UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Denkleiers • Leading Minds • Dikgopolo tša Dihlalefi

GORDON INSTITUTE OF BUSINESS SCIENCE

University of Pretoria

Enhancing a value portfolio with price acceleration momentum

Etienne Schoeman

96181215

A research project submitted to the Gordon Institute of Business Science, University of Pretoria, in partial fulfilment of the requirements for the degree of Master of Business Administration.

7 November 2012

Abstract

Value shares are notorious for remaining stagnant for extended periods of time, forcing value investors to remain locked in their investments often for excessive periods. This research study applied the price acceleration momentum indicator of Bird and Casavecchia (2007) on a value portfolio with the objective of improving the timing of value share acquisitions.

A time series study was conducted, taking into account the top 160 JSE shares over the period 1 January 1985 to 31 August 2012. A price acceleration momentum indicator was applied to enhance a value portfolio formed on the basis of book-to-market ratio, dividend yield and EBITDA/EV. Cumulative average abnormal returns (CAAR) were used to compare portfolio results statistically.

A substantial contribution is made to the literature by proving that a value-only portfolio can be significantly enhanced by the combination of price acceleration momentum. Results indicated an increase in CAAR from 199.83% to 321.29%. Risk-adjusted returns (Sharpe ratio) were also improved without the detriment of increased share price volatility (standard deviation). This research study further contributes to the literature by proving that a price acceleration momentum indicator adds no additional value over a value portfolio combined with ordinary price momentum.

Keywords: value, momentum, price acceleration momentum, CAAR, time series

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.

________________________ ___7 November 2012_

Etienne Schoeman Date

Acknowledgements

I would like to thank my wife Yolandi for her enduring love and support over the last two years while doing my MBA. She has supported me in ways that she will never understand. I love her so much.

Special thanks go out to my unborn daughter, Miané. I love you my child and cannot wait to meet you. There is a special place in my heart reserved just for you.

I thank my research supervisor, Dieter Halfar, for his insight on the topic and for always giving rapid feedback. Thank you for the direction you have guided me in.

I thank my co-supervisor, Chris Muller, for his tremendous insight and expertise. Thank you for the long hours spent together at your house modelling portfolios in the style engine. This has made the single biggest difference in the results of this research project.

Thank you to my entire family for enduring life without me the past two years. Thanks for understanding that we could not spend much time together.

I thank all my close friends who never got to spend time with me the past two years. Thanks for your understanding and for remaining true friends.

Thanks go out to my work colleagues who had to struggle at times without me while I needed to attend to the busy MBA schedule.

TABLE OF CONTENTS

1. CHAPTER 1 - INTRODUCTION TO RESEARCH PROBLEM 12
1.1 Research title 12
1.2 Introduction 12
1.3 Problem definition 13
1.4 Purpose of the study and relevance to South African business 15
1.5 Research objectives 16
2. CHAPTER 2 - LITERATURE REVIEW 17
2.1 Introduction 17
2.2 Value investing 17
2.3 Fundamental analysis 19
2.4 Technical analysis 20
2.5 Market inefficiency as a source of value 21
2.6 Investment risk and return 21
2.6.1 The capital asset pricing model (CAPM) 22
2.6.2 Multifactor models 23
2.6.3 Portfolio return calculation models 23
2.6.4 Risk-adjusted returns 26
2.7 Combining momentum with value investing 27
2.8 Summary of literature 29
3. CHAPTER 3 - RESEARCH HYPOTHESES 31
4. CHAPTER 4 - RESEARCH METHODOLOGY 34
4.1 Introduction 34
4.2 Research design 34
4.2.1 Time series research design 35
4.2.2 Average monthly returns research design (AMR) 36
4.2.3 Cumulative average abnormal returns research design (CAAR) 36
4.2.4 Sharpe ratio research design (SR) 37

4.3 Data collection, population and sampling 37
4.3.1 Data correction within sample 38
4.4 Portfolio creation 39
4.4.1 Portfolio creation – value portfolios 39
4.4.2 Portfolio creation – price momentum portfolios 40
4.4.3 Portfolio creation – price acceleration momentum portfolios 41
4.4.4 Portfolio creation – value-momentum combination portfolios 41
4.5 Unit of analysis 41
4.6 Data analysis 42
4.6.1 Step 1: Cumulative returns (CR) 42
4.6.2 Step 2: Average monthly returns (AMR) 44
4.6.3 Step 3: Cumulative average abnormal returns (CAAR) 44
4.6.4 Step 4: Risk-adjusted returns – Sharpe ratio 45
4.7 Research limitations 45
5. CHAPTER 5 - RESULTS 47
5.1 Introduction 47
5.2 Portfolio characteristics 48
5.3 Results of hypotheses and sub hypotheses 49
5.4 Hypothesis 1: Price acceleration momentum *versus* price momentum 51
5.4.1 Price acceleration momentum (PAM) 51
5.4.2 Combining price momentum with price acceleration momentum (PM_{12}-PAM) 53
5.5 Sub Hypothesis 1: Risk adjusted returns (Sharpe ratio) 55
5.6 Hypothesis 2: Value-momentum combination *versus* benchmark 56
5.6.1 Value enhanced with PM_{12} (V-PM12) 56
5.6.2 Value enhanced with PM_{12}-PAM (VM2) 58
5.7 Sub Hypothesis 2: Risk-adjusted returns (Sharpe ratio) 61
5.8 Hypothesis 3: Value-momentum combination *versus* value 62
5.8.1 Value enhanced with PM_{12} (V-PM12) 62

5.8.2 Value enhanced with PM_{12}-PAM (VM2) 64
5.9 Sub Hypothesis 3: Risk-adjusted returns (Sharpe ratio) 64
6. CHAPTER 6 – RESULTS DISCUSSION 66
6.1 Introduction 66
6.2 Price acceleration momentum *versus* price momentum 66
6.2.1 Discussion of main hypothesis results 66
6.2.2 Validity of Hypothesis 1 67
6.2.3 Discussion of sub hypothesis results 68
6.2.4 Validity of Sub Hypothesis 1 68
6.2.5 Conclusion of Hypothesis 1 69
6.3 Value-momentum combination *versus* the ALSI benchmark 70
6.3.1 Discussion of main hypothesis results 70
6.3.2 Validity of Hypothesis 2 72
6.3.3 Discussion of sub hypothesis results 72
6.3.4 Validity of Sub Hypothesis 2 73
6.3.5 Conclusion of Hypothesis 2 74
6.4 Value-momentum combination *versus* value-only 74
6.4.1 Discussion of main hypothesis results 74
6.4.2 Validity of Hypothesis 3 75
6.4.3 Discussion of sub hypothesis results 76
6.4.4 Validity of Sub Hypothesis 3 77
6.4.5 Conclusion of Hypothesis 3 78
7. CHAPTER 7 – CONCLUSION 79
7.1 Significant findings 79
7.2 Implications of findings 80
7.3 Recommendations for further research 81
8. REFERENCES 83
9. APPENDICES 87

9.1 Appendix A: Average monthly return distribution – V-PM12 portfolio *versus* ALSI benchmark 88

9.2 Appendix B: Average monthly return distribution – VM2 portfolio *versus* ALSI benchmark 89

9.3 Appendix C: Average monthly return distribution – V-PM12 portfolio *versus* Value-only portfolio 90

9.4 Appendix D: Average monthly return distribution – VM12 portfolio *versus* Value-only portfolio 91

LIST OF FIGURES

Figure 5-1: Histogram of P/E ratios for 2011 48
Figure 5-2: Cumulative returns of PAM quintiles, PM_{12} winner quintile and ALSI 52
Figure 5-3: Cumulative returns of PM_{12}-PAM quintiles, PM_{12} winner quintile and ALSI benchmark 53
Figure 5-4: Cumulative average abnormal returns of momentum related portfolios 54
Figure 5-5: Distribution of block bootstrapped Sharpe ratios 56
Figure 5-6: Cumulative returns of quintiles of value enhanced with PM_{12}, PM_{12} winner quintile and ALSI 57
Figure 5-7: Cumulative returns of quintiles of value enhanced with PM_{12}-PAM (VM2), PM_{12} winner quintile and ALSI 59
Figure 5-8: Cumulative average abnormal returns of value and value-momentum combination portfolios 60
Figure 5-9: Distribution of block bootstrapped Sharpe ratios 61
Figure 5-10: Cumulative returns of V-PM12, value winner quintile and ALSI 63
Figure 5-11: Distribution of block bootstrapped Sharpe ratios 65

LIST OF TABLES

Table 2-1: Results of recent value investment studies 18
Table 2-2: Results of recent momentum investment studies 20
Table 2-3: Results of recent value-momentum investment studies 28
Table 4-1: Variables used for portfolio comparison 39
Table 4-2: Steps in screening value shares, derived from Leivo and Pätäri (2011) 40
Table 5-1: Summary statistics of 132 screened P/E ratios 47
Table 5-2: Descriptive values for momentum portfolios 49
Table 5-3: Descriptive values for value portfolios 49
Table 5-4: Summary of performance of PAM and PM_{12} winner portfolios with hypothesis test results 52
Table 5-5: Summary of performance of PM_{12}-PAM and PM_{12} winner portfolios with hypothesis test results 54
Table 5-6: Sharpe ratios for the PM_{12} winner portfolio and the two PAM winner portfolios 55
Table 5-7: Summary of performance of V-PM12 winner portfolio and ALSI benchmark with hypothesis test results 58
Table 5-8: Summary of performance of VM2 winner portfolio and ALSI benchmark with hypothesis test results 60
Table 5-9: Sub hypothesis test results: ALSI *versus* value-momentum combination portfolios 62
Table 5-10: Summary of performance of V-PM12 and Value winner portfolios with hypothesis test results 63
Table 5-11: Summary of performance of VM2 and Value winner portfolios with hypothesis test results 64
Table 5-12: Sub hypothesis test results: Value and the two value-momentum combination portfolios 65
Table 6-1: Summary of hypothesis outcomes 78

LIST OF EQUATIONS

Equation 2-1: CAPM 22
Equation 2-2: Continuously compounded return 24
Equation 2-3: Abnormal portfolio returns (AR) 24
Equation 2-4: Market-adjusted abnormal returns 25
Equation 2-5: Average abnormal returns (AAR) 25
Equation 2-6: Cumulative average abnormal returns (CAAR) (a) 26
Equation 2-7: Cumulative average abnormal returns (CAAR) (b) 26
Equation 2-8: Sharpe ratio (SR) 26
Equation 2-9: Price momentum 28
Equation 2-10: Price acceleration momentum 29
Equation 4-1: Cumulative returns (CR) 35
Equation 4-2: Compound annual growth rate (CAGR) 35
Equation 4-3: Average monthly returns (AMR) 36

1. CHAPTER 1 - INTRODUCTION TO RESEARCH PROBLEM

1.1 Research title

Enhancing a value portfolio with price acceleration momentum.

1.2 Introduction

Individuals and institutions invest money in stock markets (and other financial markets) with the pursuit of achieving better than average returns. Literature has presented many different ways and styles in which extraordinary returns can be achieved (Yeh & Hsu, 2011; Ansari & Khan, 2012). From most of these studies, it is evident that three investment strategies are ubiquitous in global equity markets namely: value-, growth-, and momentum investing. The question of which of the investment strategies are superior is an on-going debate (Yeh & Hsu, 2011).

Value investing is an investment technique where shares, that trade at a relative discount to their intrinsic value (Guinan, 2009), are acquired and held for long periods. According to Rousseau and Van Rensburg (2004) the price of these undervalued shares can increase healthily over prolonged periods, unlocking huge value for shareholders. The principle of value investing is to buy when the share price is low and to sell when the shares price is high (Brown, 2007).

According to Strugnell, Gilbert and Kruger (2011) shares are typically classified as value shares and growth shares through their price-earnings ratios (P/E) – high P/E ratio shares are growth shares and low P/E ratio shares are value shares. According to Beukes (2011) however, there is consensus amongst the international academic community that value investing strategies outperform growth strategies. Some of the most influential value *versus* growth studies performed globally, demonstrated that the value premium is pervasive in equity markets of both the developed and developing countries (literary works cited in Beukes, 2011). Beukes (2011) further demonstrated that the value premium was particularly strong in South Africa, when compared to the United States (US), the United Kingdom (UK) and continental Europe.

Interestingly Cubbin, Eidne, Firer and Gilbert (2006) found that the cumulative returns of low P/E shares only outperformed high P/E shares after a holding period of at least eight months. This is a significant finding as it clearly demonstrates that although value shares outperformed growth shares, the effect was not immediate. Timing of value shares is therefore a challenge.

In contrast to value investing, momentum typically utilises the share price movement history to infer future increases (or decreases) of the share price, which involves the principles of technical analysis (Guinan, 2009). Banerjee and Hung (2011) defined momentum investing as a quantitative method of forming portfolios of winner and loser shares together with the rigorous application of long-short strategies. Literature on momentum investment affirms that these strategies have also presented better than average returns (Rey & Schmid, 2007; Herberg, Kohlert, & Oehler, 2011). Momentum investment involves technical analysis and is not prescriptive to growth or value styles. Momentum strategies have shown outstanding results when share prices are either on a steep upward or steep downward trajectory (Rey & Schmid, 2007).

1.3 Problem definition

From the previous section, there is distinct evidence that both value and momentum strategies are sensible. Momentum strategies are most suitable when there are strong price (and earnings) trends, both upward and downward, whereas value strategies are well applied to shares with good potential which trade below their intrinsic value. However, Pätäri, Leivo and Honkapuro (2010) found in a study on the Finnish stock market that neither a value nor a growth portfolio has statistically significant returns for holding periods in excess of two years. This indicates that buy-and-hold strategies have time limitations.

Conversely, Rousseau and Van Rensburg (2004) found that the effect of value investing became more pronounced over extended periods, beyond 12 months. The distributional comparison of the Rousseau and Van Rensburg (2004) study demonstrated that all value portfolios statistically outperformed the market benchmark as well as growth share portfolios. The authors proclaimed that the rewards were not evenly distributed over shares and time, but rather that a small fraction of the shares produced the majority of the returns. The study of the authors between 1983 and 1999 exhibited that stripping out two stellar share performers; a value portfolio outperformed the JSE benchmark by only 19 percent instead of 160 percent.

For this reason, Rousseau and Van Rensburg (2004) suggested further research on screening tools to better identify the select group of shares that have the potential outperform the rest. Rousseau and Van Rensburg (2004) concluded that there could be benefits in combining value strategies with momentum to alleviate the timing imperfection of value shares. The authors explain that low P/E shares possess poor momentum and that previous low P/E shares of 12 months earlier might perform better due to higher momentum.

A study by Bird and Casavecchia (2007) substantiated the combination of value investing with momentum. The study by the authors covered approximately 8,000 companies in 15 European countries for the period 1989 to 2004. One of their key findings was that a value strategy alone did not deliver optimum return results due the fact that some value shares remained stagnant. The authors further cautioned the use of value-only portfolios as the returns were generally due to only a small number of shares, which concurs with the results obtained by Rousseau and van Rensburg (2004).

Bird and Casavecchia (2007) provided a solution to this shortcoming, where price and earnings momentum techniques were used as timing triggers to acquire value shares. The authors demonstrated that not only did these techniques address the timing deficiency of a value portfolio, but also resulted in higher average returns. A significant finding by Bird and Casavecchia (2007) was that price acceleration momentum combined with a value strategy improved the results of a price momentum and value combination nearly twofold, from 1.65 percent average returns per month to 3.77 percent average monthly returns.

Similar to the study of Bird and Casavecchia (2007), Leivo and Pätäri (2011) conducted a study on the Finnish stock exchange for the period 1993 to 2008 that included value portfolios comprising composite value indicators, instead of individual value indicators. Leivo and Pätäri (2011) constructed value portfolios using value indicators consisting of P/E ratio, book-to-market (B/M) ratio, dividend yield (D/P) and earnings before interest, tax, depreciation and amortisation over enterprise value (EBITDA/EV). Their findings revealed that the best composite value portfolio, when combined with price momentum, improved the average annual returns of a value-only portfolio by five percent (ten percent better than the market). In addition, the authors showed that by employing a

130/30 long-short momentum strategy on a value portfolio, the average annual returns was 10.5 percent higher than a value-only portfolio. In both cases, Leivo and Pätäri (2011) also demonstrated that the volatility (measured as percentage variation) reduced from the original value-only strategy.

Both studies above combined momentum with a value portfolio and delivered progressive results. This could be a potential solution to the timing constraint associated with value shares.

1.4 Purpose of the study and relevance to South African business

The motivation for this research study is fourfold, and is as follows:

Firstly, Leivo and Pätäri (2011) suggested further research combining their composite value indicator with the more profound price acceleration momentum timing method employed by Bird and Casavecchia (2007). As a result, this research study will therefore aim to investigate the use of price acceleration momentum as a timing technique for a composite value portfolio, in order to negate the limitations of a buy-and-hold strategy. The study by Beukes (2011) also found that the JSE presented a significantly higher value premium than found in emerged markets like the United States (US) and Europe. To expand on the abovementioned research suggestions and to validate this in the South African environment, this research study will focus on JSE data exclusively.

Secondly, an interesting contrast was found between the JSE and the Finnish stock exchange by Dimson, Marsh and Staunton (2011a). These authors found that when the annualised real equity risk premiums (ARERP) of 19 Credit Suisse yearbook countries were compared, the South African JSE and the Finnish stock exchange were two opposites of the same scale. Dimson *et al.* (2011b) further presented significant differences between the Finnish stock market and the JSE in terms of market volatility. The Finnish stock market achieved a long term annual return volatility of 30.3 percent compared to 22.6 percent in South Africa. This suggests that there is a profound difference between the JSE and the Finnish stock exchange and hence presents an opportunity to study the effects of the Leivo and Pätäri (2011) study (conducted on the Finnish exchange) on the JSE. This would undoubtedly contribute to the current literature on momentum-value combination studies and would offer a reasonable comparison between value portfolios on the JSE and the Finnish stock exchange.

Thirdly, this research study presents a screening tool for value shares that may be used by institutional investors and private investors. Improved timing of value share acquisitions could yield improved returns for investors.

Fourthly, the researcher could not find evidence of a value-momentum combination study conducted in South Africa. This research study would therefore supplement the investment literature in the South African equity environment.

1.5 Research objectives

The following research objectives are identified as a basis for embarking on the chosen topic:

- Identify from previous research the most applicable momentum method to use as a timing technique for a value portfolio;
- Assess whether price acceleration momentum is an improvement over price momentum;
- Construct a value portfolio using a combined value indicator;
- Assess whether abnormal returns are possible when a price acceleration momentum technique is used to enhance a value portfolio on the JSE;
- Establish the difference in returns between a momentum-value combination portfolio, a value-only portfolio and the market benchmark, the JSE all-share index (ALSI), on an absolute basis as well as on a risk-adjusted basis.

2. CHAPTER 2 - LITERATURE REVIEW

2.1 Introduction

The fixation of investors to find the best technique that generates the highest returns has led to many different investment strategies and styles. Some of the most common investment strategies are growth investing, value investing, fundamental analysis, technical analysis and portfolio theory.

2.2 Value investing

Value investing is an investment strategy that focuses specifically on acquiring shares that trade below their intrinsic value (Brown, 2007). A share is considered to trade below its intrinsic value when the share price is below its calculated book value (Guinan, 2009, p. 144). According to Brown (2007) value investors buy shares when they trade at prices well below their intrinsic values and sell these shares in the future when their prices are high.

Value investors typically use indicators or financial ratios to distinguish between value shares and growth shares. The most popular ratios used by value investors in South Africa are the P/E ratio and B/M ratio, where value shares exert low P/E ratios and high B/M values (Nel, 2009; Strugnell, *et al.*, 2011).

According to Fama and French (2006a), growth shares can be identified as low B/M shares, as opposed to value shares that exert high B/M values. An example of growth shares is technology company shares, typically expected by investors to grow above the growth rate of the broad market (Guinan, 2009). Growth shares usually outperform value shares in the short term, but for holding periods in excess of eight months (Cubbin, *et al.*, 2006), value shares start to outperform growth shares.

Cubbin, *et al.* (2006) found in their study between 1983 and 2005 that low P/E value shares on the JSE significantly outperformed high P/E growth shares on average by 61.5 percent. This finding is in line with the study of Beukes (2011) and suggests strongly that value investing in South Africa is a successful investment strategy.

Two recent studies confirmed the prevalence of the value premium in South Africa (Auret & Cline, 2011; Beukes, 2011). Due to the relative superior performance potential of value investing as a long-term investment strategy, this research study focused primarily on exploiting the full potential of a value investment strategy. Table 2-1 is a summary of recent value investing studies, indicating positive returns achieved in all cases.

Table 2-1: Results of recent value investment studies

Author	Exchange	Sample period	Sample size	Investment style	Metric(s)	Results
Piotroski (2000)	COMPUSTAT	1976 - 1996	14,043	Fundamental & value (F-score)	Average annual returns	23.00%
Rousseau & van Rensburg (2004)	JSE	1982 - 1998	Average of top 100 per annum	Value	Average annual returns	23.64%
Cubbin, *et al*. (2006)	JSE	1983 - 2005	1,320	Value vs growth	Annual average abnormal returns	11.15%
Auret & Cline (2011)	JSE	1988 - 2006	Average of 160 per annum	Value	Monthly average abnormal returns	1.24%
Beukes (2011)	JSE	1972 - 2001	N/A	Value	Average annual returns	30.07%

Leivo and Pätäri (2011) observed that a composite value indicator, consisting of the B/M, D/P and EBITDA/EV ratios, improved the average annual returns results profoundly. The authors replaced the traditional P/E ratio with the EBITDA/EV multiple, which had the added advantage of capturing debt and cash (capital structure) in a single multiple (Guinan, 2009). In summary the combination of the three ratios enabled cheap companies, paying high dividends that exert fundamentally strong earnings, to be identified.

Value investing also exerts strong ties with fundamental analysis. Brown (2007) asserted that value investors often use fundamental analysis to derive intrinsic values of shares.

2.3 Fundamental analysis

In broad terms, fundamental analysis employs the use of financial, economic, quantitative as well as qualitative data in order to derive the intrinsic value of a security (Guinan, 2009, pp. 112-113). According to Gorton (2010) fundamental analysis typically include analysing the macroeconomic gauges, industry related trends, company financial statements like the income statements and balance sheets; and also the company's management and strategy.

Piotroski (2000) developed the so-called F-Score (fundamental score), which is a composite measure derived from nine fundamental measures found in a company's financial statements. The seminal F-score study of Piotroski (2000) showed that a high B/M portfolio with strong financials outperformed a standard high B/M portfolio by as much as 7.5 percent annually on average over a 20-year period (1976 to 1996) on the US stock market.

In contrast to Piotroski's F-score (2000), Mohanram (2005) developed a G-Score where tailored fundamental indicators were applied to low B/M shares (growth shares). Mohanram (2005) used eight signals comprising cash flow profitability, earnings growth, earnings stability, capital expenditure and advertising intensity to compile a composite G-Score. These fundamental signals were directly derived from company financial statements. Mohanram (2005) found that low B/M shares with high G-Scores outperformed low B/M shares with low G-Scores. These results are profound in recognising that winning and losing shares could be differentiated even among low B/M shares. However, most of the difference was attributed to low B/M shares with low G-scores that deteriorated more rapidly in price (Mohanram, 2005).

The use of fundamental analysis does not provide a clear answer as to whether a value or growth strategy is preferred, but suggests that companies with strong underlying financial positions are more likely to perform well. However, there is a clear difference between the results obtained by Piotroski's F-Score study (2000) and Mohanram's G-Score study (2005), indicating that value shares with strong fundamentals are more inclined to outperform growth shares with strong fundamentals. This would further suggest that when value investing is combined with fundamental analysis, higher returns are likely.

2.4 Technical analysis

Technical analysis is the opposite of fundamental analysis (Bettman, Sault, & Schultz, 2009). Guinan (2009, p. 297) defined technical analysis as a technique to forecast future movements in share price by making use of price history or trading volumes. Although several formats of technical analysis exist, one of the most popular technical analysis strategies found in literature is momentum (Park & Irwin, 2007). Momentum involves long and short positions on shares – long positions are taken on shares that display positive momentum, and shares with negative momentum are short sold. Table 2-2 contains results of recent momentum studies, indicating positive returns are realizable when momentum investment strategies are employed.

Both price and earnings momentum techniques have presented excess returns (Rey & Schmid, 2007; Leivo & Pätäri, 2011), but Bird and Casavecchia (2007) demonstrated that price acceleration momentum was a superior indication of positive momentum.

Table 2-2: Results of recent momentum investment studies

Author	Exchange	Sample period	Sample size	Investment style	Metric(s)	Results
Leivo & Pätäri (2011)	OMX Helsinki	1993 - 2008	Average of 51 - 110 per annum	Momentum	Average annual returns	20.11%
Rey & Schmid (2007)	OMX Helsinki	1994 - 2004	N/A	Momentum (*long & short*)	Average annual returns	43.79%
Muller & Ward (2012)	JSE	1985 - 2011	Average of top 160 per annum	Styles (momentum)	CAGR	26.10%

According to Ansari and Khan (2012) shares that display positive momentum have consistently shown future return performance. This seems to indicate that positive momentum provides an opportunity to identify the timing of share acquisition opportunities.

2.5 Market inefficiency as a source of value

According to Bettman, *et al.* (2009) momentum is economically significant and returns are robust over time and through numerous global stock markets. This provides significant opposition to the efficient market hypothesis.

Hirschey and Nofsinger (2010, pp. 162-164) defined the efficient market hypothesis (EMH) as theory that all available and relevant information (public and non-public) regarding a security is reflected in the price of the security. Under the EMH, there would be no advantage to any particular portfolio above another. These portfolios would be equally weighted in terms of risk and return, making it impossible for one investor to outperform another (Hirschey & Nofsinger, 2010, p. 162).

According to Fama and French (2006a; 2006b) the value and size premium not only exist, but are pervasive in equity markets internationally. Fama and French (2008) found several additional anomalies, for example share issues, share buybacks and momentum, which produced excess returns. These excess returns for such anomalies go against the strong form of the EMH. Market inefficiencies therefore give rise to value in equity markets.

The presence of market inefficiencies like momentum and the value premium in global equity markets indicates that the opportunity exists to achieve abnormal returns (Fama & French, 2012). The question then arises if these higher than expected returns would be a result of increased risk.

2.6 Investment risk and return

With the combination of momentum and value portfolios, it is important to consider the risk of the newly formed portfolios that ostensibly delivers higher returns. Bodie, Kane and Marcus (2011, pp. 280-282) identified two distinct types of risks of any portfolio on a particular stock exchange, namely systematic- and non-systematic risk. The systematic risk of a portfolio is the risk induced by market-wide price movements and cannot be diversified out, whereas the non-systematic risk (diversifiable risk) of the portfolio is risk associated with the return variance of the portfolio which is attributed to firm-specific components. It has been proven that with an increasing number of shares in the portfolio, the non-systematic risk approached zero (Bodie *et al*, 2011, p. 281). Non-systematic risk can therefore be diversified out by increasing the amount of shares in a portfolio. Hence, this research study included portfolios of shares instead of individual shares.

Traditionally the capital asset pricing model (CAPM) is seen as a method of explaining risk and return on the stock market. The motivation for the use of the CAPM in portfolio management is because it is so "intuitively appealing" (Ward & Muller, 2012, p. 2).

2.6.1 The capital asset pricing model (CAPM)

A study by Fama and French (2006a) indicated that the US stock market between 1926 and 1963 exhibited significant evidence that the CAPM explained the higher returns of value shares. The authors found no evidence of the CAPM explaining returns on the US stock market after 1963. The CAPM expression is given in the following equation:

Equation 2-1: CAPM

$$E(R_i) = R_f + \beta_i(R_m - R_f)$$

Where:

$E(R_i)$ equals the expected return of portfolio i,

R_f is the risk free return rate (usually the ten-year government bond return rate),

β_i is the *beta* value of portfolio i and

R_m equals the return of the broad market.

Beta (β_i) is an indication of the risk of the portfolio in relation to the market and a measure of the share price volatility with respect to the market (Hirschey & Nofsinger, 2010, p. 132). In the CAPM formula of equation 1, the returns of the portfolio are higher due to higher values of *beta* (Hirschey & Nofsinger, 2010, p. 134), and hence higher risk.

However, van Rensburg and Robertson (2003) and Strugnell, *et al.* (2011) found that smaller *beta* values were associated with higher returns in the South African equity market, contrary to the assumptions of the CAPM. These results indicate that a lower risk was associated with higher returns. This unambiguously validates the inability of the CAPM to explain JSE share returns. These results are comparable to those of Fama and French (2006a) who found smaller *beta* values for value shares, indicating that higher portfolio returns of value shares are not associated with higher risk in terms of the CAPM. Ward and Muller (2012) reaffirmed the negative correlation of beta with cross sectional returns on the JSE over the period 1985 to 2011.

2.6.2 Multifactor models

Alternatively, the arbitrage pricing theory (APT) suggests that multiple factors can explain the returns of a share (Hirschey & Nofsinger, 2010, pp. 140-142). A generic regression equation can be used to derive drivers of returns of portfolios or indexes. These can offer investors insight into factors influencing their returns (Hirschey & Nofsinger, 2010, p. 142).

Fama and French (1995) found significant evidence of a value and size premium on the US stock market. The authors derived a CAPM regression equation that explained cross sectional returns as a function of two additional variables – the B/M ratio and the company size (market capitalisation). This is commonly referred to as the Fama-French Three-Factor Model (Hirschey & Nofsinger, 2010, p. 143), abbreviated FF3F model. The FF3F model (Fama & French, 1995) asserts that higher returns of smaller market capitalisation company shares are due to lower information availability of companies and their activities. Larger companies are more closely scrutinised and more information about earnings and earnings expectations are published. The authors also reason that high B/M shares deliver higher returns because of increased risk due to relative financial distress. Fama and French (2008) later updated their view, affirming that a mispricing phenomenon caused the B/M effect and not distress factors.

2.6.3 Portfolio return calculation models

Using continuous compounding for return calculations, produce more accurate return estimations in the long term (Benninga, 2008, pp. 257-258). Benninga (2008) asserts that the continuously compounded return calculation delivers marginally lower returns than the discretely compounded version. As a result of the extended period in this research study, the continuously compounded return calculation was used, as in the Equation 2-2.

Equation 2-2: Continuously compounded return

$$R_{jt} = ln\left(\frac{P_{jt}}{P_{jt-1}}\right)$$

Where:

R_{jt} is the continuously compounded return for the *j*th share at time t,

P_{jt} equals the price of the *j*th individual share at time t,

P_{jt-1} is the the price of the *j*th individual share at time t - 1

According to Leivo & Pätäri (2011) the abnormal returns of a portfolio is the difference between the actual return of the portfolio and the expected return of the portfolio as depicted in Equation 2-3.

Equation 2-3: Abnormal portfolio returns (AR)

$$AR_i = R_i - E(R_i)$$

Where:

AR_p denotes the abnormal returns of portfolio i,

R_i is the actual return of portfolio i, and

$E(R_i)$ equals the expected return of portfolio i

Several related calculation models exist that estimate returns and expected returns of portfolios, namely the market-model (index model), market-adjusted model and the mean-adjusted model, consistent with Hirschey and Nofsinger (2010, p. 200). The market-model uses the portfolio CAPM *beta* value to calculate expected returns. Due to the inability of the CAPM to explain returns on the JSE (refer to section 2.6.1), the market-model was not used in this study. The market-adjusted model was used instead as it does not use the CAPM to estimate expected returns. The market-adjusted model is illustrated in the following equation (Hirschey & Nofsinger, 2010, p. 200).

Equation 2-4: Market-adjusted abnormal returns

$$AR_{jt} = R_{jt} - R_{mt}$$

Where:

AR_{jt} equals the abnormal returns of the jth share on day t,

R_{jt} is the actual return of the common stock of the jth share on day t, and

R_{mt} is the return of the market (or market index) on day t

Abnormal returns are commonly aggregated over shares in the portfolio to get the average abnormal returns (AAR) of the portfolio (Hirschey & Nofsinger, 2010, p. 200) as in the equation below:

Equation 2-5: Average abnormal returns (AAR)

$$AAR_{it} = \frac{\sum_{j=1}^{N} AR_{jt}}{N}$$

Where:

AAR_{it} equals the average abnormal returns of portfolio i on day t,

N is the number of shares in portfolio i

Muller and Ward (2012) assert that using AAR is "methodologically weak" (p. 5) compared to using cumulative returns, in the same way as used in event studies in the form of cumulative average abnormal returns (CAAR). This is also affirmed by Hirschey and Nofsinger (2010, p. 200). Consequently, this research study used CAAR to compare portfolio performance over the duration of the study. CAAR over period T_1 to T_2 are calculated as in Equation 2-6.

Equation 2-6: Cumulative average abnormal returns (CAAR) (a)

$$CAAR_{T1,T2} = \frac{\sum_{j=1}^{N}\sum_{t=T1}^{T2} AR_{jt}}{N}$$

Where:

$CAAR_{T1,T2}$ equals the cumulative average abnormal returns from day T_1 to day T_2

Alternatively, CAAR can be calculated by the following equation:

Equation 2-7: Cumulative average abnormal returns (CAAR) (b)

$$CAAR_{T1,T2} = \sum_{t=T1}^{T2} AAR_{it}$$

2.6.4 Risk-adjusted returns

In addition to abnormal returns, AAR and CAAR, the Sharpe ratio (SR) is used to distinguish between the performances of portfolios. The SR in Equation 2-8 below is a measure of the risk premium earned by the portfolio relative to the total risk of the portfolio expressed as the portfolio standard deviation (Hirschey & Nofsinger, 2010, p. 147).

Equation 2-8: Sharpe ratio (SR)

$$\boldsymbol{SR} = \frac{\bar{R}_{\boldsymbol{p}} - \bar{R}_{\boldsymbol{f}}}{\boldsymbol{SD_p}}$$

Where:

$\bar{R}_p$ is the average return of the portfolio,

$\bar{R}_f$ is the average risk-free rate of return, and

SD_p is the standard deviation of the portfolio returns.

Hirschey and Nofsinger (2010, p. 147) cautioned against the use of the Sharpe ratio (SR) as an absolute gauge of performance and suggested that it could be useful for comparison purposes only. Leivo and Pätäri (2011) observed increasingly skewed return distributions for higher average return investment strategies, which inevitably disqualifies the standard deviation as a true proxy for risk. In addition to this view, Zakamouline and Koekebakker (2009) assert that the standard deviation is a useful proxy for risk when the underlying return distribution is normally distributed. As a result, the Sharpe ratios of portfolios in this research study were used for relative comparison purposes only.

2.7 Combining momentum with value investing

Bird and Casavecchia (2007) defined three types of value shares:

- Type one value shares, which are value shares that will immediately start performing once they have been identified as value shares;
- Type two value shares, which will only start to perform after some time in the future;
- Type three value shares, which are value shares that will remain stagnant and that are not likely to ever perform

According to Bird and Casavecchia (2007), type one shares are highly desirable, the acquiring of type two shares are to be delayed until they start to perform and type three value shares are to be avoided.

Leivo and Pätäri (2011) used price momentum (PM) as a timing indicator in their study on the Finnish stock exchange (refer to Section 1.3). Bird and Casavecchia (2007) obtained significant average monthly returns (AMR) when price acceleration momentum (PAM), instead of PM was used as a timing method for value portfolios (3.77 percent). These results and other recent value-momentum study results are depicted in Table 2-3.

According to Bird and Casavecchia (2007, p. 232), high PAM is an indication that the share is likely to be in the initial stages of its price cycle, where acceleration of price normally follows. Lee and Swaminathan (2000) provide an alternative view that momentum is predictable from past share trading volumes. The authors further found that value shares with low past trading volumes displayed increasingly better future earnings, which is essentially similar to the price cycle explanation of Bird and Casavecchia (2007).

Table 2-3: Results of recent value-momentum investment studies

Author	Exchange	Sample period	Sample size	Investment style	Metric(s)	Results
Bird & Casavecchia (2007)	15 European exchanges	1989 - 2004	8,000	Value & price momentum	Average monthly returns	V-M: 1.65% V: 1.28%
Bird & Casavecchia (2007)	15 European exchanges	1989 - 2004	8,000	Value & price acceleration momentum	Average monthly returns	V-M: 2.46% V: 1.28%
Leivo & Pätäri (2011)	OMX Helsinki	1993 - 2008	Average of 51 - 110 per annum	Value & price momentum	Average annual returns	V-M: 24.82% V: 19.85%

The crude PM indicator, as used in the study of Leivo and Pätäri (2011), did not differentiate the momentum price cycle of the share. Bird and Casavecchia (2007) offered an uncomplicated method of determining shares with high momentum acceleration. However, the price acceleration method has been uncontested.

Therefore, the price acceleration momentum method of Bird and Casavecchia (2007) and the price momentum method of Leivo and Pätäri (2011) were used in this research study. Price momentum (PM) and price acceleration momentum (PAM) are calculated as follows (Bird & Casavecchia, 2007):

Equation 2-9: Price momentum

$$PM = \left(\frac{P_{jt} - P_{jt-J}}{P_{jt-J}}\right) \times 100\%$$

Where:

PM is the price momentum of the individual share,

P_{jt} equals the price of the jth individual share on day t,

P_{jt-J} is the price of the jth individual share on day t-J, and

J is called the formation period (Rey & Schmid, 2007), for example, J will equal 12 when the 12-month price momentum is calculated.

Equation 2-10: Price acceleration momentum

$$PAM = \frac{PM_x}{PM_y}$$

Where:

PM_x equals the intermediate term price momentum, and

PM_y is the long term price momentum.

Bird and Casavecchia (2007) used the 12-month PM over the 24-month PM (x equal to 12 and y equal to 24) as the PAM indicator in their study. Consequently the same PAM philosophy was used in this research study. As for the price momentum relative, Muller and Ward (2012) recently determined the optimal formation period of 12 months with a holding period of three months for the JSE. The 12-month price momentum was consequently used as the basis of comparison in this study.

Combining momentum with a value portfolio presents the opportunity to rebalance portfolios regularly to maintain shares in the portfolio that are likely to accelerate in the future. Regular rebalancing of portfolios will reduce the likelihood of retaining shares that are in their late price cycles and likely to decline in the immediate future. Rebalancing of portfolios will therefore be performed every three months to align with that of Bird and Casavecchia (2007).

2.8 Summary of literature

The benefits of the value investing style are prevalent in the literature and positive returns are likely when long holding periods are maintained. However, many authors reported long periods of inactivity of value shares. Both price momentum (PM) and price acceleration momentum (PAM) methods present an opportunity to time the acquisition of value shares.

However, the combination of value and momentum is extremely limited in the literature, with the exception of Bird and Casavecchia (2007) and Leivo and Pätäri (2011) that offered solutions to the timing inadequacy of a value-only portfolio.

In the Leivo and Pätäri (2011) study, price momentum was used to enhance a value-only portfolio. This enabled to authors to improve annual average returns from 19.85 percent to 24.82 percent.

Bird and Casavecchia (2007) on the other hand reported only a marginal improvement in average monthly returns from 1.28 percent to 1.65 percent when value was combined with price momentum. However, when the authors included the acceleration momentum indicator (PAM), the average monthly returns increased to a staggering 2.46 percent. According to Bird and Casavecchia (2007), a large positive PAM value indicated the early price cycle and such shares would be likely to increase in price in the near future.

The work of Leivo and Pätäri (2011) revealed a three compositve value indicator that qualified value shares according to B/M, D/P and EBITDA/EV. In summary the combination of these three ratios enabled the identification of inexpensive companies (B/M), paying high dividends (D/P), that exert strong fundamental earnings (EBITDA/EV).

This research study therefore aimed to realise positive cumulative abnormal returns through a value portfolio consisting of the composite value indicator of Leivo and Pätäri (2011) with the PAM method of Bird and Casavecchia (2007). The study further aimed to compare price momentum with price acceleration momentum, as the latter had been uncontested in literature.

3. CHAPTER 3 - RESEARCH HYPOTHESES

The preceding chapters indicated that value strategies alone did not perform optimally and that a timing technique such as price acceleration momentum could be a feasible timing trigger for value shares. By combining the work of Bird and Casavecchia (2007) with that of Leivo and Pätäri (2011) on JSE data, the researcher postulates the following:

Hypothesis 1: The null hypothesis states that there is no difference between the CAAR of a high PAM portfolio and the CAAR of an ordinary high price momentum (PM) portfolio. The alternative hypothesis states that the CAAR of a high PAM portfolio are different to the CAAR of a high PM portfolio.

$H_{1,0}$: $CAAR_{PAM} = CAAR_{PM}$

$H_{1,A}$: $CAAR_{PAM} \neq CAAR_{PM}$

Sub Hypothesis 1: The null hypothesis states that there is no difference between the risk-adjusted returns (Sharpe ratio, SR) of a high PAM portfolio and the risk-adjusted returns of an ordinary high price momentum (PM) portfolio. The alternative hypothesis states that the risk-adjusted returns of a high PAM portfolio are different to the risk-adjusted returns of a high PM portfolio.

$H_{1S,0}$: $SR_{PAM} = SR_{PM}$

$H_{1S,A}$: $SR_{PAM} \neq SR_{PM}$

Hypothesis 2: The null hypothesis states that the CAAR of a value portfolio enhanced with price acceleration momentum are equal to zero. Stated differently the null hypothesis states that there is no difference between returns of the combination portfolio and the JSE ALSI. The alternative hypothesis proclaims that the CAAR of a value portfolio enhanced with price acceleration momentum are different to zero.

$H_{2,0}$: $CAAR_{VM} = 0$

$H_{2,A}$: $CAAR_{VM} \neq 0$

In Hypothesis 2, the CAAR are compared to zero due to the CAAR of the ALSI being exactly zero when the market-adjusted abnormal returns calculation of Equation 2-4 was applied.

Sub Hypothesis 2: The null hypothesis states that there is no difference between the risk-adjusted returns (Sharpe ratio, SR) of a value portfolio enhanced with price acceleration momentum and the risk-adjusted returns of the All-share index (ALSI). The alternative hypothesis states that the risk-adjusted returns of a value portfolio enhanced with price acceleration momentum are not equal to the risk-adjusted returns of the ALSI.

$H_{2S,0}$: $SR_{VM} = SR_{ALSI}$

$H_{2S,A}$: $SR_{VM} \neq SR_{ALSI}$

Hypothesis 3: The null hypothesis states that that there is no difference between the CAAR of a value portfolio enhanced with price acceleration momentum and the CAAR of a value-only portfolio. The alternative hypothesis states that the CAAR of a value portfolio enhanced with price acceleration momentum are not equal to the CAAR of a value-only portfolio.

$H_{3,0}$: $CAAR_{VM} = CAAR_{V}$

$H_{3,A}$: $CAAR_{VM} \neq CAAR_{V}$

Sub Hypothesis 3: The null hypothesis states that that there is no difference between risk-adjusted returns of a value portfolio enhanced with price acceleration momentum and a value-only portfolio. The alternative hypothesis states that the risk-adjusted returns of a value portfolio enhanced with price acceleration momentum are not equal to the risk-adjusted returns of a value-only portfolio.

$H_{3S,0}$: $SR_{VM} = SR_V$

$H_{3S,A}$: $SR_{VM} = SR_V$

4. CHAPTER 4 - RESEARCH METHODOLOGY

4.1 Introduction

The research methodology in this research study was broadly modelled on the methodology of Bird and Casavecchia (2007). Both the study of Bird & Casavecchia (2007) and that of Leivo and Pätäri (2011) combined a momentum indicator to enhance the performance of a value portfolio. These studies were conducted in Europe and Finland respectively, while this research study utilised JSE data in order for results to be comparable. With reference to Section 1.4 and to the best knowledge of the researcher, this is the first study that involved price acceleration momentum utilising JSE data.

4.2 Research design

A deductive research approach together with a quasi-experimental time series design was used in this research study (Saunders & Lewis, 2012). This design is pervasive in the literature on studies comparing the performance of investment portfolios. Time series comparison of portfolios is visual and supports the understanding of differences between portfolios over time in the form of quintile portfolio graphs, cumulative returns (CR) and cumulative average abnormal returns (CAAR). The testing of hypotheses was done in a quantitative way in order to determine statistically significant differences.

For this quantitative research study, JSE data was used exclusively in this empirical study as discoursed in Section 1.4. This study focused on the combination of value and momentum investing techniques with the aim of distinguishing between portfolio returns and risk adjusted portfolio returns. In order to successfully demonstrate this in a quantitative way, time series data of several years was utilised to cover three broad areas of the methodology design.

The three broad areas included time series graphs, average monthly returns (AMR) and cumulative average abnormal returns (CAAR). This design approach was chosen to achieve comprehensive comparison of the different investment styles. Monthly returns were determined utilising the continuously compounded return calculation consistent with Equation 2-2. The three designs are discussed below.

4.2.1 Time series research design

The time series research approach was aligned with that of Muller and Ward (2012). This graphical method was useful in visually comparing quintile portfolios of the chosen investment styles with a benchmark portfolio, the ALSI. The specific time series design cumulated portfolio returns (CR) over the full duration of the study by means of compounding, as per Equation 4-1.

Equation 4-1: Cumulative returns (CR)

$$CR_{T_2} = \prod_{i=T_1}^{T_2} \left(1 + R_{T_1}\right) - 1$$

Where

CR_{T_2} equals the cumulative returns at time T_2,

R_{T_1} is the actual portfolio returns at time T_1.

A summary measure that was useful in comparing investments is the compound annual growth rate (CAGR). The CAGR is not the actual growth of an investment, but can be defined as "an imaginary number that describes the rate at which an investment would have grown if it had grown at a steady rate" (Guinan, 2009, p. 47). The CAGR is given in Equation 4-2.

Equation 4-2: Compound annual growth rate (CAGR)

$$CAGR = \left(\frac{P_{iT_f}}{P_{iT_0}}\right)^{\left(\frac{1}{\#\ of\ years}\right)} - 1$$

Where:

P_{iT_f} is the value of portfolio i at the end, time T_f,

P_{iT_0} equals the value of portfolio i at the beginning, time T_0, CAGR was useful in this research study as a single value comparison of portfolio return performance. CAGR figures were added to time series graphs to supplement cumulative return trends consistent with Muller and Ward (2012).

4.2.2 Average monthly returns research design (AMR)

It was not initially intended utilising average monthly returns (AMR) for comparing portfolios. Since the study of Bird and Casavecchia (2007) portrayed results in the form of AMR, this method was included in this study in order to facilitate comparison of results. AMR of portfolios were calculated by averaging monthly returns as in the Equation 4-3 and used in comparing performance of portfolios.

Equation 4-3: Average monthly returns (AMR)

$$AMR_{it} = \frac{\sum_{t=1}^{n} R_{it}}{n}$$

Where:

AMR_{it} equals the average monthly returns of portfolio i on day t,

R_{it} is the returns of portfolio i at month t,

n is the number of months

4.2.3 Cumulative average abnormal returns research design (CAAR)

Although AMR were used to align with Bird and Casavecchia (2007), the CAAR method is an improvement when used analogous to the method used in event studies (Muller & Ward, 2012). CAAR values for each portfolio were derived from Equation 2-7, based on AAR values. The application of the method was equivalent to that of Benninga (2008, p. 380), where AAR for each portfolio were cumulated over the duration of the study.

4.2.4 Sharpe ratio research design (SR)

The aim of sub hypotheses in this research study was to compare returns of portfolios on a risk-adjusted basis. Consistent with Section 2.6.4, the Sharpe ratio of each winner and benchmark portfolio was determined by utilising the average monthly returns of the portfolio for the full study duration.

A risk free rate of eight percent per annum was assumed for the Sharpe ratio calculation, which is based on a reasonable average for a ten-year government bond rate in South Africa for the past few years. The standard deviations of returns of portfolios were derived from the actual monthly returns.

4.3 Data collection, population and sampling

Access to JSE data from 1985 until 2012 was provided by C. Muller (personal communication, September 24, 2012), in the form of a proprietary 'style engine' as used in the studies by Muller and Ward (2012) as well as Ward and Muller (2012). The 28-year time period sufficiently coincided with the study of Bird and Casavecchia (2007) spanning from 1989 to 2004, as well as the study of Leivo and Pätäri (2011) conducted over the period 1993 to 2008.

The 'style engine' comprised JSE share price data obtained from Sharenet as well as published company financial statement data obtained from INET. The dataset included all companies listed on the JSE from 1 January 1985 to 31 August 2012, including unlisted and newly listed companies.

The sample population consisted of the JSE all share index (ALSI), which was on average the top 160 companies by market capitalisation each year. According to Muller and Ward (2012), the top 160 companies signify 99 percent of the total combined market capitalisation of all the companies listed on the JSE. Companies with micro market capitalisations were excluded from the sample population in order to reduce the risk of thin trading (low liquidity). The problem with thinly traded shares is that it often results in unrealistically low CAPM *beta* values, negatively affecting expected return calculations. In addition, trading shares that exert low liquidity are often subjected to long waiting periods and are therefore incompatible with the investment strategy investigated in this research study.

In addition, companies needed to be listed for at least two years for inclusion in portfolios to accumulate enough financial information, for example to perform PAM calculations. Although the population start date is 1 January 1985, the portfolio returns of the sample were initiated at the end of December 1986. The resultant sample population had to be corrected for certain biases and inaccuracies.

4.3.1 Data correction within sample

Basiewicz and Auret (2009) found that the inclusion of transaction costs had a significant effect on the persistence of the size and value effects on the JSE. However, the studies of Bird and Casavecchia (2007), as well as Leivo and Pätäri (2011) did not include transaction costs. In order to compare results of this research study with those of the above authors, transaction costs were ignored.

Leivo and Pätäri (2011) also addressed survivorship bias by not excluding companies from the dataset that ceased to exist during the period of the study. Survivorship bias, according to Deaves (2004), distorts actual returns and data needs to be corrected for this bias in time series research studies. During this research study, share prices were kept constant for companies that delisted between rebalancing periods, until they dropped off the list after the rebalancing step.

Another common bias, 'looking ahead bias' was corrected by incorporating a three-month lag time between published financial information and actual company financial year-end. This is in line with the study of Muller and Ward (2012) and that of Strugnell *et al* (2011) who also used three-month lag periods between company financial year-end and reporting dates. This is comparable with the methodology of Bird and Casavecchia (2007), where a four-month lag period was incorporated.

An additional crucial correction step involved correction for share splits, share issues and consolidations. These corrections were backwardly adapted in time series data of the style engine. Share buy backs were ignored, as it mostly only affect the investor taking up the share buy-back offer. Dividends and special dividends have a material impact on returns and were taken into consideration for portfolio return calculations at the end of each month.

4.4 Portfolio creation

Table 4-1 is a summary of metrics that were used for comparing portfolios. Throughout the study, portfolios were compared with each other in pairs of two. Two-sample hypothesis testing was preferred above paired tests as the underlying distributions of each portfolio provided additional insight.

Table 4-1: Variables used for portfolio comparison

Abbreviation	Variable
AMR	Average monthly returns
CAGR	Compounded annual growth rates
CR	Cumulative returns
CAAR	Cumulative average abnormal returns
SD	Standard deviation of returns
SR	Sharpe ratio

4.4.1 Portfolio creation – value portfolios

The portfolio creation methodology of this research study was broadly based on that of Muller and Ward (2012) and the quintile portfolio creation method of Bird and Casavecchia (2007). For example, in creating a value portfolio, shares were ranked from one to 160 according to their value indicator(s) and divided into five portfolios (quintiles) – one being the portfolio with the greatest value indicators and five the portfolio with the weakest value indicators. All other portfolios in this research study were created utilising this philosophy.

For the creation of value portfolios, the three-composite value indicator of Leivo and Pätäri (2011) was incorporated. As outlined in Section 1.3, Leivo and Pätäri (2011) found the most successful three-composite value indicator consisting of the D/P, the B/M and the EBITDA/EV ratios. These value indicators were calculated individually and combined into a composite indicator by means of a total ranking (in ascending order). Financial statement information from INET was used within the style engine to obtain values for the ratios.

Table 4-2: Steps in screening value shares, derived from Leivo and Pätäri (2011)

Example screening value shares	Rank ascending (D/P)	Rank ascending (B/M)	Rank ascending (EBITDA/EV)	Add rank and rank again ascending
Share A	37	22	12	71
Share B	19	9	11	39
Share C	2	8	4	14
Rank shares according to composite value				x

As presented in Table 4-2, each value indicator was calculated for each individual share and ranked in ascending order. The ranking of the three individual indicators were added and for a second time ranked in descending order. Shares were subsequently divided into five (quintile) portfolios.

The above process was repeated every twelve months over the duration of the study to simulate a buy and hold value investing strategy. Return results of each portfolio were displayed in longitudinal time series graphs as defined in Section 4.2. This portfolio was also used as the basis for the momentum enhanced portfolios

4.4.2 Portfolio creation – price momentum portfolios

Muller and Ward (2012) observed that on the JSE, a 12-month momentum strategy with a three month holding period performed optimally. This correlates with the findings of Novy-Marx (2012) who observed higher returns when momentum is applied between seven and 12 months backward. Consequently, a 12-month price momentum with a three month rebalancing period philosophy was used in this research methodology.

The 12-month price momentum was calculated for each share in the population of top 160 shares utilising Equation 2-9 (with J equal to 12). The population of 160 shares were ranked in descending order according to their 12-month price momentum and subsequently divided into five quintiles. The quintile with the highest price momentum was the winner portfolio while the loser portfolio comprised the lowest price momentum. The rebalancing procedure was performed every quarter. The price acceleration momentum portfolios were created in a similar fashion.

4.4.3 Portfolio creation – price acceleration momentum portfolios

Three different momentum-type portfolios were created. The price momentum (PM) portfolio formed the benchmark for the other two, since it had been optimised previously by Muller and Ward (2012) and hence involved the 12-month price momentum. The second momentum portfolio used the PAM indicator, which was determined by dividing the 12-month PM by the 24-month PM as per Equation 2-10.

The third momentum portfolio was created by the combination of the two portfolios, PM_{12} and the PAM. This is consistent with the methodology of Bird and Casavecchia (2007).

In the subsequent step, shares were ranked from large to small momentum values and divided into five quintiles with the winner quintile having the highest values and the loser portfolio the lowest. Portfolio returns were calculated after every month and the above procedure repeated on every rebalancing phase. The outcome of these portfolios is shown in Section 5.4.

4.4.4 Portfolio creation – value-momentum combination portfolios

The three momentum-type portfolios created as per the above steps were combined with the three composite value indicator of Leivo and Pätäri (2011) to form three distinct value-momentum portfolio groups. These groups were again divided in five quintile portfolios each, with the winner portfolio the exerting the strongest momentum and value characteristics.

4.5 Unit of analysis

The unit of analysis was time series average monthly portfolio returns. Monthly closing prices of individual shares were used to calculate the weighted-average monthly portfolio returns (AMR). Monthly returns were calculated using the continuously compounded return calculation of Equation 2-2. Dividends were included in monthly return calculations in the month they were paid out.

Rey and Schmid (2007) identified a deficiency with momentum in that it is closely associated with high transaction costs, particularly because of short selling. This research study therefore ignored short selling.

Only long positions were taken on shares, where shares included in portfolios were acquired on an equal-weight basis initially. A process of three-monthly rebalancing of portfolios was performed as indicated in Section 2.7. Portfolios were kept constant for a three-month holding period, where after rebalancing was done and return calculations performed. At each rebalancing occurrence, the above process was repeated. The three-monthly rebalancing process was repeated for each quintile portfolio for the entire period. When shares ceased to exist within the three month holding period, the share prices were kept constant (zero return) until the next rebalancing phase, where they simply dropped out of the selection list.

After the final rebalancing step at the end of the data set was concluded, cumulative returns (CR) of portfolios were compared longitudinally to establish the relative performance of each of the portfolios. Several analysis criteria were used to compare portfolio performance as defined in the following section.

4.6 Data analysis

Data analysis was aligned with the research design of Section 4.2. After data collection, screening and portfolio creation, several steps were performed to examine the data. Hypothesis was subsequently performed at the 5 percent level of significance, which is in line with similar tests in the literature. Null hypotheses were rejected when *p*-values were less than 0.05.

4.6.1 Step 1: Cumulative returns (CR)

Cumulative returns (CR) of portfolios were plotted on time series graphs for the period 31st of December 1986 until the 31st of August 2012. For comparison, time series plots of the ALSI and the 12-month price momentum winner portfolios were also presented in the time series graphs. The CAGR of each portfolio was calculated and displayed on the graphs. Sets of portfolios were analysed visually and compared on the basis of CAGR as an initial step. Although insightful, this method was not statistically significant.

It is however possible to perform hypothesis testing on the difference in portfolio CR. To be able to perform statistical hypothesis testing on CR, each portfolio required a distribution of CR. Since this is a single value obtained at the end of the study duration for each portfolio, a bootstrap method was needed to obtain a distribution of CR for each individual portfolio.

According to Ruiz and Pascual (2002, p. 271) and Ledoit and Wolf (2008, p. 850), financial time series data suffers from kurtosis and clustering of volatilities. This poses challenges with hypothesis tests that infer distributional associations. The bootstrap method however is free of any distributional assumption and offers a viable solution to hypothesis testing irrespective of the distribution (Ruiz & Pascual, 2002, p. 271).

The block bootstrap method (Lahiri, Furukawa, & Lee, 2007; Kreiss & Paparoditis, 2011) is often used in time series data as it captures blocks of data where volatilities have clustered. In a block bootstrapping test, blocks of data of length λ are randomly sampled and replaced in a new time series, called the bootstrap time series.

The block bootstrap method was utilised to randomly sample average monthly returns (AMR) values from each portfolio and replacing it in a new time series for each portfolio. The distribution of CR behaved very similar to that of stock returns, which are log-normally distributed (Benninga, 2008, p. 483). It was therefore necessary to generate a block bootstrap distribution of the logarithm of CR for each portfolio. The bootstrap process was repeated for 5,000 iterations. A block length was chosen as three months ($\lambda = 3$) to coincide with the rebalancing period.

Hypothesis testing was subsequently performed on the bootstrapped distributions. The most common non-parametric hypothesis is the Wilcoxon-Mann-Whitney (WMW) test due to its ability to produce reliable results, irrespective of the underlying distribution (Qu, Zhao, & Rahardja, 2008). Hypothesis testing therefore comprised the non-parametric two-tailed WMW test (called the Mann-Whitney test in StatTools 5.7 ®). All WMW tests were performed utilising the StatTools 5.7 ® statistics package.

Fagerland (2012) cautioned, however, that for large samples, the WMW test results become more erroneous. The sample size for the WMW test was determined by the conversion of the sample size of a t-test through the asymptotic relative efficiency (Gou, 1999). In order to maintain statistical significance all sample sizes for hypothesis testing were adjusted to a minimum of 50 samples throughout the research study.

4.6.2 Step 2: Average monthly returns (AMR)

Average monthly returns (AMR) for each portfolio were determined by Equation 4-3. Bird and Casavecchia (2007) observed skewed return distributions of winner portfolios, which the authors attributed to auto-regression and heteroskedasticity. As a first step, therefore, the Chi-squared normality test was performed on each of the winner portfolio monthly return distributions. It was found that only 60 percent of these distributions were normally distributed at a 5 percent level of significance. Consequently the WMW hypothesis testing method was used as in the preceding step (Step 1).

Each of the portfolios included 308 monthly average returns. However, the required sample size was 105. As a result of the larger than required actual sample size, portfolio average monthly return subsets of 105 sample size were created by using a block bootstrap method (as in the preceding step).

A randomisation procedure in Microsoft Excel ® picked 105 random average monthly returns from each original portfolio AMR. This essentially created a bootstrap distribution of average AMR. The WMW hypothesis test was consequently performed on pairs of bootstrapped distributions. The results of these hypothesis tests are discussed in Chapter 5.

4.6.3 Step 3: Cumulative average abnormal returns (CAAR)

Portfolio returns were converted to CAAR by employing Equation 2-7. The CAAR method is an improvement over the abnormal (excess) returns methodology used in the Bird and Casavecchia (2007) study, as outlined in Section 2.6.3.

In order for CAAR to be used in hypothesis testing it had to be in distribution format. Average abnormal returns were firstly calculated from Equation 2-5. A block bootstrap process was used to draw random AAR values from portfolios into a bootstrap AAR time series. A bootstrapped CAAR was calculated from this series and ran for 5,000 iterations to return a distribution of CAAR for each portfolio.

Chi-squared normality tests were performed on each of the distributions and 33 percent of the distributions failed the test at a 5 percent level of significance. As per Step 2, this justified the use of a non-parametric hypothesis testing method. To maintain Methodological uniformity, the WMW test was performed to determine statically significant differences between pairs of bootstrapped CAAR distributions.

4.6.4 Step 4: Risk-adjusted returns – Sharpe ratio

Bird and Casavecchia (2007) did not perform risk-adjusted comparisons between the portfolios in their study, whereas Leivo and Pätäri (2011) used the Sharpe ratio and the adjusted Sharpe ratio to compare portfolios on a risk-adjusted basis. Since the sub hypotheses of this research study involve comparison on a risk-adjusted basis, this research study incorporated comparisons of the Sharpe ratios as per the methodology of Leivo and Pätäri (2011). Sharpe ratio calculations were performed utilising Equation 2-8 and actual AMR values of each of the portfolios. The average risk free rate was assumed as eight percent per annum.

According to Hirschey and Nofsinger (2010) the Sharpe ratio is not useful as an absolute measure and Sharpe ratios should only be compared on a relative basis. However, according to Leidot and Wolf (2008) the bootstrap method proposes a much more accurate way to test statistical differences between portfolio Sharpe ratios. The authors also reason that other distribution-dependent Sharpe ratio tests are not useful when the data is of time series type. Hence, the Sharpe ratio hypothesis testing in this research study comprised block bootstrap testing.

Leidot and Wolf (2008) recommended a studentised bootstrap, which is in essence the non-parametric bootstrap equivalent of the t-test. To align the testing of sub hypotheses with the block bootstrap method used in the main hypotheses, the studentised version was not adopted. The block bootstrap method offered the advantage of visually comparing distributions whereas the studentised bootstrap method merely exhibits the relative difference. Consequently Sharpe ratio hypothesis testing comprised the block bootstrap method with a block length of three months as in earlier steps, followed by the two-tailed WMW test.

4.7 Research limitations

Due to the nature of its design, this research study posed limitations. These limitations are listed as follows:

- The findings are limited to JSE sample data for the period 1 January 1985 to 31 August 2012. No conclusion can be drawn outside this population and timeline.

- Inferences would not be possible for shares or portfolios that were excluded from the data set. Due to the selection process, shares included in the sample population should be considered profoundly different and direct comparison should be avoided.
- Momentum indicators are backward looking and therefore ignore any future influence. The results of this research should not be subjected to any forecasting as external influences can occur.
- There are many ways to construct portfolios, *inter alia*; based on risk appetites of investors using the modern portfolio theory. The research findings would be limited to the methods used in this research study, including all assumptions, inclusions and exclusions.
- This study ignored short selling of shares and results of this study would not be comparable to studies where short selling was included.
- According to the Fama and French (2006a; 2006b) three factor model (FF3F), small value firms produce anomalous returns. This research study ignored any firms smaller than those in the All Share Index (ALSI) and is therefore not representative of the shares of micro market capitalisation firms.
- Investment management fees, transaction costs, taxes, share buy-backs, company share incentive schemes and backfill bias was not included and/or corrected in this study and would therefore limit the direct comparison of share price behaviour in practice.

5. CHAPTER 5 - RESULTS

5.1 Introduction

To develop an indication of the opportunity for value investing in South Africa, a grab sample was collected from McGregor BFA of the top 160 companies listed on the JSE at the end of December 2011. The summary statistics of Price to earnings (P/E) ratio data is show in Table 5-1 below (constructed with the StatTools 5.7® package)

Table 5-1: Summary statistics of 132 screened P/E ratios

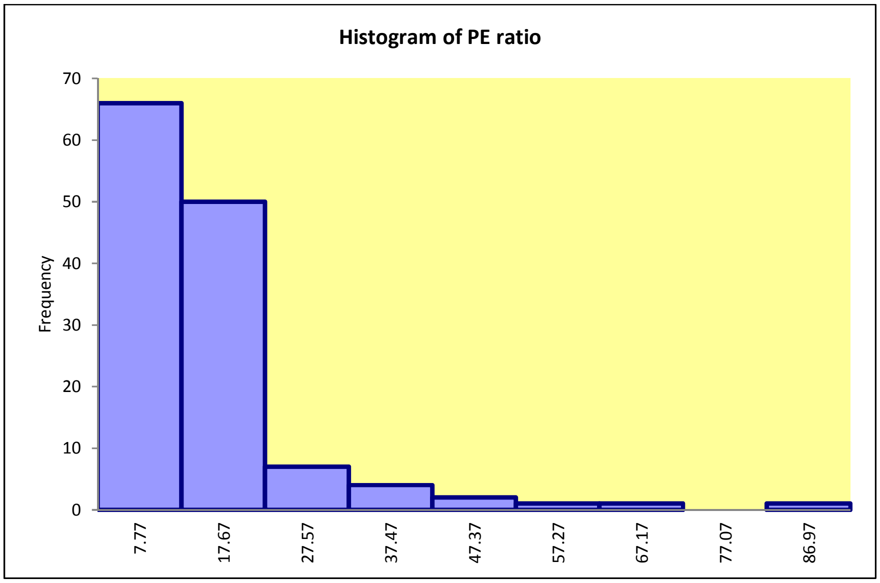
One Variable Summary of P/E ratio	
Mean	15.38
Variance	144.76
Std. Dev.	12.03
Skewness	3.44
Kurtosis	18.79
Median	12.63
Mean Abs. Dev.	6.95
Mode	11.45
Minimum	2.82
Maximum	91.92
Range	89.10

Note: Unrealistic low P/E values of less than 2 and above 100 were deleted. Source: McGregor BFA

Table 5-1 indicates that the average P/E ratio of the JSE was 15.38 at the end of December 2011. With the median only 12.03 the distribution is right skewed and is also confirmed by the skewness of 3.44. A histogram of this distribution is presented in Figure 5-1.

As observed from Figure 5-1, approximately half of the shares had a P/E ratio of less than 13. This is indicative of a pervasive number of value shares listed on the JSE at the time. It is therefore concluded that opportunities exist on the JSE that would allow the introduction of timing indicators, like price momentum and price acceleration momentum.

Figure 5-1: Histogram of P/E ratios for 2011



Source: McGregor BFA

5.2 Portfolio characteristics

The total population of JSE shares for the study period comprised over 14,000 shares and spanned from the 1st of January 1985 to the 31st of August 2012. This population included listed shares, delisted shares and newly listed shares. Prior to any quintile portfolio creation, these shares were screened to include the top 160 shares by market capitalisation.

There were 29.9 shares on average per quarter in each portfolio over the duration of the study. The average 12-month price momentum and PAM values are presented in Table 5-2 for each quintile in the combined momentum portfolio. The total number of shares that were included in all portfolios throughout the entire study period comprised 573 shares.

Table 5-2: Descriptive values for momentum portfolios

	Ave PM12	Ave PAM	Ave Market Cap (R 000)
Quintile 1	89.1%	8.4	11 089
Quintile 2	40.0%	1.1	9 687
Quintile 3	10.4%	0.8	7 901
Quintile 4	-2.9%	-0.3	8 186
Quintile 5	-10.5%	-1.3	7 737

Performance results for the value indicators in each value quintile are provided in Section 5.6 and 5.8. The average number of shares in each quintile was 29.6 per quarter for a twelve month holding period. The total number of shares that were included equalled 567. The value winner portfolio (quintile 1) exhibited the lowest average market capitalisation, while quintile 5 comprised the shares with the highest average market capitalisation.

Table 5-3: Descriptive values for value portfolios

	Ave B/M	Ave D/P	Ave EBITDA/EV	Ave Market Cap (R 000)
Quintile 1	1.41	5.5%	0.30	3 411
Quintile 2	0.97	4.4%	0.22	5 969
Quintile 3	0.76	3.4%	0.18	8 582
Quintile 4	0.58	2.7%	0.14	11 851
Quintile 5	0.39	1.6%	0.10	14 113

5.3 Results of hypotheses and sub hypotheses

Results of each hypothesis and sub hypothesis are shown sequentially in the sections below. The time series graphs are firstly exhibited in each sub section and shown in Figures 5-2, 5-3, 5-6, 5-7 and 5-10. Cumulative returns (CR) are plotted in time series graphs in order to compare portfolio performance visually over the full duration of the study. Higher cumulative returns equal better portfolio performance.

In addition, compound annual growth rates (CAGR) are presented on the right hand side of each of Figures 5-2, 5-3, 5-6, 5-7 and 5-10. As discussed in Section 4.2.1 the CAGR is a suitable single value figure to employ in comparing performance of portfolios, although not statistically significant.

Subsequent to CR and CAGR, average monthly returns (AMR) are presented for each of the portfolios. However not the subject of qualifying the main hypothesis testing, it allowed for comparison with the main benchmark studies on the combination of value and momentum (Bird & Casavecchia, 2007; Leivo & Pätäri, 2011). Average monthly returns are portrayed for each of the portfolios and can be viewed in Tables 5-4, 5-5, 5-7, 5-8, 5-10 and 5-11.

Adding to AMR comparison, the cumulative average abnormal returns (CAAR) results were produced. The CAAR method is preferred when hypothesis testing is performed on time series financial studies (Benninga, 2008; Muller & Ward, 2012). Qualifying main hypotheses in this study involved testing the differences between CAAR of portfolio pairs statistically. Portfolio CAAR values are depicted in Tables 5-4, 5-5, 5-7, 5-8, 5-10 and 5-11, while the full CAAR trends are presented in Figures 5-4 and 5-8.

After performance metrics were obtained, the non-parametric Wilcoxon-Mann-Whitney two-tailed test was performed on portfolio pairs (as outlined in Section 4.6). The z-statistic for each such pair was determined and a statistically significant result, at the five percent level, is indicated with an asterisk next to the associated *p*-value. Z-statistics and *p*-values appear in Tables 5-4, 5-5, 5-7, 5-8, 5-10 and 5-11.

Lastly, the portfolio Sharpe ratios are presented. Sub hypotheses involved comparing portfolios with regard to their Sharpe ratios, a proxy for risk-adjusted returns (Section 2.6.4). Sharpe ratios are depicted in Tables 5-4, 5-5, 5-7, 5-8, 5-10 and 5-11. The Wilcoxon-Mann-Whitney z-statistics and *p*-values are also depicted in the tables. As above, the asterisk next to a *p*-value indicates statistical significance at the five percent level.

Distributions of the average Sharpe ratios for momentum related portfolios and value-momentum combination portfolios are portrayed in Figures 5-5, 5-9 and 5-11 respectively. Results are presented in the above chronology in order of hypothesis.

5.4 Hypothesis 1: Price acceleration momentum *versus* price momentum

Three portfolio methods were used in this hypothesis, the 12-month price momentum (PM_{12}), the price acceleration momentum (PAM) and combined price momentum with price acceleration momentum (PM_{12}-PAM). The performance of these strategies is briefly exhibited below.

5.4.1 Price acceleration momentum (PAM)

Figure 5-2 illustrates the results of the five PAM quintiles alongside the PM_{12} winner quintile and the ALSI benchmark portfolios. These results established that the PM_{12} winner portfolio outperformed the PAM winner portfolio with CR of 341.06 times and 158.59 times respectively.

As presented in Figure 5-2, the PAM winner portfolio (PAM1) produced a CAGR of 21.82 percent *versus* 25.51 percent achieved by the PM_{12} winner portfolio. There was a significant difference observed in the CAAR of the two portfolios where the PM_{12} winner portfolio achieved CAAR of 209.77 percent and the PAM winner quintile only 130.78 percent from Table 5-4. Figure 5-4 confirms the consistent outperformance of the PM_{12} winner portfolio over that of the PAM winner portfolio.

Coherent with the Section 4.6, the Wilcoxon-Mann-Whitney (WMW) test was performed on portfolio returns to determine statistical significance. Table 5-4 illustrates statistical significance for all z-statistics as evidenced by their low *p*-values obtained. The difference in CR, AMR and CAAR of the two portfolios were statistically significant at the five percent level.

Figure 5-2: Cumulative returns of PAM quintiles, PM_{12} winner quintile and ALSI

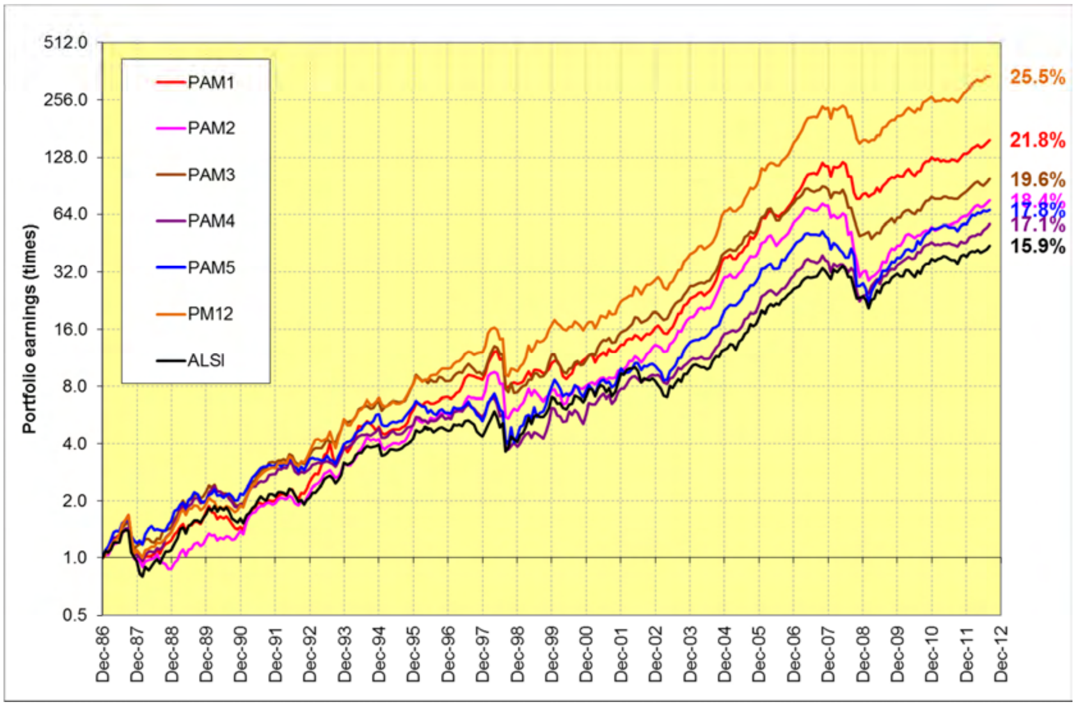


Table 5-4: Summary of performance of PAM and PM_{12} winner portfolios with hypothesis test results

Performance and Hypothesis test results	PM_{12} portfolio	PAM portfolio	z-statistic	WMW *p*-value
Cumulative returns (CR)	341.06	158.59	-4.464	0.0000 *
Average monthly returns (AMR)	2.08%	1.83%	-5.010	0.0000 *
Cumulative average abnormal returns (CAAR)	209.77%	130.78%	3.974	0.0001 *
Compound annual growth rate (CAGR)	25.51%	21.82%		

Note: Hypothesis test: Wilcoxon-Mann-Whitney (two-tailed); * indicates statistical significance at the 5% level; sample size equals 50

5.4.2 Combining price momentum with price acceleration momentum (PM_{12}-PAM)

Figure 5-3 expresses that the combined PM_{12}-PAM winner portfolio achieved significantly higher CR of 963.81 times, while the PM_{12} winner portfolio realised CR of 341.06 times. Figure 5-3 also demonstrates a significant difference in CAGR achieved for the two winner portfolios. The PM_{12}-PAM winner portfolio realised an average out-performance of 5.13 CAGR percentage points over that of the PM_{12} winner portfolio. The superior performance of the PM_{12}-PAM winner portfolio is also reflected in the elevated AMR and CAAR attained (Table 5-5). CAAR trends are displayed in Figure 5-4, confirming the steady outperformance of the PM_{12}-PAM winner portfolio.

Figure 5-3: Cumulative returns of PM_{12}-PAM quintiles, PM_{12} winner quintile and ALSI benchmark

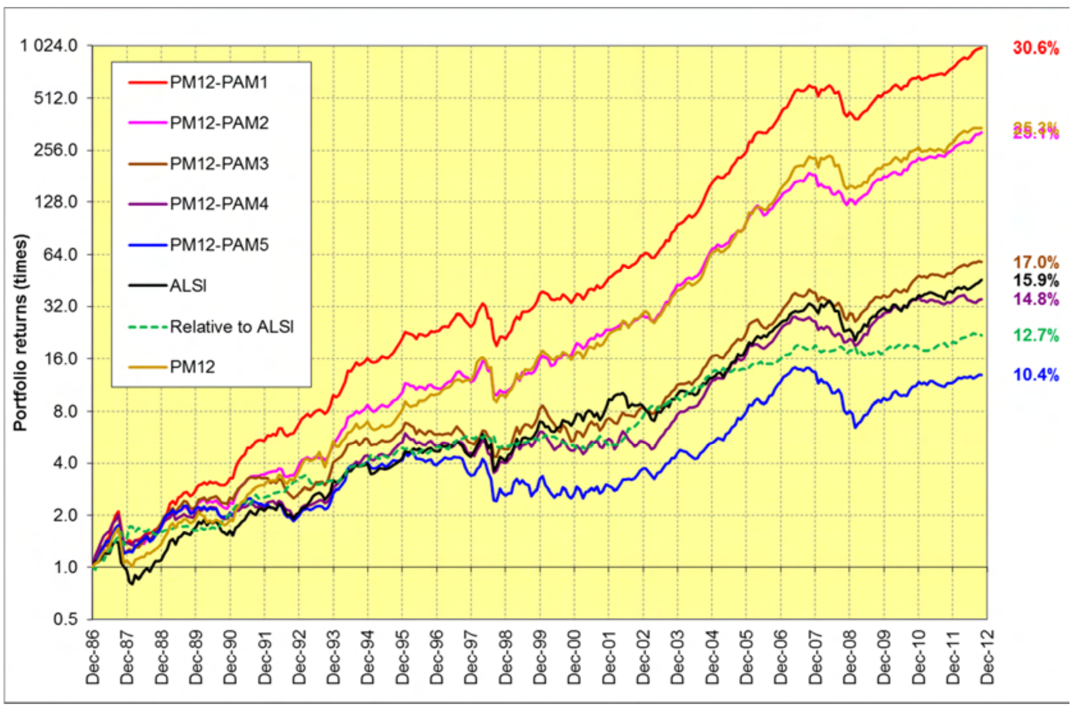


Figure 5-4: Cumulative average abnormal returns of momentum related portfolios

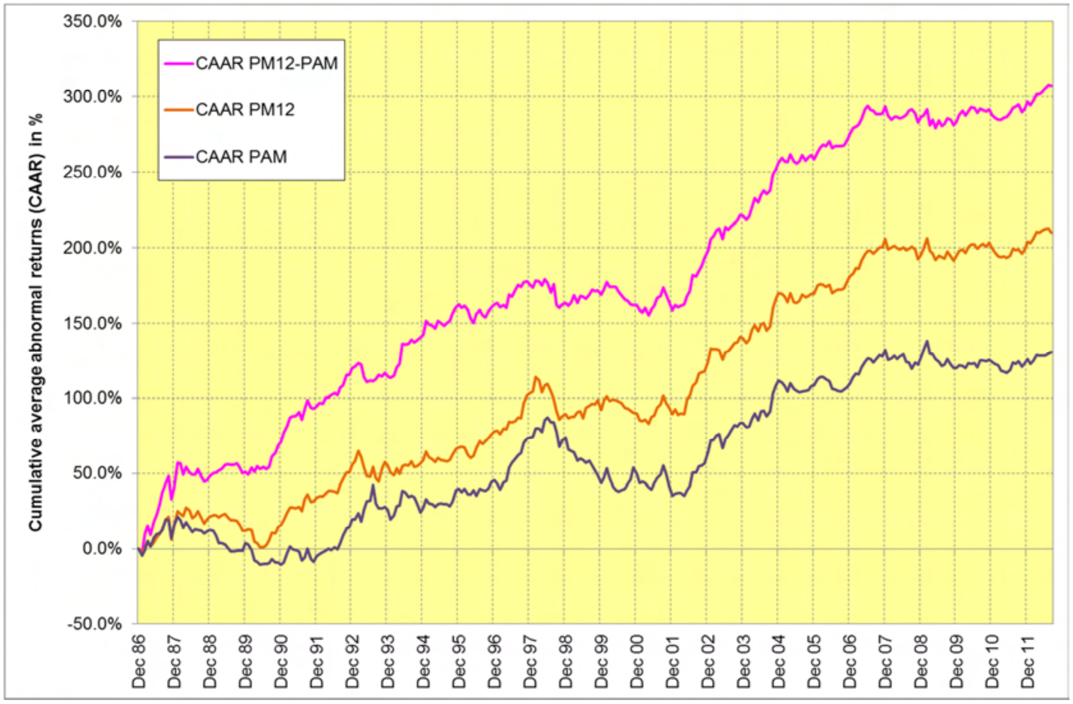


Table 5-5: Summary of performance of PM_{12}-PAM and PM_{12} winner portfolios with hypothesis test results

Performance and Hypothesis test results	PM_{12} portfolio	PM_{12}-PAM portfolio	z-statistic	WMW *p*-value
Cumulative returns (CR)	341.06	963.81	3.285	0.0010 *
Average monthly returns (AMR)	2.08%	2.40%	7.043	0.0000 *
Cumulative average abnormal returns (CAAR)	209.77%	306.88%	-6.463	0.0000 *
Compound annual growth rate (CAGR)	25.51%	30.64%		

Note: Hypothesis test: Wilcoxon-Mann-Whitney (two-tailed); * indicates statistical significance at the 5% level; sample size equals 50

Table 5-5 depicts the two-tailed Wilcoxon-Mann-Whitney test results. The ensuing z-statistics all displayed statistically significant *p*-values of less than 0.05, for all test cases, namely the difference in CR, AMR and CAAR for the two winner portfolios.

5.5 Sub Hypothesis 1: Risk adjusted returns (Sharpe ratio)

Table 5-6 indicates the difference between all the momentum related portfolios via the Sharpe ratios (SR), where the PM_{12}-PAM winner portfolio achieved the most prominent SR of 0.326. The second highest SR of 0.246 was achieved by the PM_{12} winner portfolio. The PAM winner portfolio achieved a SR of 0.203. The standard deviation of returns of the PM_{12}-PAM winner portfolio was lower (5.29 percent) than that of the other two portfolios.

Table 5-6: Sharpe ratios for the PM_{12} winner portfolio and the two PAM winner portfolios

Sub Hypothesis results	PM_{12} portfolio	PAM portfolio	PM_{12}-PAM portfolio
Average monthly returns (AMR)	2.08%	1.82%	2.39%
Monthly standard deviation (SD)	5.72%	5.68%	5.29%
Sharpe ratio (SR)	0.246	0.203	0.326
WMW *p*-value		0.0946	0.0000 *

Note: Hypothesis test: Wilcoxon-Mann-Whitney (two-tailed); * indicates statistical significance at the 5% level; sample size equals 105

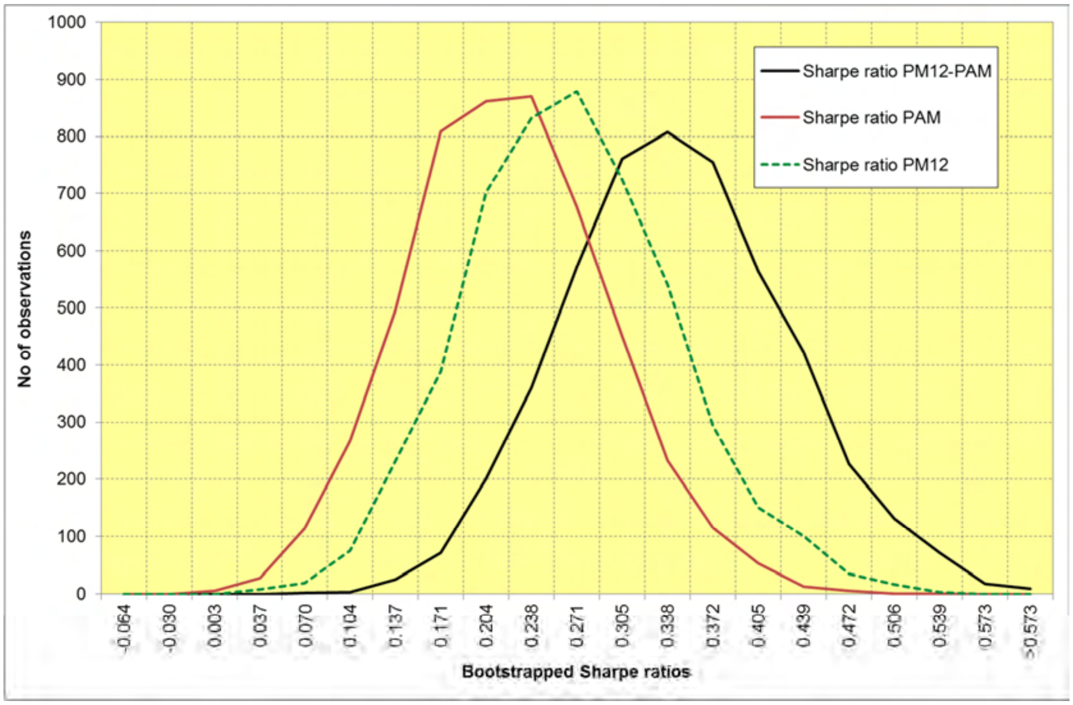
As outlined in Section 4.6, the block bootstrap method was used to re-create distributions of Sharpe ratios for the different winner portfolios. The resultant bootstrapped Sharpe ratio distributions are displayed in Figure 5-5.

These bell-shaped curves indicate considerable overlap of the bootstrapped Sharpe ratio distributions. However, the difference between the SR of the PAM and PM_{12} winner portfolios are not statistically significant at the five percent level as opposed to the difference between the PM_{12}-PAM and PM_{12} winner portfolios which had a *p*-value

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Denkleiers • Leading Minds • Dikgopolo tša Dihlalefi

of less than 0.05. Table 5-6 indicates that the difference between the SR of the PAM and PM_{12} winner portfolios are only statistically significant at the ten percent level.

Figure 5-5: Distribution of block bootstrapped Sharpe ratios



5.6 Hypothesis 2: Value-momentum combination *versus* benchmark

Two portfolio methods were used in this hypothesis, the combination of value with PM_{12}-PAM as well as the combination of value and price momentum (PM_{12}). Time series graphs of the CR of each quintile are displayed together with their CAGR. The performance results of the two combination portfolios are concisely presented below.

5.6.1 Value enhanced with PM_{12} (V-PM12)

From Section 5.4 it was evident that the rudimentary PM_{12} winner portfolio achieved noticeable CAAR, but was outperformed by a combination of PM_{12} and PAM. A value portfolio enhanced with PM_{12} was therefore an apparent choice for comparison. Figure 5-6 indicates a steady outperformance of the winner portfolio of value enhanced with PM_{12} over the ALSI. The V-PM12 winner portfolio achieved a CAGR of 32.08 percent, which is a staggering 16.20 CAGR percentage points higher than achieved by the ALSI, which only attained 15.88 percent CAGR.

Figure 5-6: Cumulative returns of quintiles of value enhanced with PM_{12}, PM_{12} winner quintile and ALSI

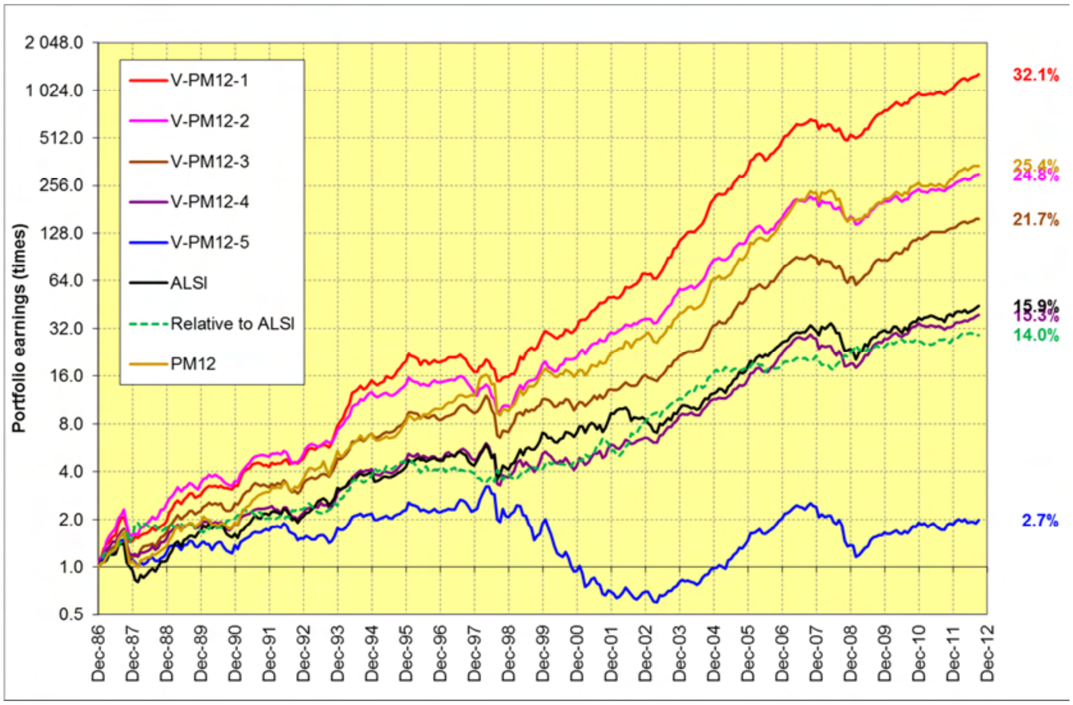


Table 5-7 depicts statistically significant differences between the ALSI and the V-PM12 winner portfolio with respect to CR, AMR as well as CAAR. This is evidenced by the extremely small *p*-values of close to zero.

Table 5-7: Summary of performance of V-PM12 winner portfolio and ALSI benchmark with hypothesis test results

Performance and Hypothesis test results	ALSI	V-PM_{12} portfolio	z-statistic	WMW *p*-value
Cumulative returns (CR)	43.79	1252.10	8.421	0.0000 *
Average monthly returns (AMR)	1.40%	2.47%	12.294	0.0000 *
Cumulative average abnormal returns (CAAR)	0.00%	328.54%	-9.208	0.0000 *
Compound annual growth rate (CAGR)	15.88%	32.08%		

Note: Hypothesis test: Wilcoxon-Mann-Whitney (two-tailed); * indicates statistical significance at the 5% level; sample size equals 50

5.6.2 Value enhanced with PM_{12}-PAM (VM2)

From Section 5.4 it is evident that the PM_{12}-PAM winner portfolio outperformed the ordinary PM_{12} winner portfolio. It could be predicted that combining this style with a value portfolio would result in an improved performance over a value portfolio combined with price momentum. However, this prediction is false as observed in Figure 5-7 where the resultant CAGR of 31.8 percent of the PM_{12}-PAM enhanced value winner portfolio (VM2) was less than that of the PM_{12} enhanced value portfolio of 32.08 percent. Visually, over the duration of the study, the VM2 winner portfolio still performed well beyond the price momentum (PM_{12}) winner portfolio (Figure 5-7) and especially the ALSI benchmark.

Figure 5-7: Cumulative returns of quintiles of value enhanced with PM_{12}-PAM (VM2), PM_{12} winner quintile and ALSI

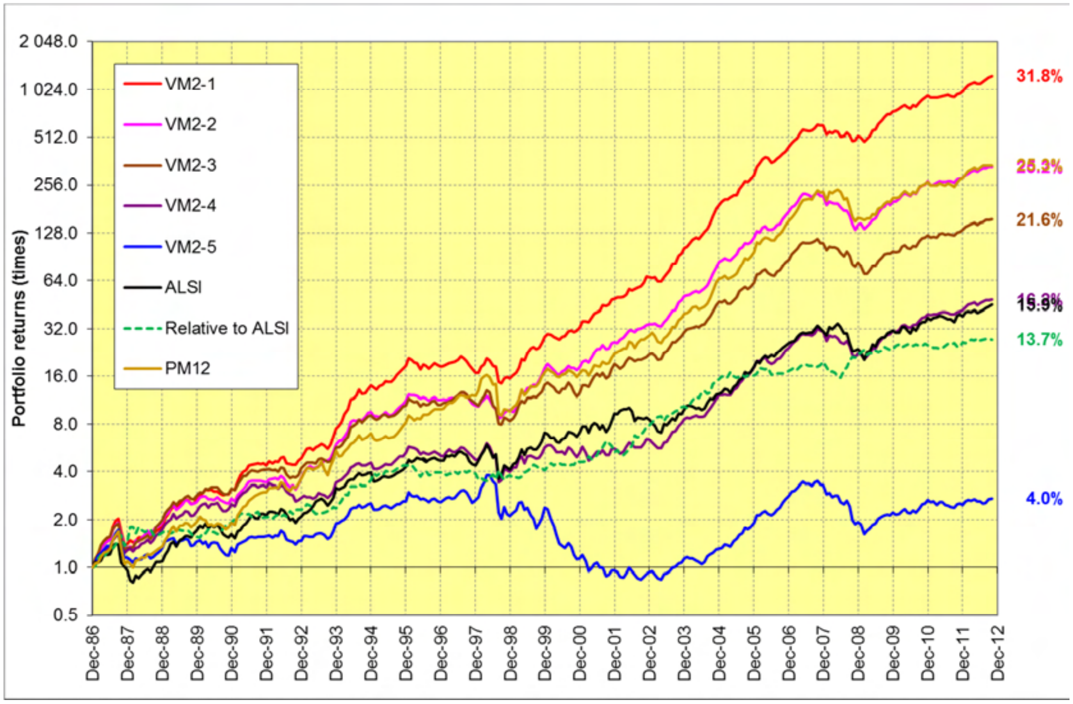


Table 5-8 illustrates that all hypothesis tests with respect to the difference in AMR, CR and CAAR of the VM2 winner portfolio and the ALSI, produced statistically significant z-statistics (*p*-values less than 0.05). The CAAR trends of the Value, V-PM12 and VM2 are presented in Figure 5-8. Both combination portfolios displayed trends that are significantly apart from the CAAR of the ALSI of zero.

Figure 5-8: Cumulative average abnormal returns of value and value-momentum combination portfolios

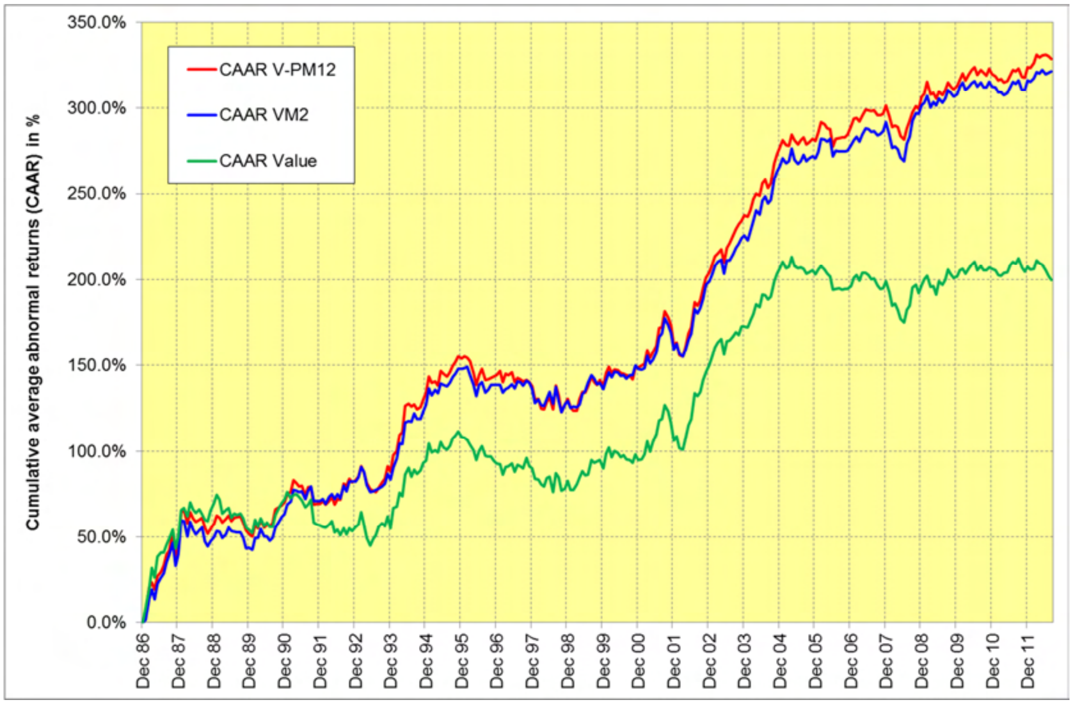


Table 5-8: Summary of performance of VM2 winner portfolio and ALSI benchmark with hypothesis test results

Performance and Hypothesis test results	ALSI	VM2 portfolio	z-statistic	WMW *p*-value
Cumulative returns (CR)	43.79	1187.69	8.276	0.0000 *
Average monthly returns (AMR)	1.40%	2.44%	12.271	0.0000 *
Cumulative average abnormal returns (CAAR)	0.00%	321.29%	-9.208	0.0000 *
Compound annual growth rate (CAGR)	15.88%	31.77%		

Note: Hypothesis test: Wilcoxon-Mann-Whitney (two-tailed); * indicates statistical significance at the 5% level; sample size equals 50

5.7 Sub Hypothesis 2: Risk-adjusted returns (Sharpe ratio)

The statistical analysis results in Table 5-9 indicate that the VM2 winner portfolio achieved a Sharpe ratio of nearly three times that of the ALSI benchmark. This is a significant difference in relative terms. Apart from the lower AMR, the SR of the ALSI benchmark is negatively influenced by its higher standard deviation of 5.78 percent. The monthly returns of the VM2 winner portfolio resulted in a standard deviation of 4.88 percent and that of the V-PM12 winner portfolio 5.03 percent.

It can be observed from Figure 5-9 that the bootstrapped SR distributions of the value-momentum combination portfolios were significantly apart from that of the ALSI. Hence the small *p*-values of both momentum-value combination portfolios compared to the ALSI as in Table 5-9.

Figure 5-9: Distribution of block bootstrapped Sharpe ratios

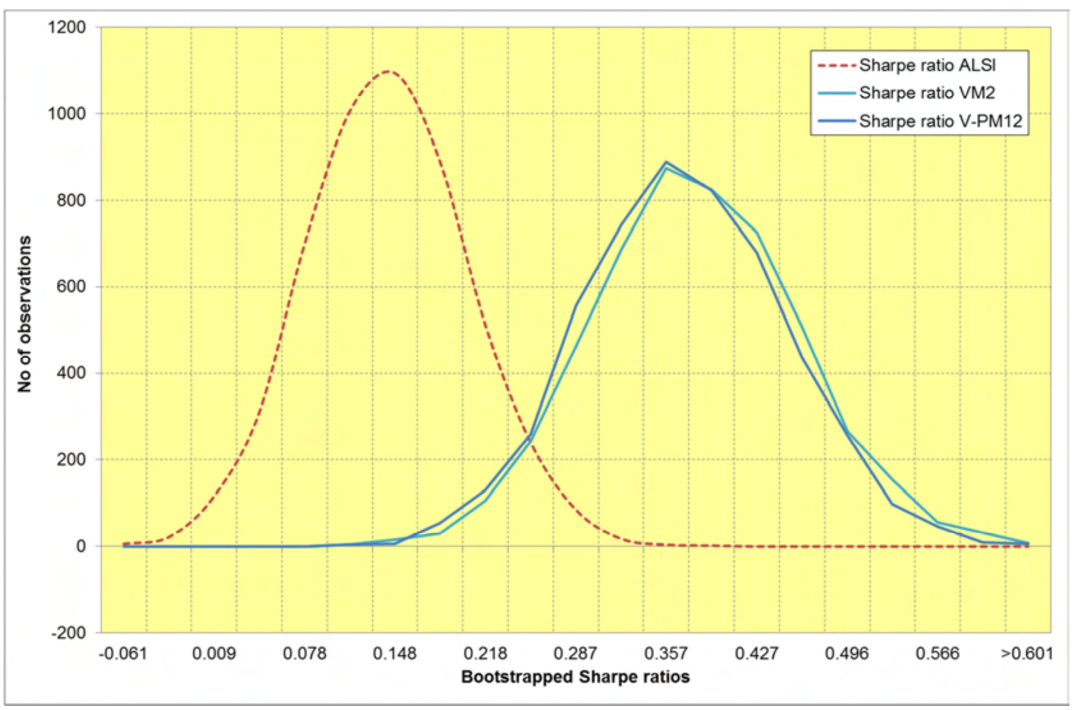


Table 5-9: Sub hypothesis test results: ALSI *versus* value-momentum combination portfolios

Sub Hypothesis results	ALSI portfolio	V-PM12 portfolio	VM2 portfolio
Average monthly returns (AMR)	1.40%	2.46%	2.44%
Monthly standard deviation (SD)	5.78%	5.03%	4.88%
Sharpe ratio (SR)	0.127	0.356	0.363
WMW *p*-value		0.0000 *	0.0000 *

Note: Hypothesis test: Wilcoxon-Mann-Whitney (two-tailed); * indicates statistical significance at the 5% level; sample size equals 105

5.8 Hypothesis 3: Value-momentum combination *versus* value

The same two portfolio methods as in Section 5.6 were utilised in this hypothesis, but compared with a value-only strategy instead of the ALSI benchmark. The performance of the two combination portfolios against that of the value-only strategy is succinctly portrayed below.

5.8.1 Value enhanced with PM_{12} (V-PM12)

With reference to Figure 5-10, the V-PM12 winner portfolio achieved CAGR of 32.08 percent, which was an outperformance of 3.63 CAGR percentage points over the value-only winner portfolio of 25.76 percent. The V-PM12 winner portfolio achieved CAAR of 328.54 percent against the 199.83 percent of the value-only portfolio.

The difference in CR, AMR and CAAR of the V-PM12 and value-only portfolios proved to be statistically significant at the five percent level as evidenced by the extremely small *p*-values in Table 5-10.

Figure 5-10: Cumulative returns of V-PM12, value winner quintile and ALSI

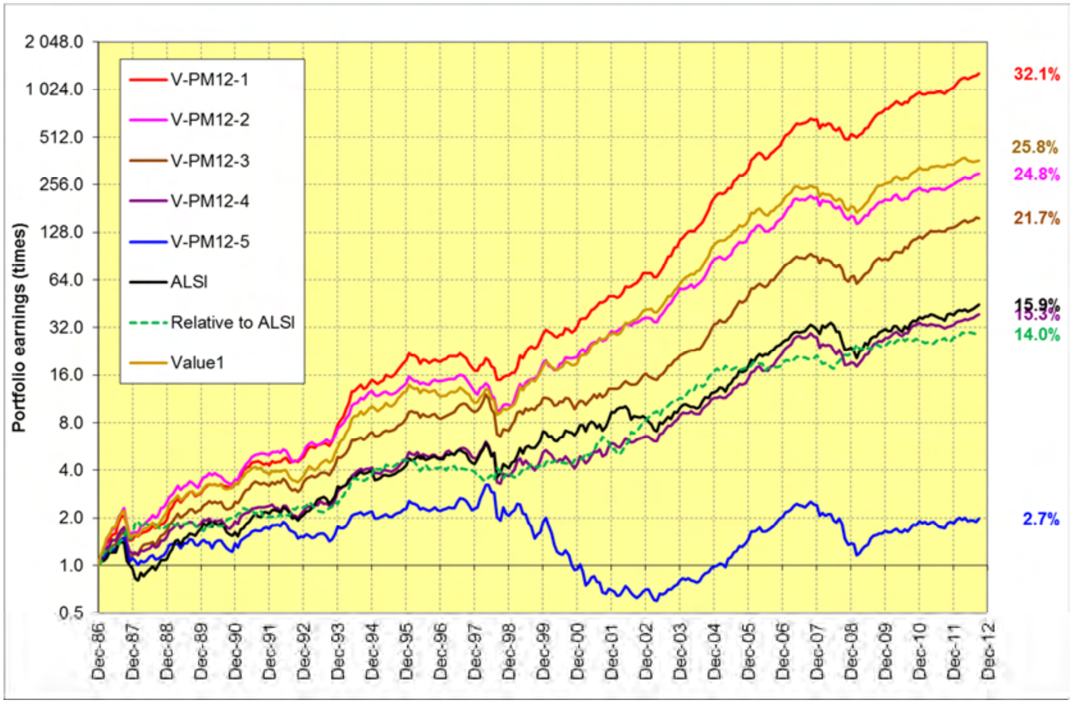


Table 5-10: Summary of performance of V-PM12 and Value winner portfolios with hypothesis test results

Performance and Hypothesis test results	Value portfolio	V-PM_{12} portfolio	z-statistic	WMW *p*-value
Cumulative returns (CR)	358.64	1252.10	5.201	0.0000 *
Average monthly returns (AMR)	2.05%	2.47%	8.581	0.0000 *
Cumulative average abnormal returns (CAAR)	199.83%	328.54%	-6.104	0.0000 *
Compound annual growth rate (CAGR)	25.76%	32.08%		

Note: Hypothesis test: Wilcoxon-Mann-Whitney (two-tailed); * indicates statistical significance at the 5% level; sample size equals 50

5.8.2 Value enhanced with PM_{12}-PAM (VM2)

Figure 5-7 depicts a CAGR of 31.77 percent achieved by the VM2 winner portfolio. This equates to an out-performance of 6.01 percent CAGR over the value-only winner portfolio. Table 5-11 displays statistically significant differences between the VM2 and Value winner portfolios with respect to CR, AMR and CAAR.

Table 5-11: Summary of performance of VM2 and Value winner portfolios with hypothesis test results

Performance and Hypothesis test results	Value portfolio	VM2 portfolio	z-statistic	WMW *p*-value
Cumulative returns (CR)	358.64	1187.69	3.154	0.0016 *
Average monthly returns (AMR)	2.05%	2.44%	8.215	0.0000 *
Cumulative average abnormal returns (CAAR)	199.83%	321.29%	-6.215	0.0000 *
Compound annual growth rate (CAGR)	25.76%	31.77%		

Note: Hypothesis test: Wilcoxon-Mann-Whitney (two-tailed); * indicates statistical significance at the 5% level; sample size equals 50

5.9 Sub Hypothesis 3: Risk-adjusted returns (Sharpe ratio)

Table 5-12 indicates that the VM2 as well as V-PM12 winner portfolios achieved Sharpe ratios of nearly 20 percent greater than the value winner portfolio. These differences are statistically significant as evidenced by the *p*-values that are all below 0.05. This difference is also evident in the shift between bootstrapped SR distributions in Figure 5-11. No significant difference can be observed in the standard deviation between the three portfolios.

Figure 5-11: Distribution of block bootstrapped Sharpe ratios

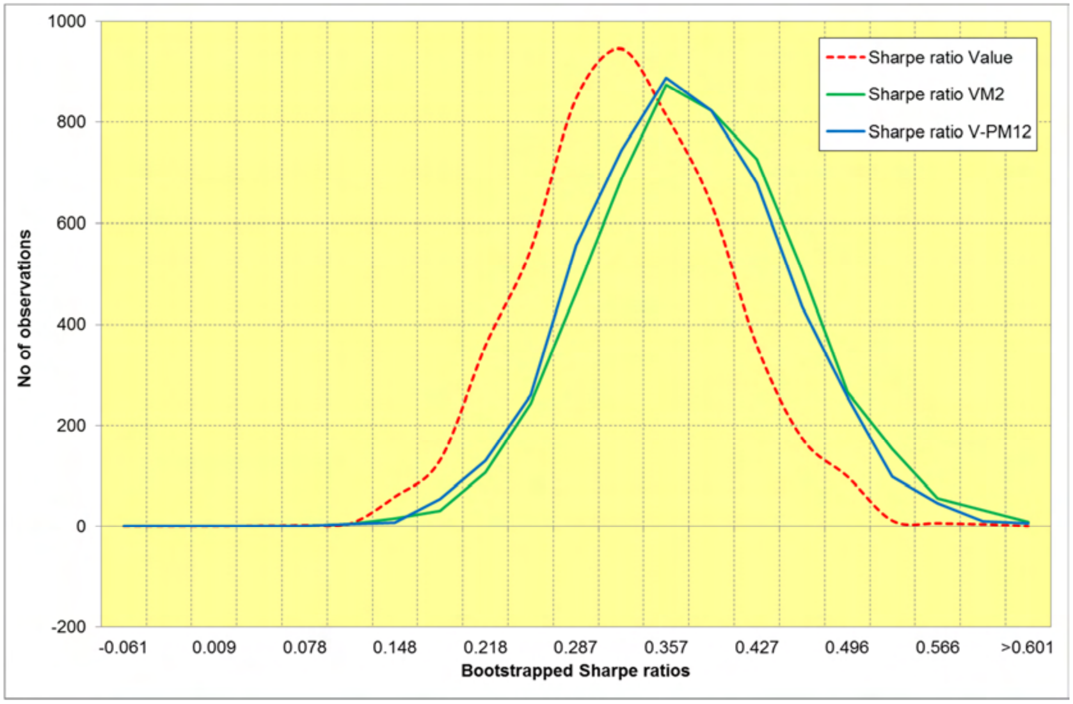


Table 5-12: Sub hypothesis test results: Value and the two value-momentum combination portfolios

Sub Hypothesis results	Value portfolio	V-PM12 portfolio	VM2 portfolio
Average monthly returns (AMR)	2.22%	2.46%	2.44%
Monthly standard deviation (SD)	5.00%	5.03%	4.88%
Sharpe ratio (SR)	0.311	0.356	0.363
MWM *p*-value		0.0204 *	0.0089 *

Note: Hypothesis test: Wilcoxon-Mann-Whitney (two-tailed); * indicates statistical significance at the 5% level; sample size equals 50

The results of this chapter indicate overwhelming outperformance of the value-momentum combination portfolios over both the ALSI benchmark and a value-only strategy. These results are discussed and interpreted in the following chapter.

6. CHAPTER 6 – RESULTS DISCUSSION

6.1 Introduction

The results of Chapter 5 highlight that combining value with momentum (acceleration) on the JSE, is a feasible investment approach where significant market out-performance is possible. With the exception of the stand-alone PAM portfolio, all momentum and combination portfolios created in this research study achieved this out-performance while improving risk-adjusted returns over the compared benchmark in each hypothesis. The results for each hypothesis are sequentially discussed in subsequent sections of this chapter.

6.2 Price acceleration momentum *versus* price momentum

6.2.1 Discussion of main hypothesis results

The price acceleration momentum concept of Bird and Casavecchia (2007) is both unique and sparse in literature. The methodology remains largely unexplored. The aim of this hypothesis was to substantiate dissimilarity between price acceleration momentum and the unsophisticated price momentum.

The results in Section 5.4 illustrate that PAM is a weaker momentum indicator than PM_{12} as a result of its underperformance with respect to CR, AMR, CAAR as well as CAGR. This result may infer that the weakness of this indicator is the consequence of it being only a relative measure. For example, the same PAM of value two can be obtained by a PM_{24} of one percent and PM_{12} of two percent, but also by a PM_{24} of ten percent and PM_{12} of 20 percent. The latter case indicates much higher momentum and is more likely to deliver improved results in the near future.

The use of PAM can therefore not be considered a true proxy for momentum or its acceleration, but rather its relative acceleration. A PM_{12} of two percent is considered low, although greater than zero. Yet, the resultant PAM of two percent can be considered good, but only if the true price momentum is also superior.

It can therefore be inferred that Bird and Casavecchia (2007) was cognisant of this fact when the authors combined price momentum with its acceleration in their methodology.

In combining the two strategies, a significant improvement was made from both individual stand-alone strategies. The PM_{12}-PAM winner portfolio achieved a significant CAGR of 30.64 percent; while PM_{12} and PAM achieved 25.51 percent and 21.82 percent CAGR's respectively.

Both the superior performance of the PM_{12}-PAM winner portfolio and the sub-optimal results of the PAM portfolio were statistically significant compared to that of the ordinary price momentum, at the five percent level. This is evidenced by the low *p*-values obtained for the CR, AMR and CAAR hypothesis tests.

6.2.2 Validity of Hypothesis 1

The hypothesis under examination was to qualify if price acceleration momentum is statistically different from price momentum. Disqualifying Hypothesis 1 would mean that either strategy is preferred. Hypothesis 1 is restated as:

$H_{1,0}$: $CAAR_{PAM} = CAAR_{PM}$

$H_{1,A}$: $CAAR_{PAM} \neq CAAR_{PM}$

The null hypothesis states that there is no dissimilarity between the CAAR of a high PAM portfolio and the CAAR of a high price momentum (PM) portfolio. The alternative hypothesis states that the CAAR of a high PAM portfolio is unlike to the CAAR of a high PM portfolio.

For the case of PAM, The null hypothesis of Hypothesis 1 was rejected at the five percent significance level. The alternative hypothesis was adopted, which states that the CAAR of a high PAM portfolio is different to the CAAR of a high PM portfolio.

For the case of PM_{12}-PAM, the null hypothesis was rejected at the five percent level of significance. For the combination of PM_{12} and PAM, the alternative hypothesis was endorsed, which states that the CAAR of a high PAM portfolio is different to the CAAR of a high PM portfolio.

6.2.3 Discussion of sub hypothesis results

When PAM alone is compared with PM_{12}, it can be observed from Table 5-6 that no additional volatility is introduced as the standard deviation of monthly returns remained practically constant (5.72 to 5.68 percent). However, when the PM_{12} was combined with PAM, there was a dramatic reduction in the standard deviation of returns to 5.29 percent. The result was not at the expense of returns, where the average monthly returns improved nearly 15 percent to a value of 2.39 percent.

However, Leivo & Pätäri (2011) asserted that the appropriateness of the standard deviation of returns as a measure of risk has been questioned in literature. The authors reason that as average returns improve, the return distributions become more right-skewed for which the Sharpe ratio gets penalised due to increased standard deviation.

In addition, Zakamouline and Koekebakker (2009) affirmed that the standard deviation can be considered a measure of risk when returns are normally distributed. Since all three momentum portfolio average monthly returns failed the Chi-squared normality test (results not shown in Chapter 5), and are hence not normally distributed, the standard deviation cannot be considered a true measure of risk. Coherent with Hirschey and Nofsinger (2010, p. 147), the Sharpe ratio may be used as a relative measure. Hence the Sharpe ratios are not used in this study as absolute measures of performance and no comparison is done outside of this research study. However, the Sharpe ratio is a useful tool in comparing portfolios on a relative basis.

6.2.4 Validity of Sub Hypothesis 1

The sub hypothesis under consideration was to qualify whether the risk-adjusted returns of a price acceleration momentum portfolio is statistically different from the risk-adjusted returns of a price momentum portfolio. Sub Hypothesis 1 is restated as follows:

$H_{1S,0}$: $SR_{PAM} = SR_{PM}$

$H_{1S,A}$: $SR_{PAM} \neq SR_{PM}$

The null hypothesis states that there is no difference between the Sharpe ratio (risk-adjusted returns) of a high price acceleration momentum (PAM) portfolio and the Sharpe ratio of a high price momentum (PM) portfolio. The alternative hypothesis states that the Sharpe ratio of a high PAM portfolio is different to Sharpe ratio of a high PM portfolio.

The null hypothesis of Sub Hypothesis 1 is therefore rejected for the difference in Sharpe ratios of the PM_{12}-PAM and PM_{12} portfolios on the basis of the statistical significant *p*-value of less than 0.05. The alternative hypothesis was therefore adopted which states that the risk-adjusted returns of a high PAM portfolio differs from the risk-adjusted returns of a high PM portfolio.

However, the null hypothesis of Sub Hypothesis 1 was defended for the difference in Sharpe ratios of the PAM and PM_{12} portfolios. The p-value of 0.0946 (Table 5-6) was statistically insignificant at the five percent level.

6.2.5 Conclusion of Hypothesis 1

For both momentum methods the alternative main hypothesis was endorsed. However, the CAAR of the PAM portfolio is statistically lower than that of the PM_{12} portfolio, whereas the CAAR of the PM_{12}-PAM portfolio achieved statistically superior results compared to the CAAR of the PM_{12} portfolio. The researcher is therefore in accordance with Bird and Casavecchia (2007) that price acceleration momentum is a more powerful indication of momentum as it incorporates the relative change in momentum.

It is furthermore established that PAM as a stand-alone strategy is mediocre and should not be used, as it is merely a relative indicator. This research study provided this insight and concurs with Bird and Casavecchia (2007) that price acceleration momentum has to be combined with momentum.

The sub hypothesis however, could only be rejected for the difference in Sharpe ratios of the PM_{12}-PAM and PM_{12} winner portfolios. It is therefore concluded that combining PAM with PM adds significant value in terms of average monthly returns, not to the expense of additional risk.

6.3 Value-momentum combination *versus* the ALSI benchmark

6.3.1 Discussion of main hypothesis results

The results of Section 5.6 is coherent with that of Leivo and Pätäri (2011), who observed positive abnormal returns for a value portfolio enhanced with price momentum. The authors recorded average annual returns of 24.82 percent (refer to Table 2-3), which beat the OMX Helsinki market by ten percent. The results of this research study compare well with that of Leivo and Pätäri (2011), where the value combined with price momentum winner portfolio achieved monthly average returns of 2.47 percent, which is equivalent to an average of 29.62 percent when annualised. The ALSI benchmark produced converted average annual returns of 16.80 percent. This indicates a similar, but marginally better out-performance of the value-momentum combination portfolio over the ALSI.

In contrast, Bird and Casavecchia (2007) reported mediocre results for their value portfolio enhanced with price momentum. Average monthly returns of 1.65 percent (Table 2-3) were achieved by the winner portfolio. No benchmark performance was provided although the authors recorded above expected results. The average monthly returns of 1.65 percent are subordinate to the 2.47 percent achieved in this research study.

However, when price acceleration was added to the value and price momentum combination, a marginal decrease in performance was observed. The average monthly returns reduced to 2.44 percent. A slight decrease in all other performance measures was observed (Table 5-7 and Table 5-8). The implication of this observation is that the value portfolio enhanced with price momentum effectively subsumed the advantage of added price acceleration momentum. This draws an interesting paradox with results obtained by Bird and Casavecchia (2007) who found that a value portfolio enhanced with the combination of PM and PAM improved results over a value portfolio enhanced with only PM. The authors found that an ordinary price momentum enhanced value winner portfolio achieved average monthly returns of 1.65 percent as opposed to the 2.46 percent for the value winner portfolio enhanced with price momentum and price acceleration momentum (refer to Table 2-3).

The researcher offers three explanations for this conflicting result. Firstly, it is unknown if Bird and Casavecchia (2007) utilised the optimum PM in their methodology. If their six-month PM was indeed sub-optimal, combining value with PM would naturally yield inferior results. Novy-Marx (2012) found significant evidence that momentum performs optimally when considered from seven to 12 months earlier, or intermediate past. Since this falls outside of the six month price momentum of Bird and Casavecchia (2007), it could be seen as sub-optiimal. To further support this proposition, this research study found that combining price momentum with value delivered average monthly returns of 2.47 percent (from Tables Table 5-7), while the same portfolio in the Bird and Casavecchia (2007) study achieved only 1.65 percent (from Table 2-3).

Secondly, the work of Lee and Swaminathan (2000) provides a rational explanation to this divergent result. The authors found that momentum could be predicted by observing past trading volumes of shares. Lee and Swaminathan (2000) found that momentum is more pronounced midst low volume winner shares and high volume loser shares. Their analysis indicated that low volume shares tend to be value shares and high volume shares growth shares. The authors further found that low volume (value) shares displayed progressively greater future earnings. If this theory holds, then combining price momentum, price acceleration and value, could mean that shares have significant overlap and hence only marginally higher returns than combining only price momentum and its acceleration.

In aid of this explanation, Fama and French (2006a; 2012) observed that the value premium is more profound in small market capitalisation stocks (small stocks). The authors further asserted that momentum returns are larger for small stocks. Under this philosophy, the consolidation of momentum and value would add only marginal value. Since this research study included only the top 160 shares listed on the JSE, the small stock effect would have been limited. But the fact that Bird and Casavecchia (2007) observed the tremendous elevation in returns is probably a small stock effect. The authors specified no lower limit on market capitalisations in their study over 15 country exchanges, but did however ignore share prices below one pound.

In addition, value seems to be concentrated at smaller company stocks in South Africa, as evidenced in Table 5-3, where quintile one value shares exerted the minimum average market capitalisation. Interestingly market capitalisations increased as the quintile number increased. This observation is coherent with the explanations of Fama and French (2006a; 2012) and implies that there is significant overlap of value and momentum in the South African equity environment.

A third explanation is simply that the price acceleration momentum indicator (PM_{12}/PM_{24}) used in this study is deficient for the South African equity conditions. The particular indicator was selected on the basis of the Bird and Casavecchia (2007) study and further optimisation is still required.

6.3.2 Validity of Hypothesis 2

Both value-momentum combination winner portfolios performed significantly superior to the ALSI benchmark. For both portfolios, the compound annual growth rates achieved (32.08 and 31.77 percent) was more than double that of the benchmark of 15.88 percent (Table 5-7 and Table 5-8). Table 5-7 and Table 5-8 indicate statistically significant z-statistics for the difference in cumulative returns, average monthly returns and cumulative average abnormal returns of the ALSI with the two value-momentum portfolios. The hypothesis being challenged is re-stated as follows:

$H_{2,0}$: $CAAR_{VM} = 0$

$H_{2,A}$: $CAAR_{VM} \neq 0$

The null hypothesis proclaims that the CAAR of a PAM enhanced value portfolio are equal to zero. The alternative hypothesis states that the CAAR of a PAM enhanced value portfolio are not equal to zero.

Consequently, the null hypothesis of Hypothesis 2 was rejected for both winner portfolios. The alternative hypothesis was therefore accepted, which states that the CAAR of a value portfolio combined with a PAM timing technique are not equal zero.

6.3.3 Discussion of sub hypothesis results

The sub hypothesis is concerned with the difference in risk-adjusted returns of a value portfolio enhanced with price acceleration momentum and the ALSI benchmark. Accepting the sub hypothesis would mean that any change in average returns are associated with a change of risk in the same direction, keeping the Sharpe ratio constant and aligned with that of the ALSI.

The Sharpe ratios of the two value-momentum portfolios are nearly three times that of the ALSI as observed in the bell curves of Figure 5-9. The superior average monthly returns achieved by the two portfolios are not positively correlated with increased level of risk. The standard deviation of average monthly returns for each combination portfolio decreased significantly from the 5.78 percent of the ALSI. From Table 5-9, the value portfolio enhanced with PM_{12} displayed a standard deviation of monthly returns of 5.03 percent while that of the value portfolio combined with PM_{12}-PAM achieved 4.88 percent.

One way of explaining this improvement lies in the inefficient distribution of average returns of the ALSI benchmark. The average monthly returns of the ALSI exhibited a negative skewed distribution that peaked around two values, minus two percent and positive three percent. Refer to Appendix A for the average return distribution of the ALSI. In contrast, the average return distributions of the value-momentum portfolios presented more compressed negative tails and slightly longer and marginally denser right tails, more positively skewed, with the absence of the additional peak below zero. These distributions were more concentrated to positive values and also marginally more leptokurtic (refer to Appendix A and B).

Bird and Casavecchia (2007) did not comment on the distribution of their benchmark returns, but found that when momentum was combined with value, the abnormal returns distribution excluded a high fraction of shares that underachieved. The results of this research study concurred with this observation.

Leivo and Pätäri (2011) also observed an increase in average returns for all value-momentum combination portfolios above the benchmark as well as lower standard deviations. The authors did not compare average return distributions to the market benchmark. No additional inference is made from the results of the authors, except to comment that results far exceeded the market benchmark.

6.3.4 Validity of Sub Hypothesis 2

Sub Hypothesis 2 is recalled as:

$H_{2S,0}$: $SR_{VM} = SR_{ALSI}$

$H_{2S,A}$: $SR_{VM} \neq SR_{ALSI}$

The null hypothesis proposes that the risk-adjusted returns (Sharpe ratio) of a value portfolio with a PAM timing technique are indifferent to the risk-adjusted returns of the ALSI. The alternative hypothesis states that there is a difference in the risk-adjusted returns of a value portfolio with a PAM timing technique and the risk-adjusted returns of the ALSI.

As a result of the statistically significant p-values reported in Table 5-9, the null hypothesis of Sub Hypothesis 2 was rejected. The alternative hypothesis of Sub Hypothesis 2 was accepted, which states that the risk-adjusted returns of a high PAM enhanced portfolio are not equal to the risk-adjusted returns of the ALSI benchmark.

6.3.5 Conclusion of Hypothesis 2

The two methods used in combining momentum with a value portfolio demonstrated significant outperformance of the market benchmark, where both simulated portfolios achieved CAGR's of more than double that of the market.

This superior performance did not result in higher risk, but instead decreased the risk as measured by the reduction in standard deviation of returns. The researcher concurs with Bird and Casavecchia (2007) that underperforming shares in the portfolio could be eliminated by combining value with momentum. Consequently the alternative hypothesis of Hypothesis 2 and Sub Hypothesis was endorsed.

6.4 Value-momentum combination *versus* value-only

6.4.1 Discussion of main hypothesis results

The value-only portfolio of this research study achieved 25.76 percent annualised average returns (Table 5-10), which exceeded the results obtained by Leivo and Pätäri (2011) of 19.85 percent (Table 2-3). This research study also demonstrated an outperformance of the value-only winner portfolio over the value-only winner portfolio of the Bird and Casavecchia (2007) study. The latter study achieved 1.28 percent average monthly returns (Table 2-3) compared to 2.05 percent average monthly returns attained in this research study (Table 5-10).

The researcher therefore concurs with the view of Beukes (2011) that the value premium is pervasive in South Africa, although the author reported slightly higher average annual returns of 30.07 percent. The study of Rousseau and van Rensburg (2004), which attained average annual returns of 23.64 percent, are more comparable.

Results of the value and price momentum combination winner portfolio of this research study are not disparate from those in literature. As discussed in Section 6.3.1, Leivo and Pätäri (2011) achieved average annual returns of 24.82 percent *versus* the 29.62

percent achieved in this research study (annualised from monthly averages). In relative terms, the same basis percentage improvement has been observed.

Bird and Casavecchia (2007) obtained average monthly returns of 1.65 percent for a value portfolio enhanced with price momentum (Table 2-3). This is approximately two thirds the return achieved in this research study. The researcher maintains the view as expressed in Section 6.3.1, that much optimisation is still needed on the price acceleration momentum indicator used in this research study. Optimisation is also still possible with respect to the value portfolio enhanced with price momentum in the Bird and Casavecchia (2007) study.

With respect to the combination of value with price acceleration momentum, almost identical results to the Bird and Casavecchia (2007) study were attained. The latter study produced average monthly returns of 2.46 percent (Table 2-3) while this research study achieved average monthly returns of 2.44 percent (Table 5-11). In both cases the improvement over a value-only portfolio is consistent, but much more pronounced in the Bird and Casavecchia (2007) study. This finding strengthens earlier discussion regarding the optimisation of value and value enhanced with price momentum in the Bird and Casavecchia (2007) study.

With respect to the value-only portfolio, as evidenced in Table 5-11, CAAR of 199.83 percent were achieved, while the VM2 portfolio realised CAAR of 321.29 percent. The V-PM12 portfolio achieved the highest CAAR of 328.54 percent as per Table 5-10.

6.4.2 Validity of Hypothesis 3

The objective of this hypothesis is to determine if price acceleration momentum is statistically different from a buy and hold value-only strategy. Accepting Hypothesis 1 would mean that neither strategy is preferred. Hypothesis 1 is restated as:

$H_{3,0}$: $CAAR_{VM} = CAAR_{V}$

$H_{3,A}$: $CAAR_{VM} \neq CAAR_{V}$

The null hypothesis declares that that there is no difference between the cumulative average abnormal returns of a a value-only portfolio and the cumulative average abnormal returns of a value portfolio combined with price acceleration momentum. The alternative hypothesis states that the cumulative average abnormal returns of a value portfolio combined with price acceleration momentum is not equal to the cumulative average abnormal returns of a value-only portfolio.

The Wilcoxon-Mann-Whitney z-statistics presented in Table 5-10 depicts conclusive statistical significance at the five percent level. Consequently the null hypothesis of Hypothesis 3 was rejected. The alternative hypothesis, stating that the CAAR of a value-only portfolio is not equal to the CAAR of a value portfolio combined with price acceleration, was therefore accepted.

6.4.3 Discussion of sub hypothesis results

Table 5-12 presents the Sharpe ratios of the value-only portfolio and the two value-momentum combination portfolios. The Sharpe ratio of the value-only portfolio, of 0.311, was improved by nearly 16 percent when momentum was added to the portfolio. The VM2 portfolio obtained the highest Sharpe ratio of 0.363 with the V-PM12 portfolio virtually the same at 0.356. As discoursed in Section 2.6.4, Sharpe ratios are not comparable on an absolute basis but on a relative basis. Hence, relative changes in Sharpe ratios of other authors are discussed but not compared with this research study results.

Leivo and Pätäri (2011) observed an increase in average returns for all value-momentum combination portfolios above their value-only counterparts. In two thirds of the cases the addition of momentum to value decreased the standard deviation of average returns. The Sharpe ratio for their composite value portfolio improved from 0.249 to 0.313 when price momentum was added. Annual volatility decreased only marginally from 18.73 to 17.87 percent.

Although the combination of value and momentum resulted in marginal improvement in Sharpe ratios, Leivo and Pätäri (2011) found that return distribution asymmetry was affected negatively. Hence the rejection of the validity of the Sharpe ratio by the authors and endorsement of the adjusted Sharpe ratio. The adjusted Sharpe ratio was not utilised in this research study.

However, this study found that the standard deviation remained virtually the same for the V-PM12 portfolio and marginally decreased from 5.00 to 4.88 percent for the VM2 portfolio (Table 5-12). Average monthly returns improved by about ten percent from 2.22 percent for the value-only portfolio to over 2.44 percent for the value-momentum portfolios. The net result was that the difference in Sharpe ratios between the two value-momentum portfolios and the value-only portfolio was statistically significant as observed in Table 5-12. This difference is graphically exhibited in Figure 5-11.

An explanation for this observation is found in analysing the distribution of average returns of the three portfolios. These distributions are exhibited in Appendix C and D. As observed from both graphs, with the addition of momentum to value, a marginal transition of returns occurred from the negative to the positive tail. This is the reason why average returns improved but standard deviations remained relatively unchanged.

In addition, the observations by Dimson *et al.* (2011b) signify that there are profound differences between the JSE and the OMX Helsinki, specifically in terms of the volatility of the market. Equity returns in Finland displayed a standard deviation of 30.3 percent, while that of South Africa only 22.6 percent. According to Leivo and Pätäri (2011) the Finnish stock market suffers from relatively low liquidity and sporadic "periphery syndrome" (p. 403), which are potential reasons for a more volatile stock market. These profound differences are interesting to compare, but hinder full comparison of risk-adjusted returns.

6.4.4 Validity of Sub Hypothesis 3

The objective of the sub hypothesis was to substantiate the difference in risk-adjusted returns of a value-only portfolio and a value portfolio enhanced with price acceleration momentum. Rejecting this sub hypothesis would imply that the risk, as measured by the standard deviation, does not change in the same relation as the returns. This would further imply that returns are not correlated to risk, as approximated by the standard deviation of returns. The sub hypothesis is restated as:

$H_{3S,0}$: $SR_{VM} = SR_{V}$

$H_{3S,A}$: $SR_{VM} = SR_{V}$

The null hypothesis declares that that there is no difference between risk-adjusted returns of a value-only portfolio and a value portfolio enhanced with price acceleration momentum. The alternative hypothesis states that the risk-adjusted returns of a value-only portfolio and a value portfolio enhanced with price acceleration momentum are not equal.

The Wilcoxon-Mann-Whitney hypothesis test produced statistically significant results, at the five percent level, for the difference in Sharpe ratios of the value portfolio and the two value-momentum combination portfolios. In both instances the *p*-value was less than 0.05. The null hypothesis of Hypothesis 3 is therefore rejected and the alternative hypothesis adopted, which states that there is a difference between risk-adjusted returns of a value portfolio enhanced with price acceleration momentum and a value-only portfolio.

6.4.5 Conclusion of Hypothesis 3

The researcher draws a similar conclusion as in Section 6.3.5 that the addition of momentum to a value portfolio reduces the fraction of underperforming shares. The result is that upside returns can be achieved without increasing the risk of the portfolio, in terms of the standard deviation. Upside returns are significantly higher than for a value-only portfolio as evidenced in the significant increase in CAAR for the two value-momentum combination portfolios.

In summary, Table 6-1 depicts each hypothesis and sub hypothesis with the relevant outcome as discussed throughout the chapter.

Table 6-1: Summary of hypothesis outcomes

Hypothesis	Portfolio	Accepted	Improvement over reference
Hypothesis 1	PAM	No	No
	PM12-PAM	No	Yes
Sub Hypothesis 1	PAM	Yes	No
	PM12-PAM	No	Yes
Hypothesis 2	V-PM12	No	Yes
	VM2	No	Yes
Sub Hypothesis 2	V-PM12	No	Yes
	VM2	No	Yes
Hypothesis 3	V-PM12	No	Yes
	VM2	No	Yes
Sub Hypothesis 3	V-PM12	No	Yes
	VM2	No	Yes

7. CHAPTER 7 – CONCLUSION

7.1 Significant findings

The use of momentum to enhance a value portfolio is particularly limited in the academic literature. Although significant improvements in portfolio returns were realised when Bird and Casavecchia (2007) combined value and momentum. The study of the authors is significant in the sense that it not only introduced the combination of value and momentum, but also the concept of price acceleration momentum. Leivo and Pätäri (2011) also demonstrated that the combination of value and momentum is an economically feasible permutation.

Price acceleration momentum, however, proved the weakest stand-alone strategy studied in this research achieving only 21.82 percent CAGR. The most plausible explanation for the under-performance is that the PAM indicator (PM_{12}/PM_{24}) is only a relative measure of change in momentum and provides no insight to the strength of momentum. The researcher concludes that price acceleration as a stand-alone strategy is feeble and should not be used as a singular investment strategy.

When price acceleration momentum was combined with price momentum, the CAGR was significantly improved to levels of over 30 percent. This pronounced increase in returns did not, however, increase the risk. A net reduction in the standard deviation of returns was observed and hence an improved Sharpe ratio was obtained for the combined portfolio.

In addition, this research study provided robust evidence that the returns of a value-only strategy can be significantly improved when combining it with price momentum. Average monthly returns were increased from 2.05 to 2.47 percent, which was an improvement from 25.76 to 32.08 percent CAGR. The research also proved that this combination significantly outperformed the market benchmark with cumulative average abnormal returns in excess of 328 percent.

This research study also delivered unequivocal proof that enhancing a value portfolio with price momentum and price acceleration momentum benefits a value-only strategy profoundly. Average returns were elevated from 2.05 to 2.44 percent, while CAGR's rose from 25.76 to 31.77 percent. The superior results achieved in this research study related well to similar academic studies of Bird and Casavecchia (2007) and Leivo and Pätäri (2011).

Nevertheless, the main reason for conducting this research was to address the timing inadequacy of value investing strategies. The findings of this research study provide sensible solutions to this deficiency in that it demonstrated two alternative solutions that improved average returns by more than 20 percent.

It is often the belief that higher returns are associated with higher risk. However, this research study proved that there was no risk disadvantage when a value strategy was combined with momentum. In fact, when momentum was combined with value, the negative tail of the average return distribution shifted toward the positive side. This provides evidence that potential downside can be eliminated through improved timing of value shares. This twofold benefit was reflected in the improvement of the Sharpe ratio from 0.311 to 0.356 percent.

A subsequent finding of this research was that adding price acceleration momentum to an optimised price momentum enhanced value portfolio produced no significant improvement. In fact a marginal reduction in results was observed. This contrasted with the findings of Bird and Casavecchia (2007) who established that the PAM indicator was an indication of change in momentum.

The researcher concluded that high acceleration of momentum stems from small value stocks that comprise the majority of the quintile one value portfolio. According to Fama and French (2006a; 2012) small stocks enjoy larger momentum proceeds, which infer that high momentum acceleration is likely to come from small value stocks.

7.2 Implications of findings

Investment practitioners would be most attentive to these findings, as significant returns are possible with investment strategies combining momentum and price acceleration momentum. The investment community is constantly striving to find better ways to out-perform the market.

Coherent with the view of Bird and Casavecchia (2007), value investors would be particularly interested in such strategies that eliminate stagnant value shares associated with traditional value portfolios. This research provides a method to identify value shares that are less likely to under-perform in the near future.

Investors pursuing reduction of systematic portfolio risk would also be interested in combining value with momentum. While these strategies reward the investor with higher returns, an added advantage is the reduction of risk in the form of standard deviation of returns.

As there is no better value-momentum combination strategy available in the South African equity environment, the price momentum enhanced value strategy would probably be pursued rather than the strategy with added price acceleration. There is no benefit in the latter and using only price momentum has the added advantage of being slightly less computational intensive.

Furthermore this research poses a challenge to the academic community to find an optimised permutation for the PAM indicator. The researcher postulates that the PAM indicator used in this research study was sub-optimal. The concept of correctly identifying accelerating stocks seems possible and appealing.

In addition, the findings of this research further challenge the efficient market hypothesis (EMH). The presence of the value and momentum premia in global equity markets already violated the EMH. Combining the two concepts proved that markets are even more inefficient and exploiting this fact could increase the potential gains.

7.3 Recommendations for further research

Although significant findings were made in this study, much is still to be understood about the acceleration of momentum. Several further research topics are therefore suggested.

Firstly, the PAM indicator still needs optimisation. In its current form it only takes into account the 12-month and 24-month past returns. Different variations need to be considered in light of the literature on momentum cycles and intermediate term past returns.

Secondly, alternative forms of the PAM indicator need to be developed. The current indicator, although parsimonious, does not display second order share price movements. A curved relationship is therefore suggested. The researcher and his co-supervisor (Chris Muller) initiated this research through a parabolic indicator. In essence, a parabola was fitted through three past return points: previous month end, six months prior and 12 months prior. When the parabolic indicator was combined with a composite value indicator, average monthly returns of 2.52 percent and CAGR of

32.7 percent were observed. This was a slight improvement on the value enhanced with PM and PAM.

Thirdly, the researcher recommends a replication of the study with slight improvements to the methodology. To improve the likelihood of identifying accelerating value shares, it is recommended that each quintile portfolio be split in a low and high momentum sub-portfolio. This would provide additional perspective and insight into the momentum behaviour of value shares. Since quintile one in the value only portfolio consisted predominantly of smaller shares, such a study would confirm if smaller shares display inherently higher momentum as proposed by Fama and French (2012).

In conclusion it is recommended that the study be replicated to include short selling. Leivo and Pätäri (2011) demonstrated considerable returns when a 130/30 long-short strategy was introduced to a momentum enhanced value portfolio. The authors also observed improved risk-adjusted returns with this combination.

8. REFERENCES

Ansari, V., & Khan, S. (2012). Momentum anomaly: evidence from India. *Managerial Finance, 38*(2), 206-223.

Auret, C., & Cline, R. (2011). Do the value, size and January effects exist on the JSE? *Investment Analysts Journal,* (74), 29-37.

Banerjee, A., & Hung, C. (2011). Informed momentum trading versus uninformed "naive" investors strategies. *Journal of Banking & Finance,* (35), 3077-3089.

Basiewicz, P., & Auret, C. (2009). Another look at the cross-section of average returns on the JSE. *Investment Analysts Journal,* (69), 23-38.

Benninga, S. (2008). *Fiancial Modeling* (3 ed.). Cambridge: The MIT Press.

Bettman, J., Sault, S., & Schultz, E. (2009). Fundamental and technical analysis: substitutes or compliments? *Accounting and Finance,* (49), 21-36.

Beukes, A. (2011). Value investing: International comparison. *The International Business & Economics Research Journal, 10*(5), 1-9.

Bird, R., & Casavecchia, L. (2007). Value enhancement using momentum indicators: The European experience. *International Journal of Managerial Finance, 3*(3), 229-262.

Bodie, Z., Kane, A., & Marcus, A. (2011). *Investments and portfolio management* (9 ed.). New York: McGraw Hill.

Brown, C. (2007). *The little book of value investing.* New Jersey: John Wiley & Sons.

Cubbin, E., Eidne, M., Firer, C., & Gilbert, E. (2006). Mean reversion on the JSE. *Investment Analyst Journal,* (63), 39-47.

Deaves, R. (2004). Data-conditioning biases, performance, persistence and flows: The case of Canadian equity funds. *Journal of Banking and Finance, 28*(3), 637-695.

Dimson, E., Marsh, P., & Staunton, M. (2011a). Fear of falling. *Credit Suisse Global Investment Returns Yearbook*, pp. 5-13.

Dimson, E., Marsh, P., & Staunton, M. (2011b). Guide to country profiles. *Credit Suisse Global Investment Returns Yearbook*, pp. 31-53.

Fagerland, M. (2012). t-tests, non-parametric tests, and large studies—a paradox of statistical practice? *BMC Medical Research Methodology, 12*(78), 1-7.

Fama, E., & French, K. (1995). Size and book-to-market factors in earnings and returns. *The Journal of Finance,* (50), 131-155.

Fama, E., & French, K. (2006a). The value premium and the CAPM. *Journal of Finance, 61*(5), 2163-2185.

Fama, E., & French, K. (2006b). Profitability, investment and average returns. *Journal of Financial Economics, 82*(3), 491-518.

Fama, E., & French, K. (2008). Dissecting anomalies. *The Journal of Finance, 63*(4), 1653-1678.

Fama, E., & French, K. (2012). Size, value, and momentum in international stock returns. *Journal of Financial Economics,* (105), 457-472.

Gorton, J. (2010, December). Technical vs fundamental analysis - the age-old battle. *Moneyweb's Personal Finance*, pp. 8-9.

Gou, J.-H. (1999). A nonparametric test for the parallelism of two first-order autoregressive processes. *Australian & New Zealand Journal of Statistics, 41*(1), 59-65.

Guinan, J. (2009). *The Investopedia guide to Wall Speak.* New York: McGraw Hill.

Herberg, T., Kohlert, D., & Oehler, A. (2011). Momentum and industry-dependence: An analysis of the Swiss stock market. *Journal of Asset Management*, 391-400.

Hirschey, M., & Nofsinger, J. (2010). *Investments: Analysis and Behavior* (2 ed.). New York: McGraw-Hill.

Kreiss, J.-P., & Paparoditis, E. (2011). Bootstrap methods for dependent data: A review. *Journal of the Korean Statistical Society,* (40), 357-378.

Lahiri, S., Furukawa, K., & Lee, Y.-D. (2007). A nonparametric plug-in rule for selecting optimal block lengths for block bootstrap methods. *Statistical Methodology,* (4), 292-321.

Ledoit, O., & Wolf, M. (2008). Robust performance hypothesis testing with the Sharpe ratio. *Journal of Empirical Finance,* (15), 850-859.

Lee, C., & Swaminathan, B. (2000). Price Momentum and Trading Volume. *Journal of Finance, LV*(5), 2017-2069.

Leivo, T., & Pätäri, E. (2011). Enhancement of value portfolio performance using momentum and the long-short strategy: The Finnish evidence. *Journal of Asset Management, 11*(6), 401–416.

Mohanram, P. (2005). Separating winners from losers among low book-to-market stocks using financial statement analysis. *Review of Accounting Studies,* (10), 133-170.

Muller, C., & Ward, M. (2012). Style-based effects on the Johannesburg Stock Exchange: a graphical time-series approach. *Unpublished research paper*.

Nel, W. (2009). The use of multiples in the South African equity market: is the popularity of the price earnings ratio justifiable from a sector perspective? *Meditari Accountancy Research, 17*(2), 101-115.

Novy-Marx, R. (2012). Is momentum really momentum? *Journal of Financial Economics,* (103), 429-453.

Park, C., & Irwin, S. (2007). What do we know about the profitability of technical analysis? *Journal of Economic Surveys, 21*(4), 786-826.

Pätäri, E., Leivo, T., & Honkapuro, J. (2010). Enhancement of value portfolio performance using data evelopment analysis. *Studies in Economics and Finance, 27*(3), 223-246.

Piotroski, J. (2000). Value investing: The use of historical financial statement information to separate winners from losers. *Journal of Accounting Research,* (38), 1-42.

Qu, Y., Zhao, Y., & Rahardja, D. (2008). WILCOXON–MANN–WHITNEY TEST: STRATIFY OR NOT? *Journal of Biopharmaceutical Statistics,* (18), 1103–1111.

Rey, D., & Schmid, M. (2007). Feasible momentum strategies: Evidence from the Swiss stock market. *Financial Markets and Portfolio Management,* (21), 325–352.

Rousseau, A., & van Rensburg, P. (2004). Time and the payoff to value investing. *Journal of Asset Management, 4*(5), 318-325.

Ruiz, E., & Pascual, L. (2002). Bootstrapping Financial Time Series. *Journal of Economic Surveys, 16*(3), 271-300.

Saunders, M., & Lewis, P. (2012). Doing research in business and management. Harlow: Financial Times Pretice Hall.

Strugnell, D., Gilbert, E., & Kruger, R. (2011). Beta, size and value effects on the JSE, 1994-2007. *Investment Analyst Journal,* (74), 1-17.

van Rensburg, P., & Robertson, M. (2003). Size, price-to-earnings and beta on the JSE Securities Exchange. *Investment Analyst Journal,* (58), 7-16.

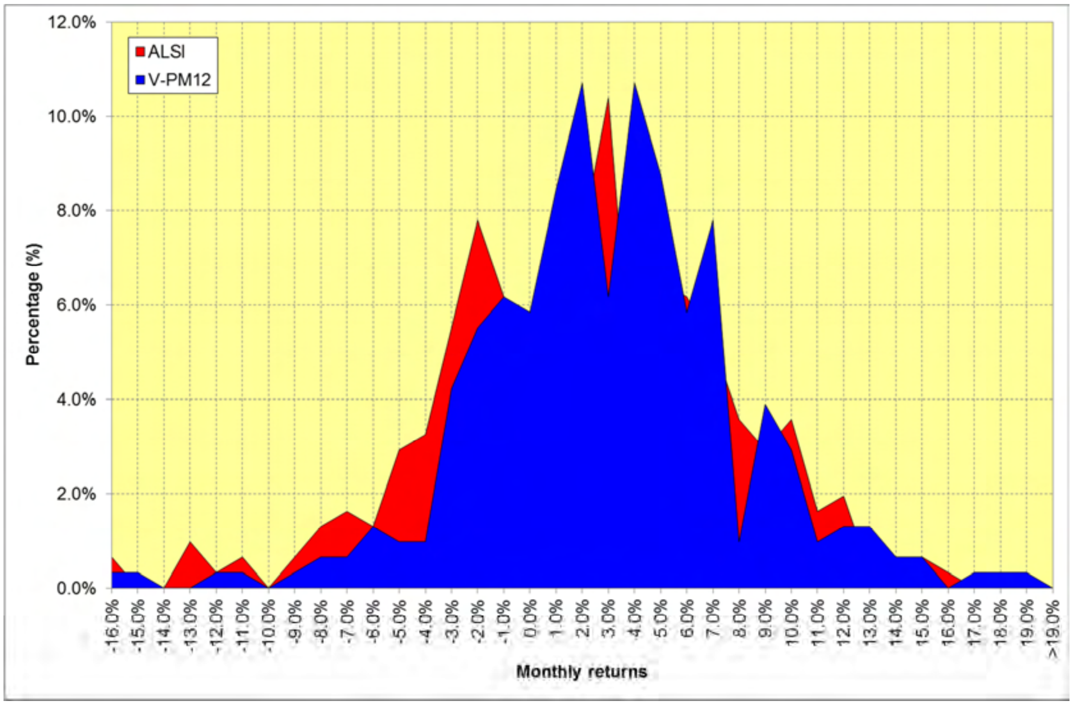
Ward, M., & Muller, C. (2012). Empirical testing of the CAPM on the JSE. *Unpublished research report*.

Yeh, I., & Hsu, T. (2011). Growth value two-factor model. *Journal of Asset Management, 11*(6), 435-451.

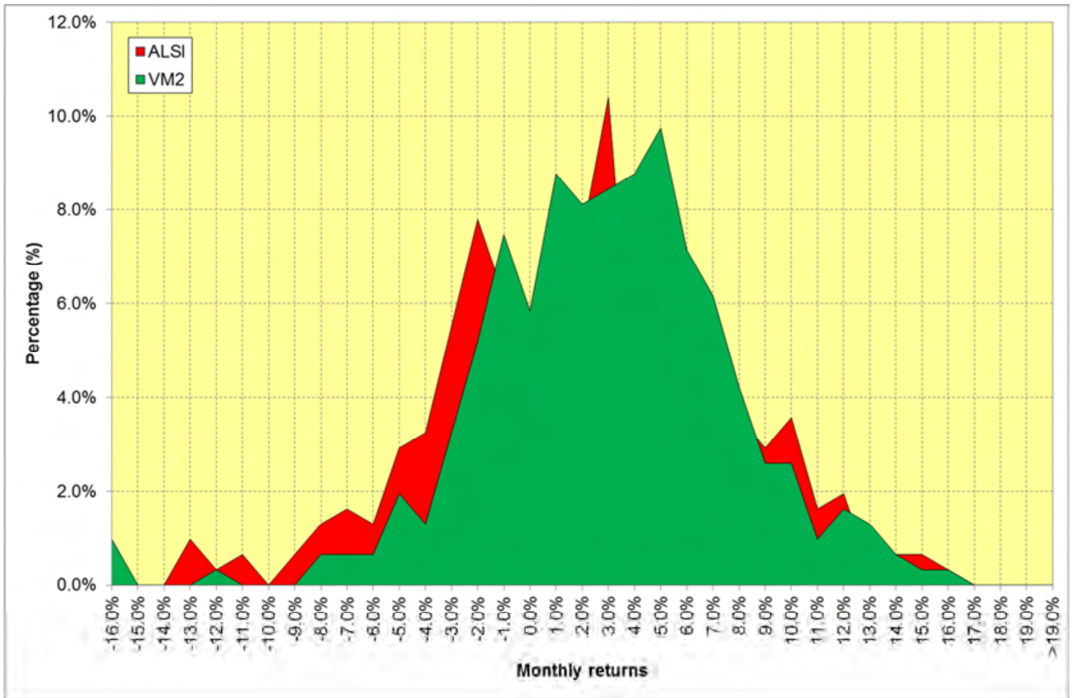
Zakamouline, V., & Koekebakker, S. (2009). Portfolio performance evaluation with generalized Sharpe ratios: Beyond the mean and variance. *Journal of Banking & Finance,* (33), 1242–1254.

9. APPENDICES

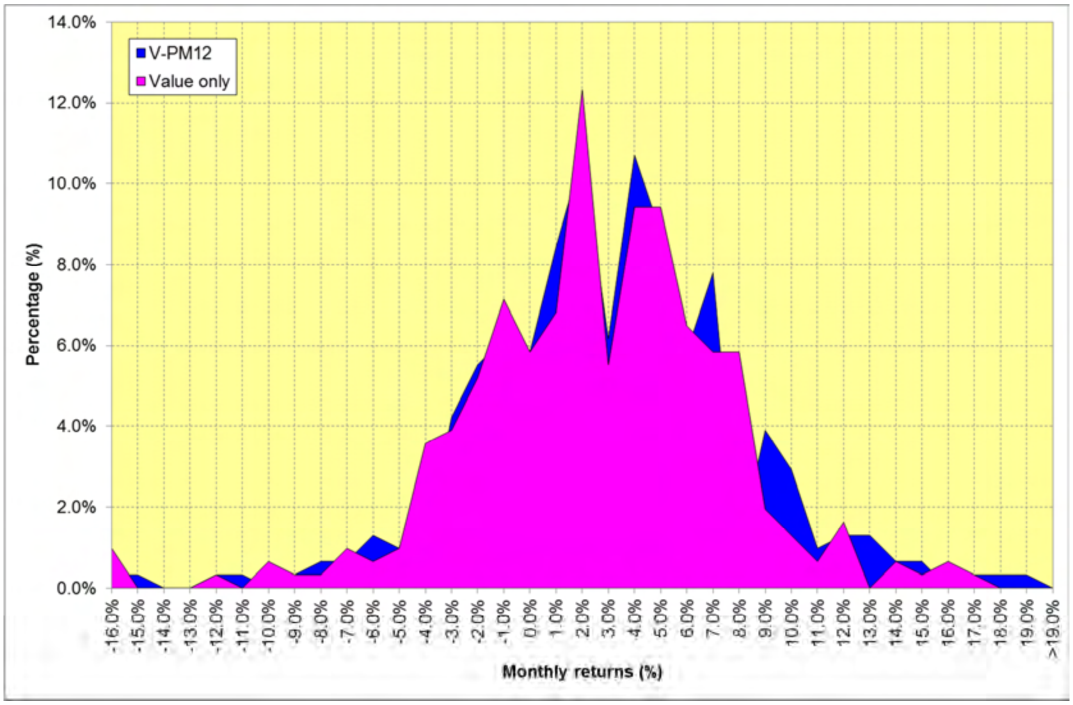
9.1 Appendix A: Average monthly return distribution – V-PM12 portfolio *versus* ALSI benchmark



9.2 Appendix B: Average monthly return distribution – VM2 portfolio *versus* ALSI benchmark



9.3 Appendix C: Average monthly return distribution – V-PM12 portfolio *versus* Value-only portfolio



9.4 Appendix D: Average monthly return distribution – VM12 portfolio *versus* Value-only portfolio