund Ltd A	MMI	Mmi Holdings Limited	RMH	Rmb Holdings Ltd
ANG	Anglogold Ashanti Ltd	FFB	Fortress Inc Fund Ltd B	MND	Mondi Ltd	SAB	Sabmiller Plc
ACL	Arcelormittal Sa Limited	GFI	Gold Fields Ltd	MNP	Mondi Plc	SLM	Sanlam Limited
APN	Aspen Pharmacare Hldgs Ltd	GRT	Growthpoint Prop Ltd	MRP	Mr Price Group Ltd	SAP	Sappi Ltd
ASR	Assore Ltd	HAR	Harmony Gm Co Ltd	MPC	Mr Price Ltd	SOL	Sasol Limited
AEG	Aveng Group Limited	IMP	Impala Platinum Hlgs Ltd	MTN	Mtn Group Ltd	SHP	Shoprite Holdings Ltd
BGA	Barclays Africa Grp Ltd	IPL	Imperial Holdings Ltd	MUR	Murray & Roberts Hldgs	SBK	Standard Bank Group Ltd
BAW	Barloworld Ltd	ITU	Intu Properties Plc	NPN	Naspers Ltd -N-	SNH	Steinhoff Int Hldgs N.V.
BIL	Bhp Billiton Plc	INL	Investec Ltd	NED	Nedbank Group Ltd	SHF	Steinhoff International Holdings Ltd
BVT	Bidvest Ltd	INP	Investec Plc	NTC	Netcare Limited	TKG	Telkom Sa Soc Ltd
BAT	Brait Se	KIO	Kumba Iron Ore Ltd	OML	Old Mutual Plc	TBS	Tiger Brands Ltd
BTI	British American Tob Plc	LGL	Liberty Group Ltd	PIK	Pick N Pay Stores Ltd	TRU	Truworths Int Ltd
CSO	Capital Shopping Centres Group Plc	LBH	Liberty Holdings Ltd	PPC	Ppc Limited	VOD	Vodacom Group Ltd
CCO	Capital&Counties Prop Plc	LBT	Liberty International Plc	PSG	Psg Group Ltd	WHL	Woolworths Holdings Ltd
CPI	Capitec Bank Hldgs Ltd	LHC	Life Healthc Grp Hldgs Ltd	RMI	Rand Merchant Inv Hldgs Ltd		
CFR	Compagnie Fin Richemont	LON	Lonmin Plc	RDF	Redefine Properties Ltd		

5.2 TRI/CTR

As described in the previous section, the Total Return Index was compared against the calculated total returns to ensure the data's validity and accuracy. A relative line has been included, which is derived from dividing the returns from the TRI's equally weighted portfolio by the returns from the CTR's equally weighted portfolio.

Figure 5: Return Graph - TRI/CTR comparison with relative line



The relative line in the graph above is especially important, as it indicates the difference between the portfolios generated using the two data sets. It is observed that the line is mostly straight at around 1, and even though there was a slight deviation away from 1 from 2007 to 2012, the fit is still very close thus the data are deemed accurate.

5.3 Portfolio returns – No transaction costs included

Seen below, the returns generated through the various styles and benchmarks are graphically represented. Parameters such as a '5% maximum weighting per share' as well as 'no transaction costs deducted' apply.

Figure 6: Return Graph - 5% max per share in portfolio, no TC

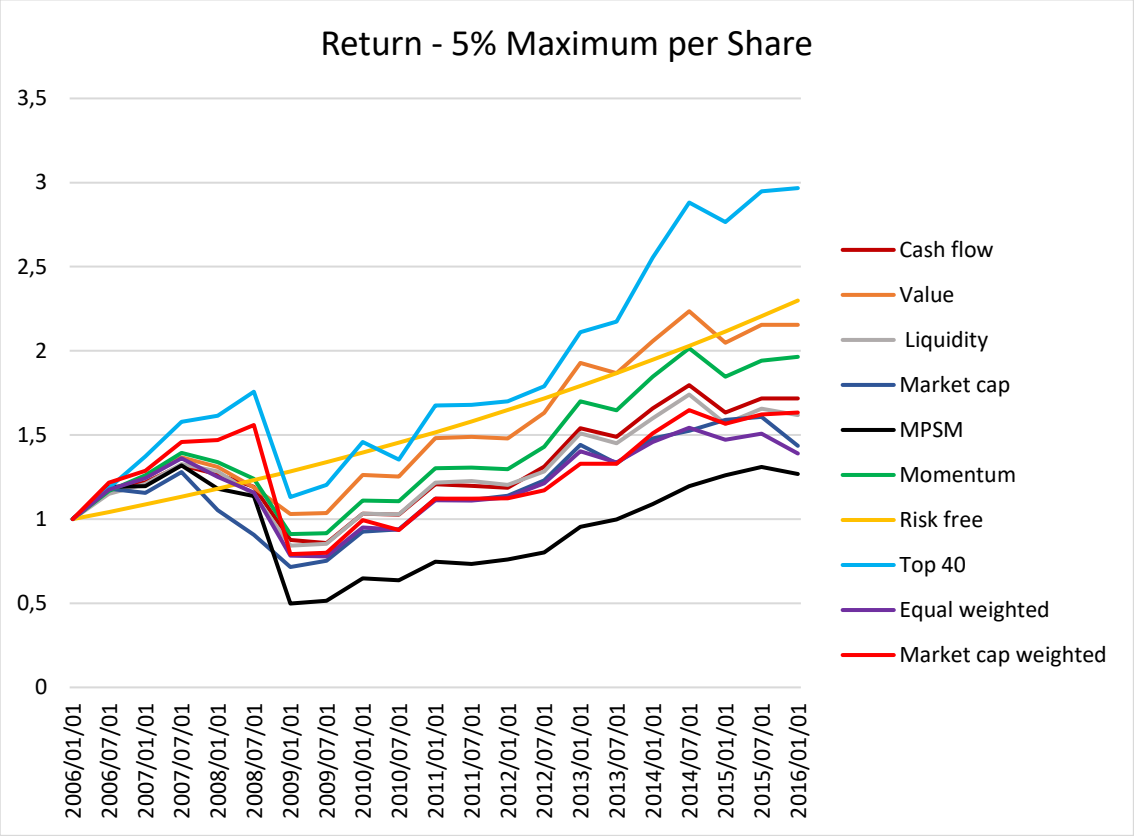


Table 4: Return Table - 5% max per share in portfolio, no TC

5% max per share in portfolio, no TC	
Type	**10-year Return**
Cash flow	72%
Value	115%
Liquidity	62%
Market cap	44%
MPSM	27%
Momentum	97%
Risk Free	130%
Top 40	197%
Equal weighted	39%
Market cap weighted	63%

As noted in Figure 6, the Value style has the highest return amongst the styles at 115% over the ten-year period. The non-style influenced MPSM has the lowest return at only 27%.

In Figure 7 below, parameters such as a '10% maximum weighting per share' as well as 'no transaction costs deducted' apply. The use of a 10% maximum per share reduces diversification of the portfolios, thus increasing the risk.

Figure 7: Return Graph - 10% max per share in portfolio, no TC

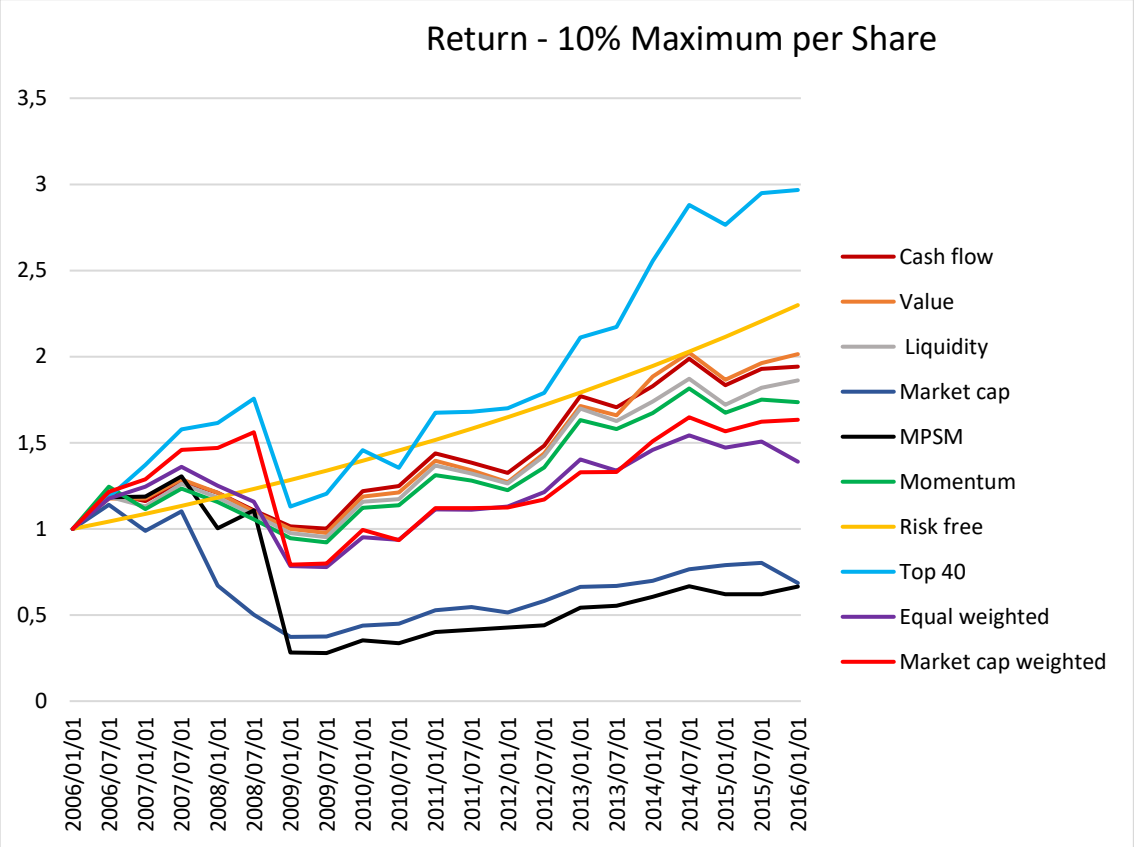


Table 5: Return Table - 10% max per share in portfolio, no TC

10% max per share in portfolio, no TC	
Type	**10-year Return**
Cash flow	94%
Value	101%
Liquidity	86%
Market cap	-31%
MPSM	-33%
Momentum	73%
Risk Free	130%
Top 40	197%
Equal weighted	39%
Market cap weighted	63%

As noted in Figure 7, the Value style has the highest return amongst the styles at 101%, over the ten-year period. The non-style influenced MPSM has the lowest and a negative return of -33%.

5.4 Portfolio returns – Transaction costs included

As indicated below, parameters such as a '5% maximum weighting per share' as well as 'transaction costs deducted' apply.

Figure 8: Return Graph - 5% max per share in portfolio, TC included

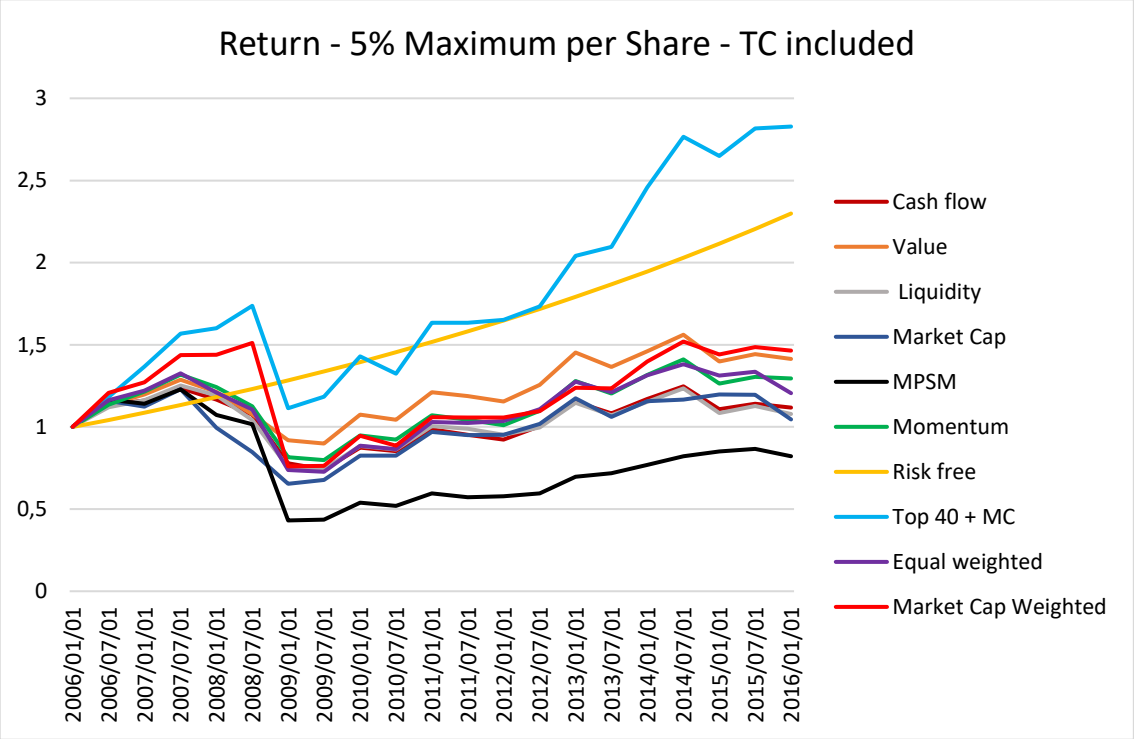


Table 6: Return Table - 5% max per share in portfolio, TC included

5% max per share in portfolio, TC included	
Type	**10-year Return**
Cash flow	12%
Value	41%
Liquidity	8%
Market cap	5%
MPSM	-18%
Momentum	29%
Risk Free	0%
Top 40	183%
Equal weighted	21%
Market cap weighted	46%

The significant effect of the transaction costs is observed in Figure 8, with the Value style still being the leading style but with a ten-year return of only 41%. This is significantly lower than the return generated which were free from the any transaction costs (115%). The lowest return generated over the period in question is once again the non-style influenced MPSM at -18%.

In Figure 9 below, the returns generated through the various styles and benchmarks are graphically represented. Parameters such as a '10% maximum weighting per share' as well as 'transaction costs deducted' apply.

Figure 9: Return Graph - 10% max per share in portfolio, TC included

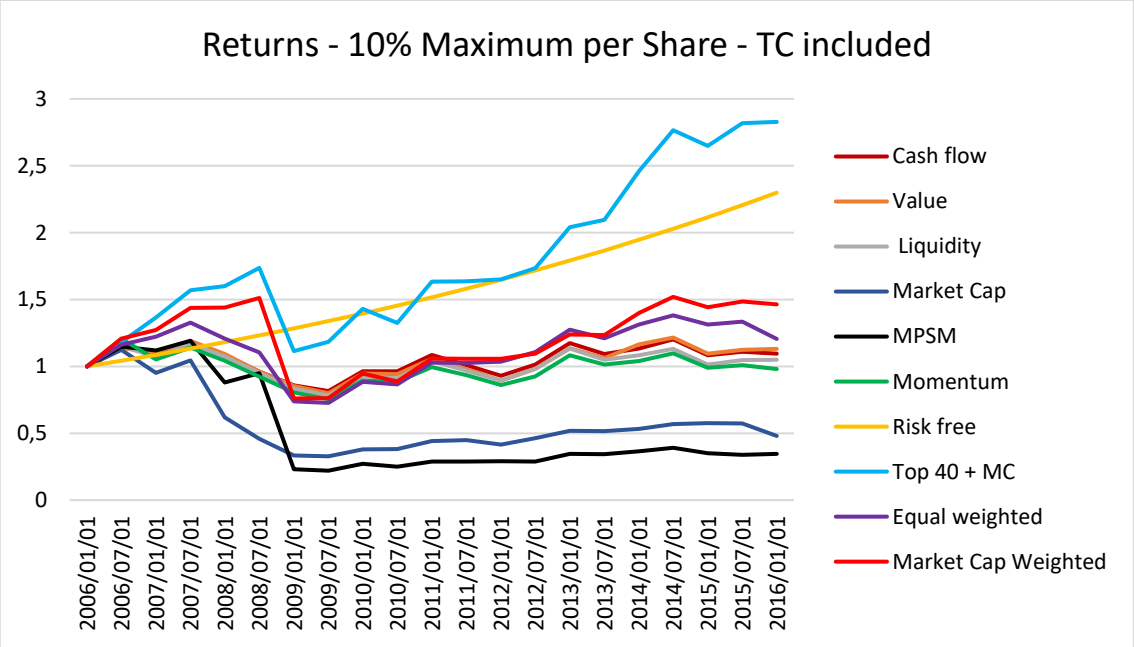


Table 7: Return Table - 10% max per share in portfolio, TC included

10% max per share in portfolio, TC included	
Type	**10-year Return**
Cash flow	9%
Value	13%
Liquidity	5%
Market cap	-52%
MPSM	-65%
Momentum	-2%
Risk Free	130%
Top 40	183%
Equal weighted	21%
Market cap weighted	46%

Similar to Figure 8, the transaction costs combined with less diversification (10% max per share) further reduce the highest style return observed. The Value style achieves a 13% return as noted in Figure 9. The non-style influenced MPSM delivers a -65% return.

The set of parameters applied to the portfolios represented in Figure 9 provided the lowest returns relative to the other three preceding portfolio groups presented in Figures 6-8.

5.5 Selected portfolio returns – risk adjustment (RA) removed

In Figure 10 presented below, the '5% maximum weighting per share' was applied to two selected styles. The selected styles consisted of the Value and Market cap styles. These styles were selected to be tested for in this manner, due to them representing the highest and lowest returns on average amongst all the styles tested. The two styles were tested for with risk adjustment applied through the MPSM process, and without risk adjustment. Thus, four different portfolios were generated amongst the two styles. The returns from these four portfolios are represented below in Figure 10.

Figure 10: Return Graph - 5% max per share in portfolio, risk adjustment removed

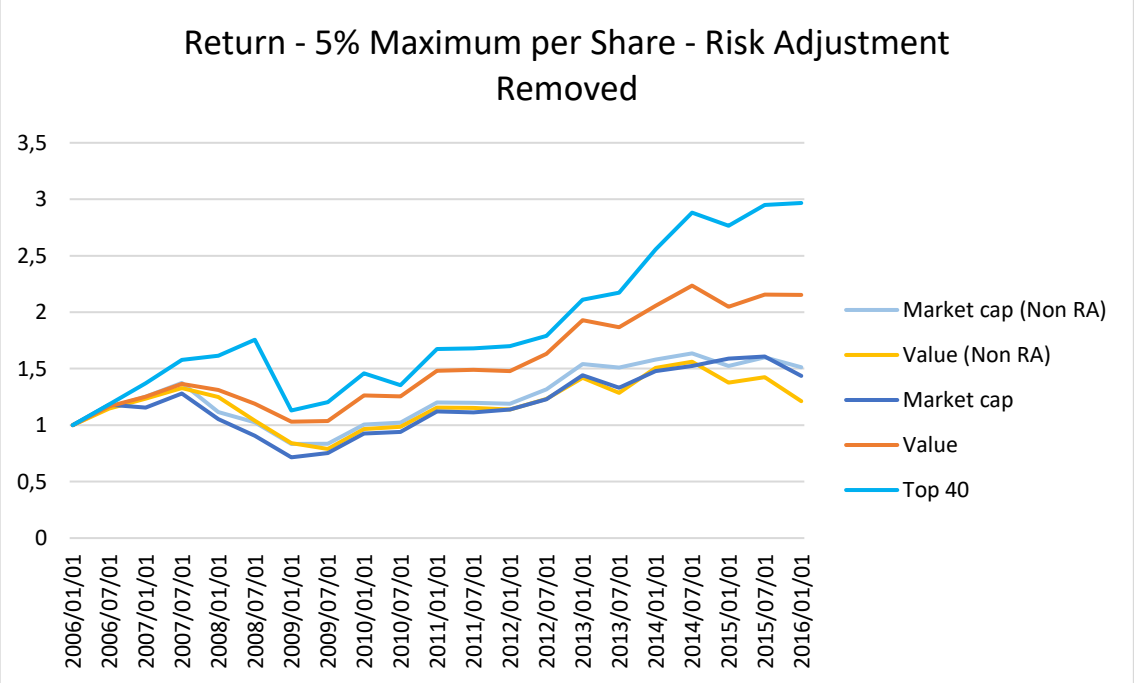


Table 8: Return Table - 5% max per share in portfolio, risk adjustment removed

5% max per share in portfolio, risk adjustment removed	
Type	**10-year Return**
Market cap (Non- RA)	51%
Value (Non- RA)	21%
Market cap	44%
Value	115%
Top 40	197%

As noted in Figure 10 above, the Value style, which achieved some of the highest returns, and the Market Cap style, which achieved some of the lowest returns, react differently to risk adjustment being removed from the portfolio generation method. The Value style is noted to benefit from the risk adjustment, whilst the Market Cap style returns indicate very little difference between risk adjustment being applied or not.

5.6 Portfolio returns – style specific

Five distinctive styles and a non-style influenced MPSM were tested and the returns, grouped per style, are presented below. These style-based portfolios, as was the case with earlier return presentations, were generated at a 5% and 10% maximum share weighting per portfolio, respectively, as well as with and without transaction costs included. These parameters resulted in four different portfolios being generated per style.

Furthermore, the portfolios generated were benchmarked against the J200's (Top 40 Index's) total returns. However, as previously indicated, to ensure that these results were as practical and applicable to a "real" scenario as possible, a management fee/cost (MC) was deducted from the return generated from the J200 Index (total return). This management fee, although only set at 0.5% per annum, was necessary, as any holding of the Index would be accompanied by an annual cost.

In Figure 11 below, the Cash Flow style portfolio returns are presented.

Figure 11: Return Graph – Cash Flow style

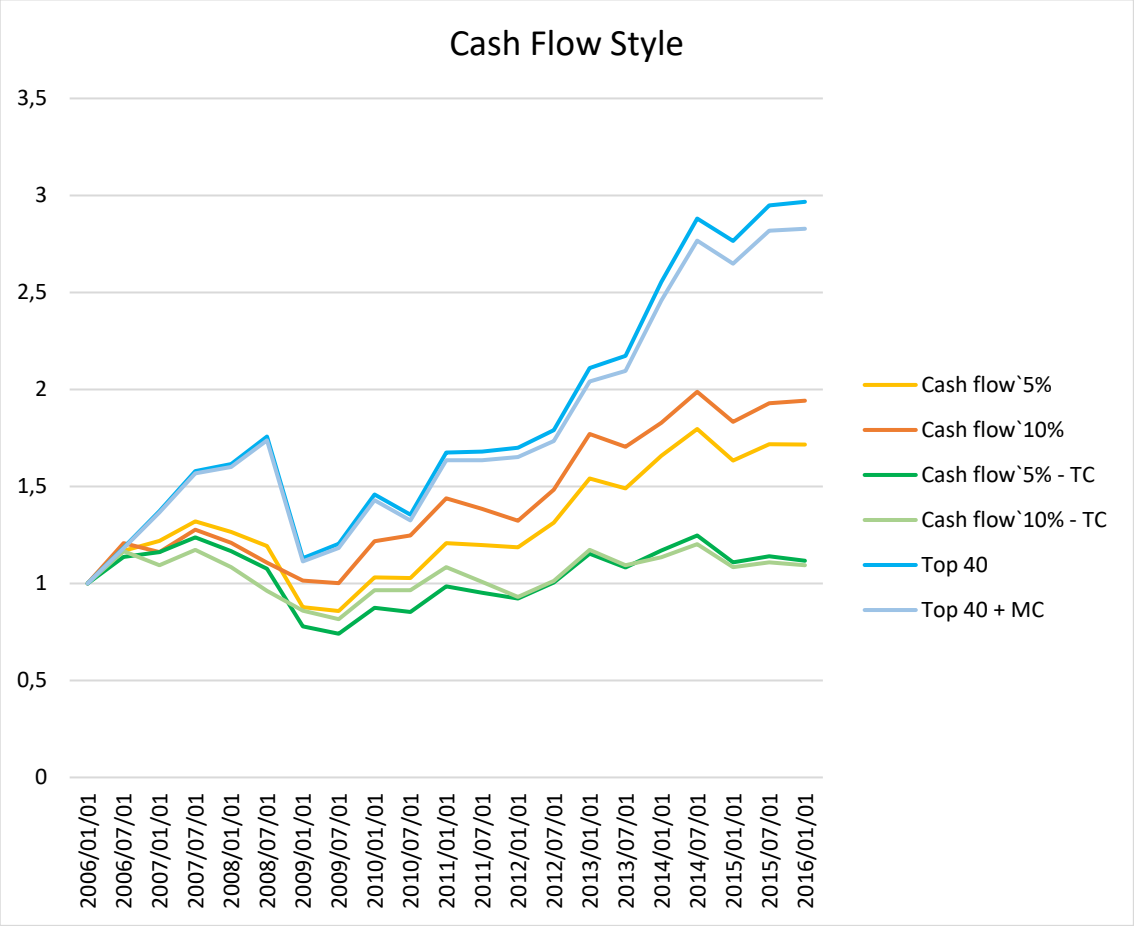


Table 9: Results Table - Cash Flow style

	5%	5% TC	10%	10% TC
Cash flow	72%	12%	94%	9%
	5%	**5% MC**	**10%**	**10% MC**
Top 40	197%	183%	197%	183%

From the results presented in Figure 11 and Table 9, it is noted that at '10% maximum weighting per share', the highest return was achieved (94%). However, if transaction costs are applied, '5% maximum weighting per share' outperforms its 10% counterpart, 12% vs. 9% respectively. The results achieved through the use of the Cash Flow style were still well below the benchmark.

In Figure 12 below, the Value style portfolio returns are presented. From previously presented results it may be stated that the Value style had one of the highest returns amongst all of the styles tested.

Figure 12: Return Graph - Value style

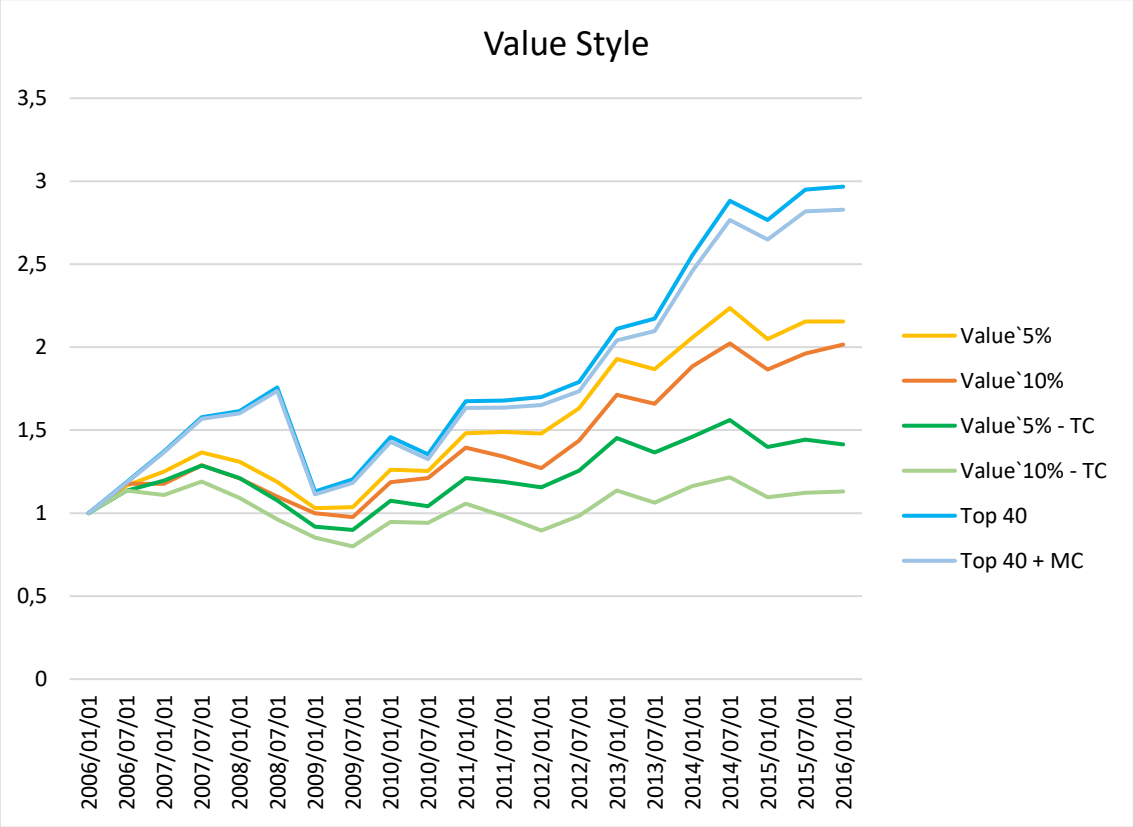


Table 10: Results Table - Value style

	5%	5% TC	10%	10% TC
Value	115%	41%	101%	13%
	5%	**5% MC**	**10%**	**10% MC**
Top 40	197%	183%	197%	183%

From the results presented in Figure 12 and Table 10, it is noted that at '5% maximum weighting per share', the highest return was achieved (115%). Furthermore, if transaction costs are applied, '5% maximum weighting per share' outperforms its 10% counterpart.

The Liquidity style portfolio returns are presented in Figure 13. The Liquidity style had an inverse return ranking methodology, as described earlier in the study, thus the lower the liquidity, the higher the expected and allocated return was.

Figure 13: Return Graph - Liquidity style

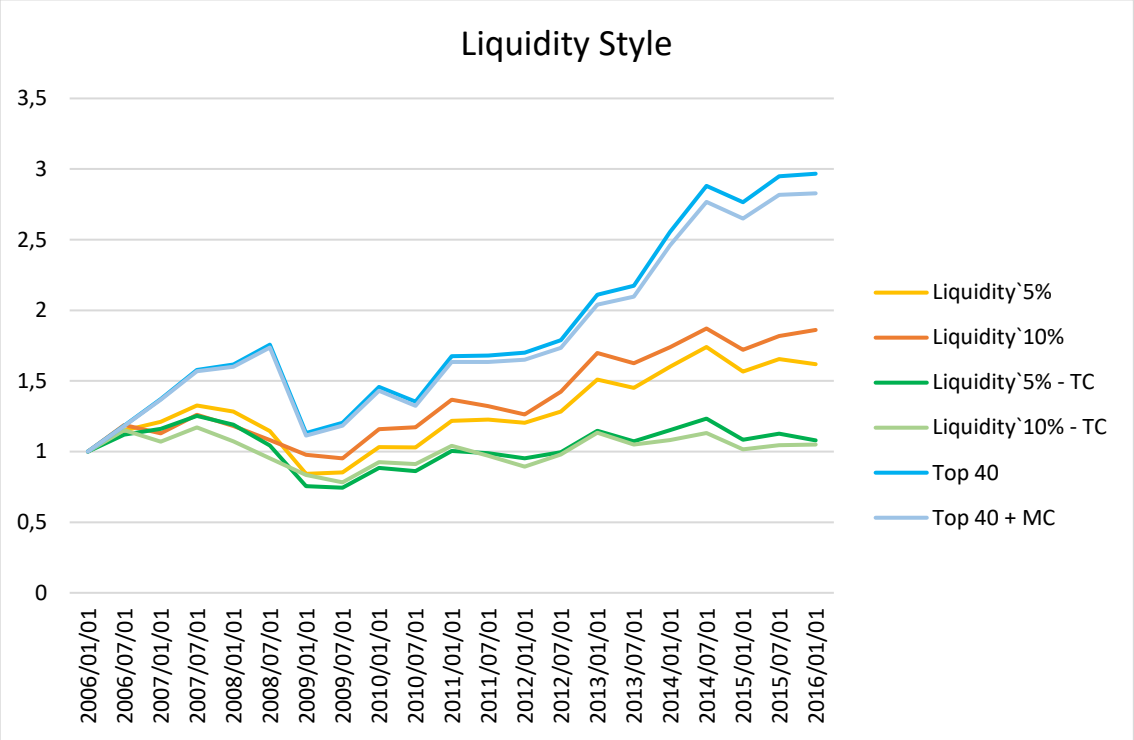


Table 11: Results Table - Liquidity style

	5%	5% TC	10%	10% TC
Liquidity	62%	8%	86%	5%
	5%	**5% MC**	**10%**	**10% MC**
Top 40	197%	183%	197%	183%

From the results presented in Figure 13 and Table 11, it is noted that at '10% maximum weighting per share' the highest return is achieved (86%). However, if transaction costs are applied, '5% maximum weighting per share' outperforms its 10% counterpart.

The Market Cap style portfolio returns are presented in Figure 14. The Market Cap style, similar to the Liquidity Style, had an inverse return ranking methodology, as described earlier in the study. Thus, the lower the market cap, the higher the expected and allocated return was. This is known as the size effect, as observed by Strugnell et al. (2011) and Van Rensburg and Robertson (2003).

Figure 14: Return Graph - Market Cap Style

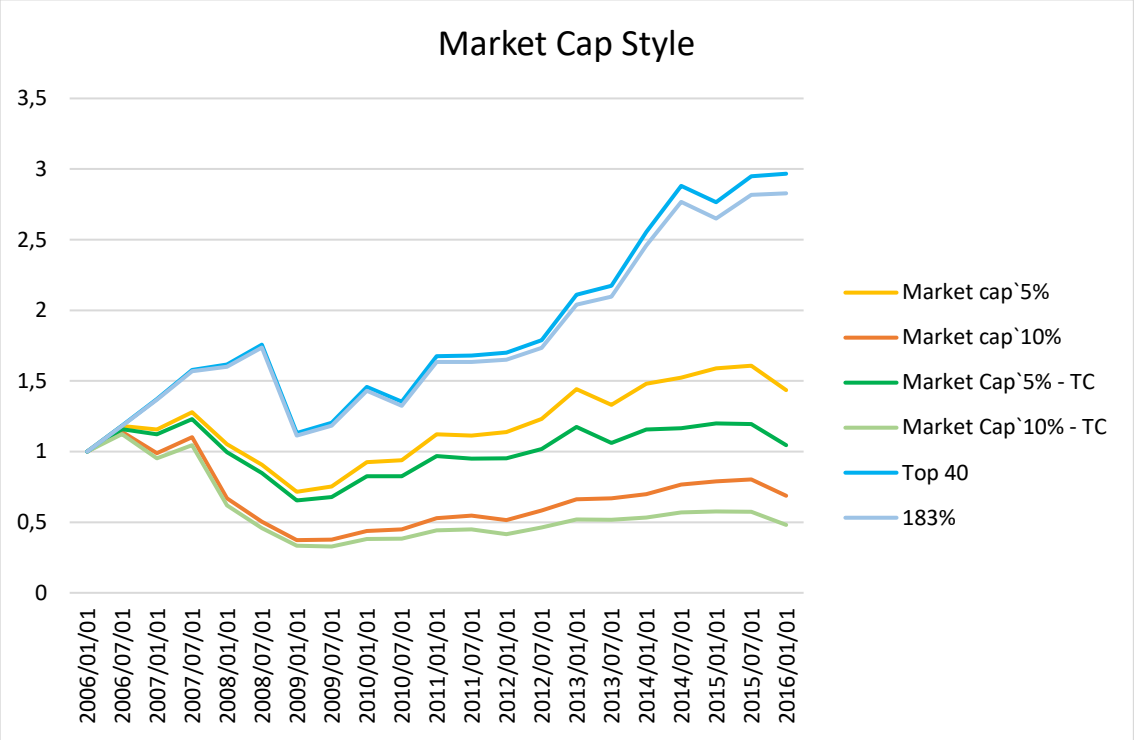


Table 12: Results Table - Market cap style

	5%	5% TC	10%	10% TC
Market cap	44%	5%	-31%	-52%
	5%	**5% MC**	**10%**	**10% MC**
Top 40	197%	183%	197%	183%

From the results presented in Figure 14 and Table 12, it is noted that at '5% maximum weighting per share' the highest return is achieved (44%). Furthermore, if transaction costs are applied, '5% maximum weighting per share' outperforms its 10% counterpart.

The Market Cap style portfolio returns are lower than the all the style returns presented previously. More significantly is the drastic effect observed when the maximum weighting per share within the portfolios are shifted to 10%. The less diversification has a very negative effect resulting in -31% and -52% returns for the '10% maximum weighting per share, no costs' and '10% maximum weighting per share, costs applied', respectively.

In Figure 15 below, the Momentum style portfolio returns are presented.

Figure 15: Return Graph - Momentum style

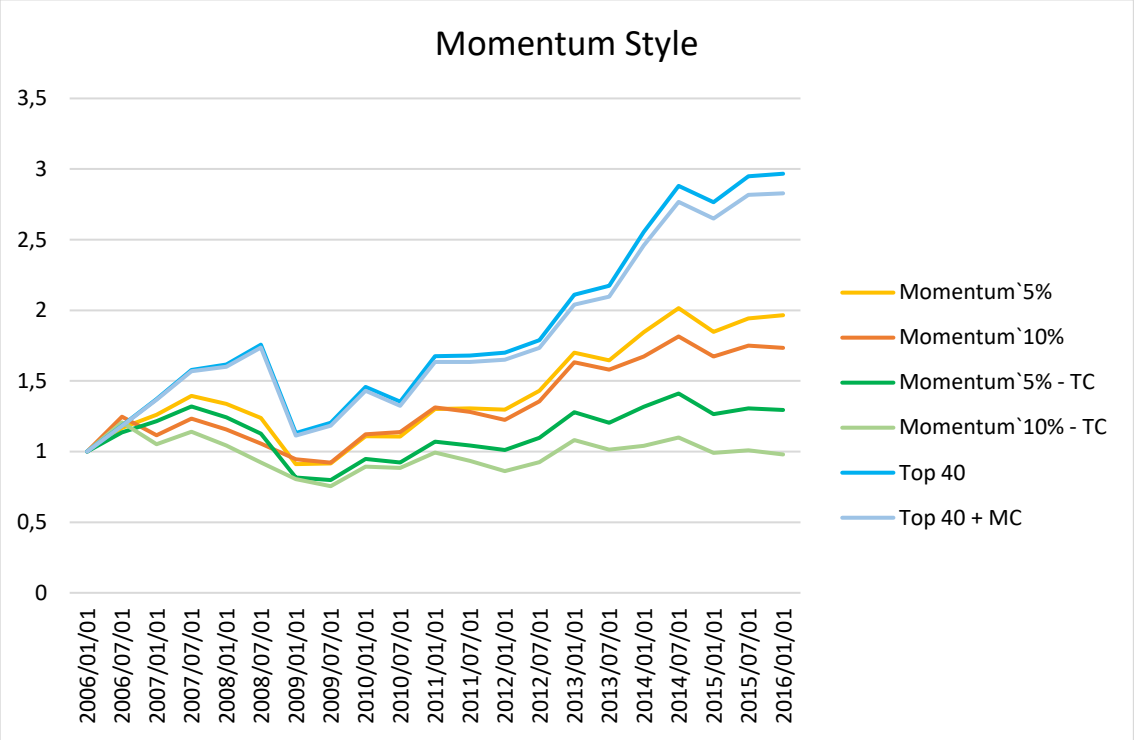


Table 13: Results Table - Momentum style

	5%	5% TC	10%	10% TC
Momentum	97%	29%	73%	-2%
	5%	**5% MC**	**10%**	**10% MC**
Top 40	197%	183%	197%	183%

From the results presented in Figure 15 and Table 13, it is noted that at '5% maximum weighting per share' the highest return is achieved (97%). Furthermore, if transaction costs are applied, '5% maximum weighting per share' outperforms its 10% counterpart.

A very important set of portfolios returns are presented below. Noted below in Figure 16 is the non-style influenced MPSM. As the name would suggest, these portfolios were not style influenced and relied purely on a risk-adjusted mean return to determine the most efficient portfolio. A 5% and 10% maximum weighting per share, as well as a cost and no cost portfolio for each, was generated, and the returns are plotted below.

Figure 16: Results Graph - Non-style influenced MPSM

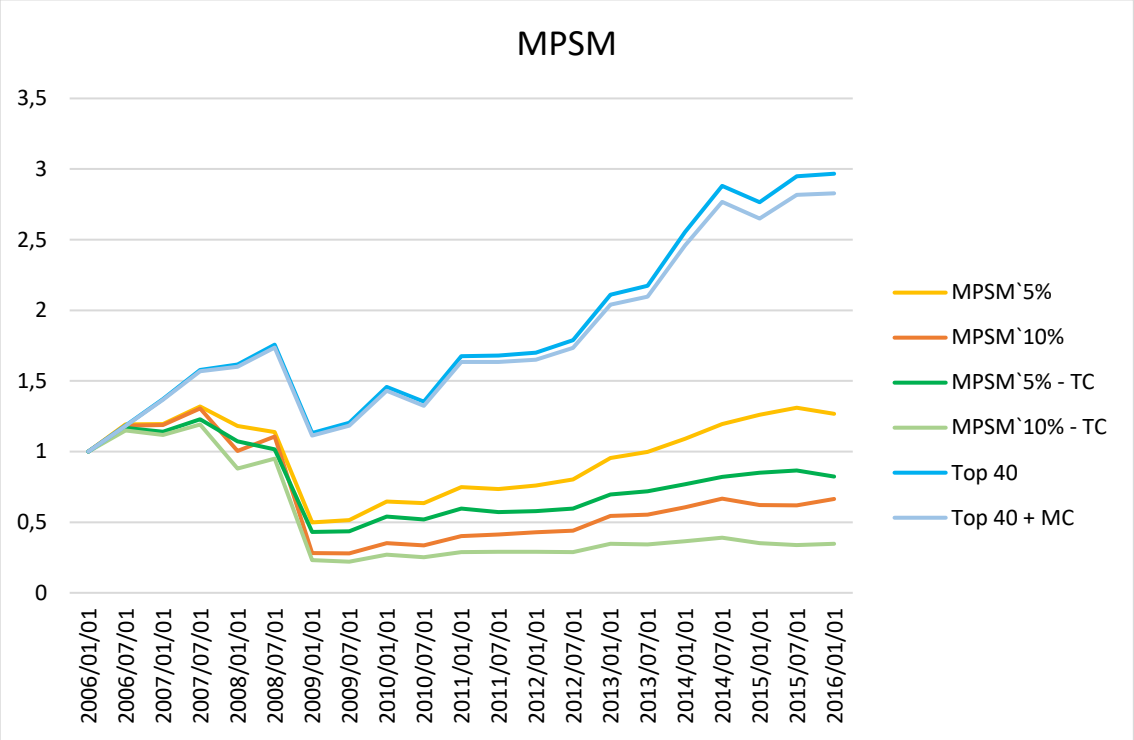


Table 14: Results Table - Non-style influenced MPSM

	5%	5% TC	10%	10% TC
MPSM	27%	-18%	-33%	-65%
	5%	**5% MC**	**10%**	**10% MC**
Top 40	197%	183%	197%	183%

From the results presented in Figure 16 and Table 14, it is noted that at '5% maximum weighting per share' the highest return is achieved (27%). Furthermore, if transaction costs are applied, '5% maximum weighting per share' outperforms its 10% counterpart, even though it's also negative return which had been achieved.

It is important to note that with this style the lowest returns were achieved, compared against all the other style portfolio and benchmark returns. The lowest return realised was -65%, with '10% maximum weighting per share' with costs applied as a parameter.

5.7 Portfolio returns – Transaction cost effect

The significant effect that the transaction costs have on the final portfolio returns are apparent, as noted in Table 15 below.

Table 15: Results Table - Transaction cost effect

Parameter	5%	5% TC	Difference (5%)	10%	10% TC	Difference (10%)
Cash flow	72%	12%	60%	94%	9%	85%
Value	115%	41%	74%	101%	13%	88%
Liquidity	62%	8%	54%	86%	5%	81%
Market cap	44%	5%	39%	-31%	-52%	21%
MPSM	27%	-18%	45%	-33%	-65%	32%
Momentum	97%	29%	67%	73%	-2%	75%

The Market Cap style was the least affected by the application of transaction costs during the rebalancing of the portfolios, while the Value style was the most affected, suffering a reduction in returns of 74% and 88% for 5% and 10% maximum weighting per share, respectively.

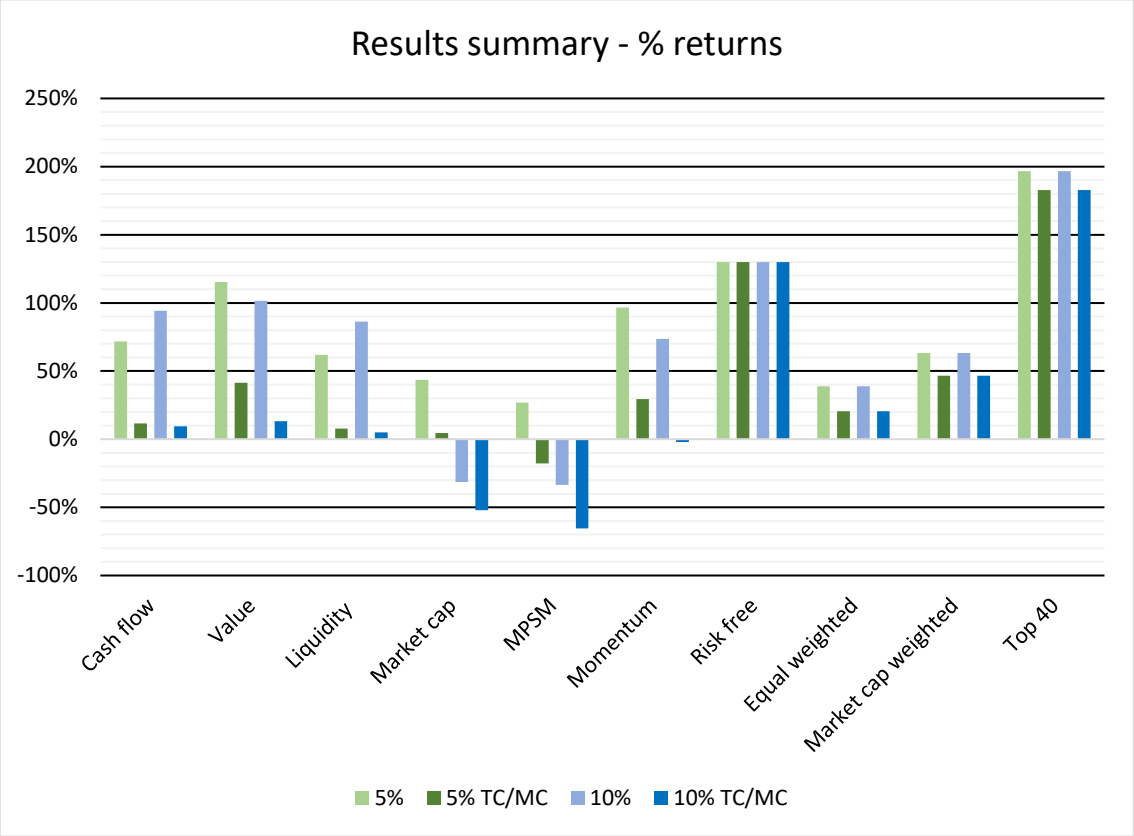
5.8 Summary of results

The following Figure and Table provides a summary of all the results obtained and explained earlier in this section.

Table 16: Results Table - Summary

Parameter	5%	5% TC	10%	10% TC
Cash flow	72%	12%	94%	9%
Value	115%	41%	101%	13%
Liquidity	62%	8%	86%	5%
Market cap	44%	5%	-31%	-52%
MPSM	27%	-18%	-33%	-65%
Momentum	97%	29%	73%	-2%
Risk free	130%	130%	130%	130%
Equal weighted	39%	21%	39%	21%
Market cap weighted	63%	46%	63%	46%
Parameter	5%	5% MC	10%	10% MC
Top 40	197%	183%	197%	183%

Figure 17: Results Graph - Summary



In Table 16 above, the green formatting indicates the best returns achieved between the styles tested, while red indicates the worst returns achieved. The Value style provides the best return over the ten-year period amongst all the other styles, and the non-style influenced MPSM realises the poorest returns.

Chapter 6: Discussion of Results

6.1 Introduction

In the preceding chapters, the rationale for this study was discussed and defended, a literature review was provided, and the knowns and unknowns surrounding the MPSM and style investment strategies were detailed. Hypotheses were created based on the literature review and the rationale set out in Chapter 1. In order to test these hypotheses, a methodology was set out and applied to obtain the results presented in Chapter 5.

Each of the above-mentioned chapters will inform the context of the findings set out in this chapter, providing insights into the possible reasons for the results and the implications of these.

Finally, the hypotheses shall be considered and all the information contained within this study shall be used to inform the decisions to accept or reject them.

6.2 Momentum

Previously, it was noted that past returns indicated future returns. Authors such as Jegadeesh and Titman (1993) claimed that past “winners” are more likely to continue with their positive trend, while past “losers” will continue losing.

In the results noted in Chapter 5, and specifically Table 16, it was seen that the Momentum style had an average performance when compared to the other styles. Furthermore, the results obtained indicated that the Momentum style was outperformed by some of the other styles at different parameters. For example, the Momentum style achieved a 73% return over the ten-year period against the 101% achieved by the Value style, under a 10% maximum share weighting per portfolio (no transaction cost) parameter. This result is contradictory to the findings of Barroso and Santa-Clara (2015), who found that a Momentum style outperformed value-based strategies.

Thus, the consideration is that it is possible that the risk adjustment of the MPSM process is causing the Momentum strategy to underperform relative to its Value counterpart. However, as indicated by Grundy and Martin (2001), stable and positive returns are

generated if the Momentum style is risk-adjusted. This indicates that the Momentum strategy in this study might have been less effective due to some other reason.

A possible explanation for the lower than expected results could be that the time period used in the study included the Global Credit Crisis, which took effect from the middle of 2008. The effect of this can be seen in most of the results' graphs as a sharp drop in returns. This is significant, because as Daniel and Moskowitz (2016) noted whilst investigating Momentum crashes, in panicked market circumstances and periods of high volatility, losses are suffered as Momentum strategies crash.

Another important finding was the transaction cost effect, which is apparent within the Momentum style returns. This effect is set out below:

Table 17: Results Table - Momentum transaction cost effect

Parameter	5%	5% TC	Difference (5%)	10%	10% TC	Difference (10%)
Momentum	97%	29%	67%	73%	-2%	75%

As noted above, the effects that the application of the transaction costs have on the Momentum style are significant; with a 67% and 75% reduction in returns due to these costs applied to the 5% and 10% weighting per share portfolios, respectively. A possible reason for this massive effect is the shifting of momentum within the J200 sample. It may be considered that a share with a positive momentum on any given month might have a significantly different momentum profile six months later, when a rebalancing occurs. Due to this constant shift in momentum, the amount traded in order to rebalance the portfolios within this style is substantial, and has an equally substantial effect on the applicable transaction costs.

Lastly, it should be noted that the Momentum style did not perform well against the Top 40 Index's returns; the Top 40 Index achieved much higher returns over the period, even after a management fee/cost of 0.5% was deducted semi-annually.

6.3 Value

Amongst the different styles tested, the Value style stood out with the highest returns achieved. This result was in line with Otuteye and Siddiquee's (2014) findings, i.e. that

there is lot of evidence that the Value investing style outperforms all other investment styles currently in use.

Furthermore, the results achieved indicate that the “Value Traps” described by Otuteye and Siddiquee (2014) were mostly avoided, possibly due to the sample being from the J200 Index, which is made up of the Top 40 shares on the JSE. These shares are considered stable and robust, and are thus unlikely to contain the “Value Traps” that can be found among smaller capped shares.

The Value style was also one of the styles selected to be applied without any risk adjustment in order to observe any difference in return. Below is any indication of the Value style’s performance, with and without risk adjustment.

Table 18: Returns Table - Value style, risk adjustment removed

5% max per share in portfolio, risk adjustment removed	
Type	**10-year Return**
Value (Non- RA)	21%
Value	115%

As noted above, it is clear that the risk adjustment process specific to the Value style has a positive effect on the return achieved.

Similar to the Momentum style, the Value style was also substantially affected by the transaction costs applied whilst rebalancing. Again, like the ever-changing momentum of shares, the same could be stated for the market price or the book equity value per share (which is the underlying determinants of value in this study). With these metrics changing every six months, the inclusion or exclusion of certain shares from the portfolio changes extensively, causing the transaction cost to be substantial due to the current shares being sold off and the new constituents being purchased.

6.4 Liquidity

As noted by Ibbotson et al. (2013) and supported by Payne et al. (2016), if a share is less liquid, it has a higher probability of providing a positive return in the long term. This is true of the results achieved in this study, however although the Liquidity style did provide average returns when compared against the other styles tested, the Top 40 Index’s returns still outperformed the Liquidity style by a large margin. For instance, in

Table 16 it could be seen that at a 10% maximum weighting per share, the return achieved by the Liquidity style was 86%. This did not come close to the 197% realised by the J200 Index at the end of the same period.
With the above mentioned in mind, it should be noted that two considerations should be made when discussing the results achieved within this study for the Liquidity style:

1. The liquidity range of the shares within the sample is relatively narrow, due to all these shares being part of the J200 Index. Thus, being well traded shares and might not represent the liquidity premium as described by Idzorek et al. (2012).

2. Generally, the liquidity premium (which might not exist due to the point made above) might come at an additional transaction cost. As Ibbotson et al. (2013) noted, less liquid shares are harder to trade and take longer to transact, thus the transaction costs tend to be higher than normal. Two percent of the amount traded during a rebalancing of the portfolio was deducted, however as Ibbotson et al. (2013) would suggest, this might not have been enough.

As it was, the transaction costs resulted in a significant reduction of the realised returns, discounting the cost-free return by as much as 81% at 10% maximum weighting per share.

6.5 Cash flow

The result achieved by the Cash Flow style in this study was contradictory to the returns achieved by Muller and Ward (2013), who found that using cash flow/price as an investment style produced a 10.1% premium per annum above the J200 Index's returns. The reason for this suboptimal performance could be due to the risk adjustment process that occurred during the portfolio generation and rebalancing. However, it should also be considered that the sample size and period was significantly smaller than the size and period used by Muller and Ward (2013). The inclusion of a larger number of shares across various industries and market cap size stratification might increase the effect of the style, thus leading to higher returns.

Among the different styles, Cash Flow provides a decent return, behind Value and similar to Momentum. However, is seems that this style (along with the Liquidity style) performs better with less diversification. This is evident by the return from the 10% maximum

weighting per share portfolio, realising a 94% return vs. the 72% return noted at 5% maximum weighting per share.

In terms of the transaction cost effect, Cash Flow, like the Liquidity, Momentum and Value styles, was heavy affected by the transaction costs deducted. This was in line with the argument captured by Asness et al. (2013) and originally made by Korajczyk and Sadka (2004) and Lesmond et al. (2004), who stated that real world returns are very different than the theoretical results would suggest, i.e. the real-world results are much lower due to factors such as transaction costs.

As stated below in Table 19, an 85% reduction in returns achieved at a 10% maximum weighting per share was noted.

Table 19: Results Table - Cash flow transaction cost effect

Parameter	5%	5% TC	Difference (5%)	10%	10% TC	Difference (10%)
Cash flow	72%	12%	60%	94%	9%	85%

The reason for the high transaction cost figure is similar to the reasoning behind the Liquidity, Momentum and Value styles' high transaction costs, i.e. with the cash flow and price of shares constantly changing, the rebalancing of this style's portfolios was intensive, resulting in large amounts traded and subsequently substantial transaction costs.

6.6 Size

Considering that the sample for this study was taken from the J200 Index, which constitutes the Top 40 shares on the JSE, as well as the fact that the literature did not provide conclusive evidence that a size effect exists; as noted in the findings of Muller and Ward (2013), when they found no significant difference in returns, among 300 shares grouped into size specific portfolios (descending) of 10 shares each. No size effect was expected.

As stated in the table below, the Market Cap or Size style delivers the weakest returns among all the other styles tested.

Table 20: Returns Table - Style returns

Parameter	5%	5% TC	10%	10% TC
Cash flow	72%	12%	94%	9%
Value	115%	41%	101%	13%
Liquidity	62%	8%	86%	5%
Market cap	44%	5%	-31%	-52%
Momentum	97%	29%	73%	-2%

As with the Liquidity style and as alluded to above, the sample of the Top 40 shares might not provide a significant enough range of market cap to apply the expected returns to effectively. The argument can be made that if a large sample base, including shares from micro-cap to large cap, is used, the size effect and thus the return achieved might be considerably different. This consideration is in line with the statement from Strugnell et al. (2011), who noted that literature suggests that the size effect exists and that smaller capped shares outperform the larger capped shares.

However, it should also be considered that as stated by Menchero et al. (2012), different sizes might be favoured by the market at different times. This indicates that the results achieved might have been considerably different during another sample period.

Moreover, a considerable result was noted when, as with the best performing style (Value), the weakest style (Size) was stripped of the risk adjustment process during its portfolio rebalancing. This was done to observe the effect on the returns achieved. Significantly, an opposite result was achieved to the result obtained from the Value style not being subjected to the risk adjustment process. The Value style obtained a benefit from being risk-adjusted, whereas the Size (Market Cap) style was not substantially affected either with or without risk adjustment. This is noted in the table below.

Table 21: Returns Table - Size/Market cap style, risk adjustment removed

5% max per share in portfolio, risk adjustment removed	
Type	**10-year Return**
Market cap (Non- RA)	51%
Market cap	44%

The transaction costs applicable to the size style are noteworthy. This is due to the fact that the results suggest, in line with the transaction cost results obtained from the other

styles tested, that due to the Size or Market Cap style not being subjected to large shifts in share weighting upon every rebalancing of the share portfolios, the amount traded is significantly smaller. The transaction costs are thus substantially lower, relative to the other styles tested as noted in Table 15.

6.7 MPSM

As the literature suggests and the results imply (in Table 16 above), the MPSM does not function well within today's dynamic and inefficient market circumstances. The MPSM obtained the lowest and even negative returns over the ten-year period tested.

For the MSPS to function ideally, a rational, ideal market should be the operating and trading environment. Fama (1970) related this ideal situation to a market in which prices would provide signals for resource allocation. Furthermore, Rösch et al. (2017) expanded on this, stating that prices in the market would reflect the fundamentals of the specific shares. However, if the above mentioned proved true, undervaluation, as identified by the Value and Cash Flow styles, would not exist or provide significant returns. Additionally, the efficiency of the market is in considerable doubt due to the aforementioned mispricing.

Furthermore, Lo (2012) noted that the assumptions supporting the efficient market theory on which the MPSM is based are no longer relevant, and the linear relationship expected between risk and reward is no longer valid.

This being said, Statman (2013) noted that the MPSM still provides the best combinations of risk vs. return, even though the returns might be negative in very negative conditions such as a financial crisis. In addition, the risk adjustment process provides a significant upside to the Value style's performance, i.e. the idea that the MSPM, combined with certain styles, provides better than non-risk adjusted returns is plausible.

The transaction cost effect is also not significantly lower in the MPSM, with styles such as the Market Cap style providing lower transaction costs as well as higher returns.

6.8 Hypotheses

Two distinct hypotheses were tested during this study:

Hypothesis 1

H0 (null): Investment styles do not enhance the risk-adjusted returns generated by applying the MPSM.

Hypothesis 2

H0 (null): Different investment styles provide different risk-adjusted returns when applied with the MPSM.

As noted in the discussion above, it may be stated that the research methodology and subsequent results were in line, in order to effectively test the hypotheses. The results obtained directly informed the acceptance or rejection of the two hypotheses.

Hypothesis 1 – Rejected

Hypothesis 1 is rejected, as all the style influenced portfolios that were risk-adjusted by means of a combination with the MSPM achieved significantly higher returns than the non-style influenced MPSM.

However, it should be noted that the enhancement was not significant enough to outperform the J200 Index.

Hypothesis 2 – Accepted

Hypothesis 2 is accepted, as the returns realised by the different investment styles were different to one another, offering a wide range of returns of between -31% for Market Cap to 115% for Value. Different maximum weightings per share and transaction cost applications were also tested, with no similarities observed in the returns generated.

6.9 Summary

The results obtained were discussed and related back to the literature in order to provide some context to the returns achieved. The strongest performer among the styles was Value, with the weakest being Market Cap. Furthermore, even though Market Cap was the weakest style, it still outperformed the non-style influenced MPSM.

Although the methodology was chosen to inform the acceptance or rejection of the hypotheses set, the design included factors to provide real world returns by means of the application of transaction costs. Furthermore, the results obtained presented rich information which provided depth to this study and may support future research.

The considerable effects of transaction costs were noted, as was the effect that risk adjustment has on the performance of certain styles such as Value. Furthermore, the performance of the J200 is noteworthy, with none of the styles tested outperforming the Index at the end of the ten-year period, even after a management fee had been applied.

The following chapter will focus on drawing conclusions from the results discussed in Chapter 6. Furthermore, Chapter 7 will provide insight into the implications of this study on the financial industry and fund management. The limitations of this study, as well as recommendations and suggestions for future research, will also be discussed.

Chapter 7: Conclusion

7.1 Introduction

All the information presented in the preceding chapters flow into this concluding chapter, where the various findings are detailed, the limitations of the study are discussed, suggestions for future research are presented, and the implications for industry are noted.

7.2 Principal findings

Although the core objective of this study was to test the two hypotheses, the methodology designed and followed enabled a wealth of additional information and results to become available, upon which certain conclusions could be based.

Starting at the main conclusions based on the testing of the two hypotheses, the following can be stated:

1. A style influenced approach does enhance the returns generated by the MPSM. It can thus be concluded that the market is operating inefficiently, and due to the style investment approach exploiting these inefficiencies and then being combined with the MPSM, they provide enhanced returns.
2. Due to the distinctive styles being fundamentally different in the way they measure and rank performance, the returns generated from the different styles varied substantially.

7.3 Additional findings – Risk adjustment

In addition to the conclusions listed above, it should also be noted that certain styles perform better once risk adjustment has been applied. This was specifically noted when the Value style was tested with and without risk adjustment taking place during portfolio generation. However, it is important to note that this conclusion is not inclusive of all styles, and some styles such as the Market cap style are not significantly influenced by the risk adjustment process. This phenomenon might require further testing to determine why this conclusion applies to some styles, but not all.

7.4 Additional findings – Transaction cost effect

Another significant finding was the substantial difference in returns achieved, which was observed when applying the transaction cost of 2% of the value traded during the rebalancing of the portfolios. This transaction cost was especially significant to certain styles, which experienced large shifts in share weighting at the end of each period due to the underling fundamental style measure shifting from one period to another. However, this being stated, the points made above do not constitute the main conclusion with regards to transaction costs. The conclusion in this regard is that most of the studies referenced during the literature review did not include transaction costs, which removes the real-world applicability of the findings presented in these studies.

Although these previous studies might provide great theoretical insights into certain principles, and many of them explicitly state and defend why they did not apply transaction costs, they lack practicality, as their findings might have been substantially different if the factors that affect day-to-day trading were considered and included.

To support this, the returns achieved by the Value style are referenced. The Value style, which was the best performing style among all the other styles tested, also had one of the highest transaction cost effects due to the dynamic nature of the underlying style measures. Thus, not only should the return achieved inform the style decision when formulating an investment strategy, but the transaction cost effect should as well. This point might require additional testing to provide a method of determining the most efficient portfolio relative to the return achieved, as well as the applicable transaction costs. This method would result in a very practical investment strategy approach.

7.5 Additional findings – J200 Index performance

Another important finding to note would be the fact that the J200 (Top 40) Index outperformed all the style influence portfolios, as well as the non-style influenced MPSM. Even after a management fee had been applied to the Index's returns, it still outperformed all the other portfolios generated. Given the time frame applicable in this study, one can conclude that passive investing in the Index would have provided a better return than actively managing the portfolios using the style influence MPMS as a strategy.

This is a considerable finding, as the high management fees charged by active portfolio managers have previously been justified by the principle that active management will beat the market and provide significantly higher returns. If this is not the case anymore, passive investment into an Index may become even more popular.

7.6 Additional findings – Market inefficiencies

As noted previously, the Value style realised the best results compared to all the other styles tested. This fact would indicate that these shares within this style's portfolio were mispriced in the market at the time of portfolio generation, and due to this, once the market compensated for this mispricing, the returns were achieved. This was also noted in the literature by Otuteye and Siddiquee (2014), who stated that there is a lot of evidence which indicates that the Value investing style outperforms all other investment styles currently in use.

However, this evidence of market inefficiency is not exclusive to the Value style; the Cash Flow style provided the same sentiment, being under-priced at the time of investment and thus providing a relatively substantial return once the pricing of the share normalised to the true value of the share, as indicated by its cash flow position.

Given the above and bearing the weak performance displayed by the non-style influenced MPSM in mind, it can be concluded that the market does operate inefficiently. If the market was operating efficiently, there would be no mispricing and the MPSM would have provided a significantly positive return.

7.7 Additional findings – Portfolio diversification

It may be stated that if, when generating portfolios a maximum share weighting of 5% is applied, the resulting portfolio would be more diversified than if 10% weighting per share was applied.

With this in mind, the conclusion may be drawn that better performance is obtained from more diversified portfolios. Although two of the styles (Cash Flow and Liquidity) indicated a higher return when less diversified, on average and with transaction costs applied, higher diversification realised higher returns. However, more diversification than what is achieved at the 5% level was not tested for, thus this might be a parameter to be explored

in future studies in order to find the perfect amount of diversification during portfolio generation.

However, this is contradictory to the fact that the J200 is market cap weighted and may provide evidence of the size effect. This is evident by 30% of the J200 index being represented by a single share, Naspers. This share has done exceptionally well in the period and is one of the main drivers to the J200's performance. Thus, in some cases less diversification is better, however the success of Naspers comes with a lot of specific risk which is better to avoid when considering a portfolio strategy.

7.8 Additional findings – Shorting the MPSM

Given the conclusions drawn thus far, as well as the results obtained, it may be considered that the weak performance of the non-style influenced MPSM, possibly as a result of the inefficient nature of the market, might provide a stock shorting strategy. In this study, shorting (selling of shares that are expected to be weak performers) was not tested for. However, the results achieved indicate possible returns if the non-style influenced MPSM was not used as a long portfolio generation strategy, but rather a short strategy. This notion is in line with findings from Van Rensburg and Robertson (2003), who noted a non-linear and inverse relationship between risk and return.

Thus, it may be concluded that the non-style influenced MPSM does not provide positive returns as a long only investment strategy, and future research might need to test this model as a shorting strategy.

7.9 Limitations of the research

The sample used in this study included the Top 40 shares within the JSE over a ten-year period. However, as noted within the discussion of the results, a possible limitation to this study is the relatively short time period as well as the limited number of shares considered. The impact of the global credit crisis, which occurred during this study's time frame, had a significant effect on the results achieved, thus longer time periods might negate the effect of such events.

However, as suggested by Lo (2012), since the global credit crisis traditional paradigms such as the Efficient Market Theory have been replaced, indicating that shorter periods around the crisis might provide good insights into the new paradigms to follow.

Furthermore, this study also did not consider any shorting of shares, which may have a significant effect on the portfolios' performances. Considering that this study aimed to be as practical and real world applicable as possible, not shorting might be noted as a major limitation.

In terms of the style metrics, it should also be noted that more accurate rankings might have been achieved if more than one measurement per style was applied. For instance, price to book value of equity was used to determine value, however price to earnings (PE) and enterprise value to earnings before interest, tax, depreciation and amortisation (EV/EBITDA) are also widely used value indicators. A combination of multiple metrics should provide a more comprehensive style ranking of the shares involved.

Lastly, the amount of data extracted and analysed was immense, and due to the fact that the calculation process in this study was not fully automated by programming Excel with Visual Basic as per Du Plessis and Ward (2009), a certain amount of human error may have occurred. However, as far as possible, various data checks and balances were applied in order to ensure data validity and accuracy, as noted in Figure 5.

7.10 Suggestions for future research

Considering some of the points raised in this chapter, the following suggestions for future research are listed:

1. It is suggested that the effect of risk adjustment vs. no risk adjustment be tested for to determine how and why this parameter affects the returns achieved by certain styles. In this study, it was found that it positively influences certain styles, but has no effect on others.
2. A method to determine not only the investment strategy that provides the highest returns, but also the least transaction costs, is suggested. This would provide a very practical method for investing, which would replicate and optimise the trading environment in which the rebalancing of portfolios would occur.
3. The effect that different levels of portfolio diversification would have on the returns achieved from generated portfolios using specific styles is suggested to be tested for. Being able to not diversify too much and thus lose possible returns, but also not having too much specific risk within a portfolio, would be the ideal.

4. A similar study to this study, testing the same hypotheses but with the additional parameter of shorting the shares, is suggested, as shorting might positively influence the returns achieved.
5. Similar to the previous point, it may be suggested that due to the weak performance achieved by the MPSM, this model should be used as a shorting strategy, with the styles strategies as the long selection method. Again, this is in line with findings from Van Rensburg and Robertson (2003), who disproved the linear relationship between risk and returns upon which the MPSM and EMT are based.
6. A similar study to this, testing the same hypotheses but with the style measures being informed by multiple measurements to determine share ranking, is suggested. More accurate rankings should be achieved, providing better allocation of proposed returns to the shares involved.
7. Finally, it is suggested that a similar study is conducted by using a larger sample size over a longer period, such as the All Share Index over 20 years. This would not only allow for more significant ranges with regards to the style metrics, but would also dilute the effects that significant market events might have, such as the drop in returns experienced due to the global credit crisis.

7.11 Implications for industry

Unfortunately, the results obtained from this study might provide evidence of what not to do in industry, rather than what to do. However, although the style influenced portfolios and the non-style influenced MPMS did not provide high yielding returns, the results obtained and findings could influence the industry significantly.

Currently many constructs such as the Capital Asset Pricing Model (CAPM) and MPSM are based on the theory that the market is efficient. These models are extensively used throughout the financial industry, and as stated by Ledoit and Wolf (2014), they are still the cornerstone of many fund managers' investment strategies. This is contradictory to the findings observed in this study, which noted an inference that the market is inefficient. Thus, as suggested by Lo (2012), the linear relationship between risk and reward is no longer valid, resulting in the outcomes of the models mentioned above being fundamentally inaccurate and flawed.

The positive effects noted by applying a style investment strategy are apparent, and as suggested in the preceding section, if a larger sample of shares were to be considered and factors such as the transaction costs and level of diversification were adjusted for, the practical use of this method as a passive investment strategy could be realised.

Furthermore, this study provides some insight into possible strategies involving the MPSM and the shorting of shares, due to the MPSM providing significantly lower returns than most of the styles and the Index it is benchmarked against.

The greatest significance of this is the fact that, as suggested by Van Rensburg and Robertson (2003), an inverted relationship exists between risk and reward. This idea is very contrarian to the belief held in industry currently, but might be the key principle to explore in order to discover better investment strategies in future.

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Appendix A – Ethical Clearance Letter

Gordon Institute of Business Science
University of Pretoria

10 August 2017

Shaun Smith

Dear Shaun,

Please be advised that your application for Ethical Clearance has been approved.

You are therefore allowed to continue collecting your data conditional to the below:

We wish you everything of the best for the rest of the project.

Kind Regards

GIBS MBA Research Ethical Clearance Committee

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