DOES IDIOSYNCRATIC RISK DERIVE PRICE MOMENTUM AND LONG TERM REVERSAL; EVIDENCE FROM THE JOHANNESBURG STOCK EXCHANGE.

by

RICH MASHAYANYIKA
STUDENT NO. 894748

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Supervisor: Mr James Britten

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ABSTRACT

This study examines if the idiosyncratic risk is the main source behind the persistence of price momentum and reversal effects. Idiosyncratic risk limits arbitrage, regardless of the arbitrageur's diversification. Price momentum is prevalent only in high idiosyncratic risk stocks, highlighting that idiosyncratic risk limits arbitrage in price momentum mispricing. Long-term reversal is not related to idiosyncratic risk. Long term reversal stocks generates a smaller aggregate return than price momentum stocks, so the findings along with those in related studies suggest that under-reaction and overreaction might be the main driving force behind long term reversal returns. The findings of this study are consistent with some of South African literature which suggest that momentum is a more persistent investing strategy than long term reversal on the Johannesburg Stock Exchange (JSE).

Keywords: idiosyncratic risk, price momentum, long term reversal, limit of arbitrage

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1 Introduction

1.1Background

The momentum anomaly first proposed by Jegadeesh and Titman (1993) continues to be a conundrum in financial economics. Jegadeesh and Titman (1993) document that over the short term (3 to 12 months), past winners tend to outperform past losers. The authors demonstrate momentum in stock prices, meaning that stocks with good past performance continue to do well, while stocks with poor past performance continue to do poorly. On the other hand, De Bondt and Thaler (1985, 1987), argued that stock prices to some extent mean revert and long term past losers tend to outperform long term past winners over a period of 3 to 5 years. They suggest that investors are subject to a trend of optimism and pessimism that result in prices to deviate systematically from their fundamental values and later to exhibit mean reversion.

Despite increasing research on price momentum and reversals and the evidence that it does exist, financial theory has not definitely explained why price momentum and reversals exists. De Bondt and Thaler (1985, 1987), Barberis, Shleifer and Vishny (1998), Hong and Stein (1999) Lee and Swaminathan (2000) and Hong, Lim, and Stein (2000) suggested that both momentum and long term reversal are caused by mispricing. Conrad and Kaul (1998) suggested that the sources of price momentum strategies are a point of contention that requires further investigation. McLean (2010) argued that in order for mispricing to persist, there must be some costs limiting arbitrageurs from making markets efficient.

1.2 Problem Statement

The academic argument over the sources of price momentum and long term reversals has drawn substantial attention from financial practitioners, since the magnitude of this anomaly seem to suggest economically exploitable opportunities. The main aim of this study is to investigate whether idiosyncratic risk is the source of price momentum and long term reversals on the Johannesburg Stock Exchange (hereafter, JSE).

1.3 Research question

Following McLean (2010), this study examines if idiosyncratic risk can explain the persistence of price momentum and long term reversals. This is important because it contributes to the understanding of the sources of price momentum and long term reversal profits.

Thus, the purpose of the study is to find answers for the following questions:

1. Is the persistence of price momentum and long term reversal a result of idiosyncratic risk?
2. Is the relation between idiosyncratic risk and expected market returns positive or negative?
3. Does idiosyncratic risk limit arbitrage in price momentum and long-term reversal portfolios?

McLean (2010), Pontiff (2006), and Shleifer and Vishny (1997) highlighted that arbitrageurs will trade on mispricing, only to the point that at least the benefit of a position is equal to its cost. The authors suggest that under that model, a costly position as represented by high idiosyncratic risk will get less arbitrage resources. McLean (2010) suggests that an adequate condition of limited arbitrage is when the largest mispricing is prevalent among highest idiosyncratic risk stocks. However, McLean (2010) argued that this condition is only adequate but not compulsory because in some instances transaction costs may be enough to limit arbitrage.

Many studies in literature have documented that in an efficient market, any profitable anomaly will be removed by rational arbitrageurs (Fama, 1970; Malkiel, 2003). However, momentum profits continued to prevail many years after its revelation. This might imply that investors must be limited in their ability to arbitrage momentum for profit. Shleifer and Vishny (1997) highlighted idiosyncratic risk as a limit to arbitrage. In their model, the authors argued that arbitrage resources are greatly concentrated in the hands of a couple of investors that have great skills in trading few assets and are under-diversified.

McLean (2010) suggested that although it might be intuitive and obvious that idiosyncratic risk is only applicable if the arbitrageur is not diversified, this is at odds with reality. Essentially, the diversification of an arbitrageur is insignificant considering the effect that idiosyncratic risk has on a risk-averse arbitrageur's determination to invest in a mispriced asset. In a condition that idiosyncratic risk is in actual fact a limit of arbitrage, then stocks with higher idiosyncratic risk would have a greater possibility of displaying higher momentum.

1.4 Research Objectives and Hypothesis testing

The academic debate over the sources of price momentum and reversals has drawn substantial attention from financial practitioners, since the magnitude of this phenomenon seem to suggest economically exploitable opportunities. The main aim of this study is to identify the sources of price momentum and reversals.

Following McLean (2010), this study examined whether idiosyncratic risk which can make holding an arbitrage position costly, can explain the persistence of price momentum and reversals on the JSE. This is important because it contributes to the understanding of the sources of momentum and reversal profits.

Thus, the purpose of the study is to find answers for the following questions:

1. Is the persistence of price momentum and long term reversals a result of idiosyncratic risk?
2. Is the relation between idiosyncratic risk and expected market returns positive, or negative?
3. Does idiosyncratic risk limit arbitrage in momentum and long-term reversal portfolios?

Hence the following null hypotheses were developed:

Hypothesis 1
The persistence of price momentum and long term reversals is not a result of idiosyncratic risk.

Hypothesis 2
There is no relationship between idiosyncratic risk and expected market returns.

Hypothesis 3
Idiosyncratic risk does not limit arbitrage in momentum and long-term reversal portfolios.

1.5 Importance and benefits of the study

Investigating if idiosyncratic risk is the source of price momentum and reversals has a positive contribution to the body of knowledge in many ways. If one considers the ascendency of price momentum as an investment style in the South African market, it is very important to explore the source of this investment strategy. This will help both individual and institutional investors as well as financial advisors to assess if the strategy is sustainable, the time it works best and the time it might to struggle to deliver.

If asset managers and traders can identify the source of price momentum and reversals, it will be easy for them to take advantage of the strategy by identifying the entry and exit points of the strategy. Momentum strategies can help investors beat the market and avoid crashes, when coupled with proper trend-following, which focuses only on stocks that are performing well.

It is also clear that the price momentum anomaly is not unique in South Africa and unlikely to arise due to data mining. However, there is little research on the driver of this profitable anomaly. This study seeks to identify its source in the South African stock market through investigating the idiosyncratic risk`s explanatory power of price momentum and reversal stocks.

As with any strategy that has been proven to work historically, there are usually two explanations: either the strategy takes more risk and is compensated for the risk or there are behavioural factors involved that allow the premium to persist. This study uses a rational, risk-based framework to explain the persistence of price momentum and reversals on the JSE.

This study is organised as follows, Section 2 presents a review of the theoretical literature and empirical evidence on price momentum inside and outside South Africa. It will also highlight the main sources of price momentum and reversals. Section 3 discusses the sample and methodology used in the study. Section 4 discusses the theoretical bases for each of the methodology and statistical tests employed as well as the corresponding results. Section 5 analyses the robustness of the study by employing an alternative methodology. Section 6 concludes.

2. Literature Review

2.1 Literature on Price Momentum outside South Africa

The impact of price momentum and the psychological biases behind it was first clearly highlighted on the US stock exchange by Jagadeesh and Titman (1993). Their paper suggests that an investment style or strategy which buys stocks with good past performance (past winners) and sell stocks with bad past performance (past losers) yield material positive returns over 3 to 12 months holding periods. They attempted to highlight the source of the profitability of this strategy and concluded that both systematic risk and the delayed stock price reaction to common factors did not have the explanatory power for the profitability of the strategy. Their results suggest that the driver of the profitability of this strategy is due to the delayed price reaction to firm-specific information. However, Jagadeesh and Titman (1993) highlighted that part of the excess returns generated in the first year disappears as holding periods are extended to two years.

Hong and Stein (1997) proposed a unified theory of under-reaction, momentum trading and overreaction in asset markets. They proposed a model in which a market is constituted with of two groups of rational agents, which are, the news watchers and momentum traders. Each news watcher perceives some confidential information but are unable to source the other news watcher`s information from the prices. Therefore, if the information spreads slowly across the market, Hong and Stein (1997) argue that the market will underreact in the short run and this under-reaction implies that momentum traders will be presented with an opportunity to make a profit from chasing the price movement trends.

Barberis et al. (1998) proposed a psychological evidence-based model on how investors form beliefs or investor sentiment. Their model asserts that in general, investors pay little attention to the statistical weight of information or evidence they are presented with. In other words, these investors pay too much attention to the strength of evidence. The authors propose that while information like earnings announcement might have low strength, the statistical weight is significant. Considering the little attention paid to earnings announcements, Barberis et al. (1998) presented a model that shows that stock prices underreact to such announcements and similar events. The authors also assumed that in line with patterns of news like a continuation of positive earnings announcements, which represents information of low statistical weight but has high strength, stock prices tend to overreact to patterns of good or bad news. In this regard, Barbaris et al. (1998) findings suggest that that both momentum and long term reversal are the result of mispricing.

Although the efficient market hypothesis suggests that the history of a stock's price provides no evidence about its future returns (Fama, 1970), evidence exists to the contrary. Chan, Jegadeesh, and Lakonishok (1999) shows that mutual funds tend to buy stocks of companies whose prices have risen recently and sell those of companies whose prices have fallen recently. They formulated and tested several hypotheses on the profitability of trading strategies based on price momentum and concluded that the profitability of such strategies depends on the investor's time horizon. In addition, Chan et al. (1999) suggest that price momentum may also exist if the market is slow to incorporate all available information about a stock's value.

Chan et al. (1999) explained the reason for the slow integration of the total impact of information by investors as the longer time horizon which analysts take to adjust their forecasts. They argue that analysts are particularly slow to review estimates for the worst-performing companies. The authors suggest that this lag may be caused by the incentives that analysts have to keep good relations with corporate managers.

Conrad and Kaul (1998) suggest that trading strategies that beat the market can be tracked back to the beginning of trading in financial assets. In their paper entitled, An Anatomy of Trading Strategies, Conrad and Kaul (1998) highlight that price momentum is profitable in the medium term (3 to 12 months) holding periods. The authors attempted to determine the sources of the expected profits of the entire class of trading strategies that are established on information contained and the past returns of individual stocks. They showed that less than 50% of the 120 strategies used in their study yield statistically significant profit. They further suggest that among the strategies they have tested, momentum and contrarian strategies generated positive significant profits.

Lee and Swaminathan (2000) used all firms listed on the NYSE and AMEX during a period of January 1965 to December 1995 with at least two years of data prior to the portfolio formation date. Their study shows that past trading volume delivers a positive relationship between momentum and value strategies. Lee and Swaminathan (2000) suggest that winner stocks are low volume stocks and low volume stocks imply that these stocks are most likely to continue to perform well as investor do not buy and sell these stocks quickly and regularly. They also suggest that loser stocks are high volume stocks which shows persistence of price momentum strategy as investors continue to sell losers. Lee and Swaminathan (2000) argues that the rationale behind trading volume is based on market misperceptions of firms' future earnings prospects[1]. They argue that low or high-volume stocks tend to be undervalued or overvalued by the market respectively. In their conclusion, the authors suggest that volume plays an integral role in explaining price momentum only in loser stocks and not winners. Lee and Swaminathan (2000) also showed that price momentum effects reverse over a period of five years, and high-volume winners and low volume losers experience faster reversals.

Hameed and Kusnadi (2002) investigated the momentum strategies with evidence from Pacific Basin stock markets. The authors find that holding past winner and selling past losers generates an average return of 0.37% per month over a 6-month holding period. Their results also suggest that momentum profits are significant when one holds large positions in high volume stocks with small market capitalisation. While Hameed and Kusnadi (2002) cautioned that past returns is not an indicator of future returns, the positive relationship between past returns and trading volume seem to suggest that high volume trading might explain momentum returns among loser stocks.

George and Hwang (2004) used the 52-week high as a reference point to analyse the return predictability in stock markets using data from the Center for Research in Security Prices (CRSP) over a period of 38 years from 1963 to 2001. The authors argued that the 52-high and low prices are public information which every trader can have access to. They further highlight that an extreme past return shows that new information has arrived, and it is the way in which traders update their beliefs which drives price momentum and reversals. George and Hwang (2004) argued that traders are not willing to continue to bid the price of a stock higher than its 52-week high even if the available good news or information on the stock allows them to do so. Since the 52-high and low price is public information, the authors suggest that as this information comes into the market, prices will eventually appreciate. George and Hwang (2004) also suggests that when a stock price is far below its 52-week high, traders are initially reluctant to sell the stock at prices which are low

[1]Lee and Swaminathan (2000) used the turnover ratio as an estimation for trading volume

as information suggests. As the information eventually prevail, since its public, the price falls. This is a validation that price momentum is an indicator of under-reaction.

George and Hwang (2004) also document that long-term reversal returns cannot be predicted based on the 52-week high model. Their conclusion suggests that price momentum and long-term reversals are most likely to be determined by different phenomenon.

Lesmond, Schill and Zhou (2004) assert that previous studies documenting substantial momentum profits such as (Jegadeesh and Titman, 1993) under-estimate transaction costs. The author provides evidence that after factoring in transaction costs the profitability of the momentum strategy disappears for shorter horizons but remains for longer horizons. The authors further argue that the main cause of the delay in price adjustments for stock returns is the validation of the existence of the cost of arbitrage, which result in the creation of the wrong impression of anomalous price behaviour and an opportunity for momentum trading when, in fact, it does not exist.

Pradhan (2016) investigates whether firm specific factors are the sources of momentum profits on the Indian markets. The author used data from the Indian national stock exchange (NSE) over a period of 20 years (April 1995 to March 2015). Pradhan (2016) find that idiosyncratic risk largely dominates the specific factors that highly determine momentum returns in the Indian market.

2.2 Literature in the South African Context

The price momentum anomaly is clearly the most robust researched anomaly. The majority of research that has been presented confirms that price momentum as a strategy is profitable on the JSE. However, the source of this anomaly is still a bone of contention in literature.

Fraser and Page (2000) investigated value and momentum strategies with evidence from the JSE using the entire industrial stock listed on the JSE from January 1973 to October 1997. Their data consisted of daily closing prices and trading indicators for all industrial companies. The authors found that both value strategies and momentum strategies can independently predict the return on a stock one month into the future and, hence earn higher returns.

Fraser and Page (2000) did not directly investigate the implications of their findings. However, they suggested that the predictive power of the value and momentum strategies can be explained by the misspecification of risk. As a result, high value and high momentum stocks may in fact involve greater risk hence, the absolute higher return made from using these strategies might be a rational compensation. Fraser and Page (2000) also suggested that overreaction might be another explanation for the high return on momentum and value strategies. However, they admitted that the causes behind the ability of the strategies to earn higher returns are genuine call for further research.

Van Rensburg (2001) analysed a decomposition of style-based risk on the JSE using monthly dividend stock adjusted data from February 1983 to March 1999 on JSE industrial stocks. The author also endorsed the existence of momentum on the JSE, but however did not give possible explanations for its existence.

Van Rensburg and Robertson (2003), used dividend adjusted monthly JSE data from the BARRA organisation between 1990 and 2000 to examine the same style strategies applied by van Rensburg (2001) using individual stock level features. Amongst these style-based factors, the authors examine momentum as a possible explanatory variable describing the cross-section of JSE returns using a stock's past 1, 6, and 12 month return. Contrary to the findings of Fraser and Page (2000) and van Rensburg (2001), whose analysis was limited to the industrial sector of the JSE, none of the measures of price momentum were significant when all JSE stocks were incorporated for analysis.

Venter (2009) investigates short term return predictability based on intraday momentum and contrarian effects on the JSE. The author only focused on the stocks which were listed on the JSE in 2007 and have a market capitalisation of at least one billion rand. Venter (2009) found statistically significant return predictability when returns are calculated from mid-quote prices. However, when more realistic return calculation assumptions like bid-ask pricing was applied, intraday momentum and contrarian effects largely disappear.

Muller and Ward (2013) investigate a style based effect on the JSE, using a graphical time series approach for a period over 27 years from 1985 to 2011. Among all the styles they investigated, the authors conclude that price momentum style with a 12 months formation period and a 3 months holding periods consistently outperformed the ALSI by around 9% per year.

Page, Britten and Auret (2013) examined the short and medium term momentum on the JSE over a 15 year period from January 1995 to December 2010. The authors documented a significant momentum effect on the JSE. However, their results suggest that the level of momentum profits falloff in the last half of their sample. The authors indicated that this decline in momentum returns can be attributed to the 2008-2009 global financial crisis. Page et al. (2013) also showed that as both estimation and holding periods is extended above nine months, excess returns start to drop indicating long term reversals.

On the issue of liquidity, Page et al. (2013) find that the momentum portfolios with high and medium liquidity had better returns compared to the low liquidity momentum portfolios on a total return basis. The authors` findings suggest that illiquidity appear to have a substantial negative effect on momentum profits. They argued that this can be explained by the under and overreaction hypothesis. Page et al. (2013) suggest that as the market under-reacts to positive news, there will be an increase in the demand for high momentum stocks which will ultimately start to increase stock prices. As a result, a highly liquid stock will be easily bought and will consequently have more upside from the buying pressure. In the same way, as the market become aware of the overreaction and that some stocks has been overbought, more liquid stock will start to experience quick long term reversal.

2.4 Mean reversion

Kahneman and Tversky (1977), De Bondt and Thaler (1985, 1987), Bhave and Libertini (2013) suggest that that investors do not act rationally when making decisions. This irrational behaviour leads to a number of exploitable market anomalies, one of which is mean reversion. Research by De Bondt and Thaler (1985, 1987) suggest that most people tend to overreact to unexpected and dramatic news events. De Bondt and Thaler (1985, 1987) also argued that stock prices to some extent mean revert and long term falling stock prices (losers) tend to outperform long term rising stock prices (winners) over a period of 3 to 5 years. They suggest that investors are subject to a tendency of optimism and pessimism that cause prices to deviate systematically from their fundamental values and later to exhibit mean reversion.

Kahneman and Tversky (1977) illustrated that human preference when making choices is based on how easy they can recall information. This resulted in humans recalling easily the recently available events which consequently lead to new information being given too much weight when making decisions because of the cognitive ease to recall it. Kahneman and Tversky (1977) `s finding explains why stock prices are prone to overreaction, investors overweight new data, such as news events, while pay no or less attention to some important information that is less or not easily recallable.

Kahneman and Tversky (1977) also suggest that investor overreact to negative news and after the initial overreaction to negative news or event happens, the investors who have been patient to continue holding the stock become loss averse and reluctant to sell their position. On the other hand, other investors become attracted by the lower price. As all investors finish grasping the new information, prices revert from the extremes causing a previously underperforming stock to outperform the winners.

Page and Way (1992) examined the stock market over-reaction with evidence from South Africa. They evaluated monthly returns of 204 stocks traded over a period between 1974 to 1989. The author`s conclusions suggest that stock markets over-react to news and events and that investors give more consideration to new information and events. Over their sample period, portfolios of past losers, on average, substantially outperform portfolios of past winners over a 36 month period by between 10% to 20% for both 2 years and 3 years formation periods. However, their results suffer from survivorship bias as the authors did not account for stocks which were delisted during their sample period.

Fama and French (1992) showed that beta alone does not adequately explain the cross-sectional variation in stock returns. They argued that the inclusion of a firm size and book-to-market (B/M) considerably improve explanatory power. Fama and French (1992) argued that size and B/M are proxies for unobservable common risk factors and concluded that their evidence is consistent with rational asset pricing.

Chopra, Lakonishok and Ritter (1992) estimated the event-varying betas for the CAPM in computing access returns for winners and losers and show that an adjustment for beta risk explains a large proportion, but not all, of the overreaction effect. Their results show overreaction effect even after adjusting for size and beta. In portfolios formed on the basis of previous five-year returns, past losers outperform prior winners by 5 to 10% per year during the following five years. They also show that the overreaction effect is different from the size effect.

Muller (1999) investigates investor overreaction on the JSE over a period of 12 years from February 1986 to January1998 using the daily returns of largest 200 listed stocks by market capitalisation. The author`s results support the overreaction hypothesis as loser strategy portfolios yielded higher excess returns when the holding period is increased. On the other hand, winner portfolios yielded lower excess returns with increasing holding periods. Muller (1999)`s analysis shows that in both cases, there was a strong reversion to the mean. This implies that the price momentum of the winner strategy portfolio might have caused the stock prices to increase further than their fair value and investors oversold loser stocks far lower than their fair value. However, their data suffers from survivorship bias as only stocks that had survived their sample period were included in their data.

Wongchoti and Pyun (2005) find that the excess contrarian returns to non-S&P 500 NYSE stocks are only significant for high-volume stocks[2]. The authors suggest that such returns cannot be explained by time-varying risk and are dominated by winner stocks. Their results are consistent with the overreaction hypothesis, as stocks whose prices have overreacted to the highest level experienced highest trading volumes. Wongchoti and Pyun (2005) also suggested that information behind the trading volume could be interpreted as another source of long term reversal profits found in their sample.

Bhave and Libertini (2013) suggested that the allure of lower prices is a major cause of mean reversion in stocks. The authors argued that, psychologically it is fulfilling to purchase an item at a lower price (discount) and it is painful to purchase an item at a higher price (premium). They argued that this is to some extend the reason portfolio managers periodically rebalance their

[2] Wongchoti and Pyun (2005) used turnover ratios to estimate to estimate volume stocks

portfolios and increase their exposure to loser (underperforming) positions and reduce their exposure to winner (outperforming) positions. These psychological biases naturally increase buying pressure for underperforming stocks and selling pressure for outperforming stocks, leading to a series of mean reversion in stocks.

Britten, Page and Auret (2016) examined the interaction between long term reversal and value on the JSE utilizing accounting data and monthly return data of all JSE recorded stocks over the period 1 January 1998 to 30 June 2013. Their results demonstrate that profits inferable from winner portfolio decreases while the loser portfolio started to produce more returns related to the winner stocks as the holding periods are stretched beyond one year.

Britten et al. (2016) highlighted that from a theoretical point of view, the overreaction theory seems not enough to explain both long term reversals and value premium present on the JSE. This might be attributed to the weak evidence of long term reversals found in their study related to other South African studies of overreaction.

More practically, Britten et al. (2016)'s results show that momentum is clearly more reliable and consistent investment strategy when compared to long-term reversals. However, the authors suggest that one must remember that momentum returns are very sensitive to portfolio holding periods and that excess returns are subsequently dissolved as holding periods increase beyond one year.

Britten et al. (2016) highlighted that the results of the medium B/M sorts suggests that McLean (2010) `s study on the influence of idiosyncratic risk on arbitrage warrant further investigations.

2.5 Idiosyncratic risk explaining momentum and reversals

In an efficient market, any profitable anomaly is eliminated by rational arbitrageurs. However, momentum profits persist many years after its revelation. This might imply that investors must be limited in their ability to arbitrage momentum phenomenon for profit (McLean, 2010).

Shleifer and Vishny (1997) highlighted idiosyncratic risk as a limit to arbitrage. In their model, the authors contended that arbitrage assets are highly positioned in a pool of funds managed by a couple of investors that have great skills in trading few assets, which are not diversified. In such a framework, investors would be more concerned about their total risk exposure, not just systematic risk. Now considering that, the equilibrium excess returns is determined by the trading strategies of these financial specialists, examining systematic risk as the main potential determinant of pricing is inappropriate. Idiosyncratic risk too hinders arbitrageurs.

Shleifer and Vishny (1997) further contend that the performance of markets in which these skilled arbitrageurs invest the capital of outside investors is questionable. They argued that the performance-based arbitrage might not be credible enough in conveying stock prices to their fair values, particularly in the extreme cases. Intuitively, well skilled and qualified arbitrageurs may evade very volatile arbitrage positions. Even though such positions offer appealing average returns, the volatility also cause the arbitrageurs to be exposed to the risk of losses and the need to disinvest portfolios as they succumb to pressure from the risk-averse investors in the fund. In light of this, the evasion of volatility by arbitrageurs causes the persistence of excess returns in stock prices.

Brandt, Goyal and Santa-Clara (2001) investigated if idiosyncratic risk matters and showed that it does not only matter but actually explains most of the variation of average stock returns through time. Their findings are somewhat different from most traditional theory, which suggest that diversification plays an integral role to eliminate idiosyncratic risk and that systematic risk cannot be diversified away, hence should be priced in by the markets. The authors are of the view that investors are more concerned by total risk not systematic risk only and therefore total risk must be priced by the market. In this regard, the authors noted that idiosyncratic risk has a larger portion of total risk and therefore has more predictive power on market returns. In line with Shleifer and Vishny (1997), Brandt et al. (2001) also noted that investors hold undiversified portfolios, therefore, the most significant measure of risk should be stock specific.

Furthermore, Brandt et al. (2001) highlighted that the general insignificance of systematic risk in predicting the market is due to its low weight on total risk and the large error in its measurement. In their conclusion, the authors argue that idiosyncratic risk influences market returns. This implies that idiosyncratic risk might explain the persistence of price momentum and reversal.

Ben-David and Roulstone (2005) indicate that managers compete with outside arbitrageurs in taking advantage of opportunities presented by mispricing in stocks. They argue that when stocks have high idiosyncratic risk, outside arbitrageurs will be restrained to engage in arbitrage trades since these trades involves taking more risk. In this case, insiders have the capacity to delay trades while mispricing increases due to the limitations on outside arbitrageurs to take advantage of the mispricing. The tendency of delaying trades while mispricing increases might explain the persistence of price momentum in stock markets.

Consistent with idiosyncratic risk limiting arbitrage trades by outsiders, Ben-David and Roulstone (2005) show that insiders and firms makes more profitable trades with high idiosyncratic risk stocks than in stocks with low idiosyncratic risk. Ben-David and Roulstone (2005) results imply that stocks with high idiosyncratic risk materially deviate from their fundamental values due to the lack of trades from insiders who intends to make a profit from higher mispricing at a later stage.

Pontiff (2006) argues that arbitrageurs are not able to avoid idiosyncratic risk, and therefore they must strike a balance between the idiosyncratic risk to which a position or a portfolio holding exposes them and expected returns from that position. The author shows that risk-averse arbitrageurs will assign smaller portfolio weights to stocks with higher idiosyncratic risk. Hence, idiosyncratic risk is likely to prevent arbitrage. In line with Pontiff (2006), most empirical studies that have examined the limits of arbitrage topic pointed out that idiosyncratic risk appears to be the only main impediment to market efficiency since holding costs force arbitrageurs to take limited positions in mispriced stocks. This enables mispricing to carry on leading to market inefficiency.

Malkiel and Xu (2006) argue that if one group of investors fail to hold the market portfolio for some reasons, the remaining group of investors will also be incapable of holding the market portfolio. In this regard, idiosyncratic risk will possibly be priced to pay off rational investors for the in-ability to hold the market portfolio.

Other things being equal, Malkiel and Xu (2006) suggest that idiosyncratic risk will affect asset returns when not every investor is able to hold the market portfolio. The authors showed that regardless of their control for factors such as size, book-to-market, and liquidity, their findings from both individual US and Japanese stocks supports the predictions of their model. Also important to note is that the cross-sectional results of their model demonstrate that idiosyncratic risk variable is more robust than either beta or size measures in explaining the cross section of returns.

Ooi, Wang and Webb (2007) examined the relevance of idiosyncratic risk in explaining the monthly cross-section of returns of REIT stocks. The authors find a positive significant relationship between idiosyncratic risk and cross-section of returns. In their analysis, the positive relationship continues to persist after the inclusion of other factors common explanatory variables such as size, B/M and momentum effects. Their results were in line with the conclusions of Malkiel and Xu (2006) that suggest that idiosyncratic risk can possibly be priced in an imperfect world where investors hold less-diversified portfolios either willingly or due to limitations.

Arena, Haggard and Yan (2008) examined the relation between price momentum and idiosyncratic risk using a sample of common stocks traded on the NYSE and AMEX from 1965 to 2002. The authors find that momentum returns are higher among high idiosyncratic risk stocks, particularly losers. In their model, higher idiosyncratic risk stocks experience faster and greater reversals. Arena et al (2008) suggest that their findings are consistent with momentum profits accredited to firm specific information with idiosyncratic risk limiting arbitrage of the momentum effect. The authors also find a positive time series relationship between momentum returns and aggregate idiosyncratic risk. This shows that idiosyncratic risk plays an integral role in the momentum effect and helps explain its persistence and increase in markets.

McLean (2010) argues that mispricing continues as long as the cost of arbitrage goes beyond the benefit. The author’s model focuses on idiosyncratic risk as the arbitrage cost, which essentially is a holding cost to any risk-averse arbitrageur. The author reveals that there is no relationship between momentum and idiosyncratic risk. McLean (2010) suggested that momentum may still be triggered by mispricing; however, transaction costs could probably act as the binding cost that limit arbitrage.

McLean (2010) suggest that reversal is rampant only in high idiosyncratic risk stocks showing that idiosyncratic risk limits arbitrage in reversal mispricing. In aggregate, the results of McLean (2010) suggest that idiosyncratic risk plays an integral role in preventing arbitrage in large mispricing, where transaction cost are less than the average returns. McLean (2010) further suggest that transaction costs are more significant in preventing arbitrage in smaller mispricing. The author argues that momentum generates smaller mispricing therefore, transaction costs are sufficient to prevent arbitrageurs from eliminating momentum mispricing.

Fu (2010) examined the impact of investor diversification and pricing of idiosyncratic risk utilising the stocks listed on AMEX, NYSE, and Nasdaq over a period from January 1980 to December 2007. The author confirms the finding that even though it is expected that investors hold diversified portfolio, most individual and households investors do not subscribe to this well documented investment phenomenon.

Fu (2010) examined the stocks held by individuals and institutions independently and found that institutions held more diversified portfolios and also that stock returns had a weaker relationship with idiosyncratic risk. In relation to stocks held by individuals and households, Fu (2010) findings suggest that these portfolios were under-diversified and idiosyncratic risk explained most of the return variations in their portfolio. Other things held constant, the increase in dominance of institutional investors in markets might imply idiosyncratic risk`s pricing and predictive power in stock returns can be expected to weaken in future.

Sonmez (2013) investigated the relationship between institutional trading, momentum and idiosyncratic risk using US listed stocks from 1963 to 2008. The author confirmed a positive relationship between future stock returns of highly priced stocks and high idiosyncratic risk and vice versa[3]. Sonmez (2013) highlighted that idiosyncratic risk may have a relationship with momentum and skewness of stock returns for institutionally owned high-priced stocks and retail owned low-priced stocks, respectively.

[3] Sonmez (2013) did not indicate the proxy he used to determine whether the stocks where cheap or expensive.

Switzer and Picard (2015) examined the relationship between idiosyncratic risk, momentum, expected returns between both developed and emerging markets. Their model compares the current month`s idiosyncratic risk to the following month returns for both developed and emerging markets stocks. Their results highlighted that idiosyncratic risk does not explain stock returns in most developed markets in their sample. On another hand, the authors' findings suggest that idiosyncratic risk has a positive relationship to month ahead-expected returns for most emerging markets stocks in their sample. Now considering that South Africa is part of the emerging markets economies, one might expect a similar relationship to exist on the JSE.

Heidari (2015) examined the interaction between overreaction, under-reaction, momentum and idiosyncratic risk. The author argues that whether price momentum is a result of investor under-reaction or overreaction remains a question in academic literature. Heidari (2015) illustrated the relationship between idiosyncratic risk and investor overreaction as well as the stock turnover as another measure of overreaction and presented results that supports the investor overreaction as the source of price momentum. Furthermore, the author`s findings show that when investor overreaction is low, price momentum will be more due to industries (industry momentum) rather than stocks.

Di Lorio and Lui (2016) investigated the extent to which idiosyncratic risk explains the fund performance using data from Australian equity pension funds, which were classified according to the Morningstar Broad Category Group definition from January 1995 to December 2008. The authors find that the explanatory power of momentum factors turn out to be weak after controlling for the association between idiosyncratic risk and momentum.

Di Lorio and Lui (2016) shows that the explanatory power of the momentum factor is not independent of the explanatory power of idiosyncratic risk, since the momentum effect is caused by the amount of information which investors can process, or similarly, the level of investor exposure to idiosyncratic risk. In this regard, when controlling for the relationship between idiosyncratic risk and momentum, the explanatory power of the momentum factor almost disappears, but the explanatory power of the idiosyncratic risk remains strong. In light of this, the results of Di Lorio and Lui (2016) shows that the presence of idiosyncratic risk plays an integral role in explaining the continuation of price momentum in markets.

Coa and Han (2016) investigated the cross-sectional relation between expected stock return and idiosyncratic risk referred by the theory of costly arbitrage. In line with the prediction of the limits to arbitrage theory, the authors find that average stock returns consistently increase in line with idiosyncratic risk for undervalued stocks and consistently decrease in line with idiosyncratic risk for overvalued stocks. The authors also argued that systematic risk exposures, firm features and other arbitrage cost measures cannot substitute the role of idiosyncratic risk. Coa and Han (2016) also find that the returns for stocks which are neither undervalued nor overvalued are unrelated to idiosyncratic risk. Overall, their results support the importance of idiosyncratic risk as an arbitrage cost.

Tayal (2016) investigated the three articles of on market efficiency and limits of arbitrage. The author`s first essay is primarily on idiosyncratic volatility as the main arbitrage cost for short sellers. The author examined whether market inefficiencies can be explained by limits of arbitrage, particularly firms' idiosyncratic risk. In line with limits to arbitrage hypothesis, Tayal (2016) findings suggests that stocks with high idiosyncratic risk yielded higher returns compared to low idiosyncratic risk stocks. The author further asserts that excess returns are economically and statistically insignificant for stocks with low idiosyncratic risk. These results imply that idiosyncratic risk is a potential reason for the inability of arbitrageurs to extract returns to exploit the profits in price momentum and long term reversal investing strategies.

The author`s second easy examined the effects of markets efficiency in an environment without limits of arbitrage. On this essay, Tayal (2016) suggests that excess returns are obtained during a time of higher volatility when investors are risk averse. The author`s third essay investigated the behaviour that generates mispricing in markets. Tayal (2016) analysed the relationship between stock price and future expected returns in the US market. The author`s results suggests a positive relationship between stock price and expected returns if the price is not related to size. After the author controlled for size, the results suggest that low priced[4] stocks materially underperformed high-priced stocks. In line with cost of arbitrage theory, the author suggests that the return

[4] Tayal used B/M to determine whether a stock is low priced or high priced

difference between high and low-priced stocks is substantial for stocks with high limits to arbitrage.

Page, Britten and Auret (2016) investigated whether idiosyncratic risk explains the persistence of size, value and momentum premiums on the JSE. They used all the listed stocks on the JSE from January 1992 to 30 November 2014. Unlike this study which uses the standard deviation of residuals to estimate idiosyncratic risk, the authors used GARCH models. Page, Britten and Auret (2016) results suggest that idiosyncratic risk does not explain momentum premium.

A common theme that unifies this literature is that the primary source of arbitrage costs occurs from holding costs, in particular, idiosyncratic risk. Most of the above studies proposes that idiosyncratic risk is the main source of mispricing which causes price momentum and reversals.

2.6 Literature review summary

The literature in in this study provides more evidence that the source of price momentum and reversal are explained by idiosyncratic risk. Shleifer and Vishny (1997) argue that arbitrageurs investing in stocks which has high idiosyncratic due to the fear of capital loses and it is this avoidance of volatility by arbitrageurs that causes the persistence of excess returns in stock prices. Brandt et al. (2001) show that idiosyncratic risk explains most of the variation of the stock prices and that it also drives the forecastability of the stock market returns. Pontiff (2006) argue that arbitrageurs are not able to hedge idiosyncratic risk, and thus they must strike a balance between the expected returns from a position and the idiosyncratic risk to which the risk exposes them. Ooi et al. (2007) find a positive significant relationship between idiosyncratic risk and cross –section of returns. Arena et al. (2008) find that momentum is higher among high idiosyncratic risk stocks. McLean (2010) suggests that reversal is rampant only in high idiosyncratic risk stocks showing that idiosyncratic risk limits arbitrage in reversal mispricing. Coa and Han (2016) show that the average returns monotonically increase with idiosyncratic risk. Tayal (2016) document abnormal returns for stocks with high idiosyncratic risk.

However, few other studies in the literature have provided contrary evidence of the source of price momentum and reversal. Kahneman and Tversky (1977), De Bondt and Thaler (1985, 1987) suggest that most people tend to overreact to unexpected and dramatic news events. Thaler (1985, 1987), argued that stock prices to some extent mean revert and long term past losers tend to outperform long term past winners over a period of 3 to 5 years. Muller (1999) supports the overreaction hypothesis as loser strategy portfolios yielded higher excess returns when the holding period is increased. Their analysis shows that there was a clear regression to the mean. Fraser and Page (2000) suggest that overreaction might be an alternative explanation for the high return on momentum and value strategies. Wongchoti and Pyun (2005) find evidence which is consistent with the overreaction hypothesis, as stocks whose prices have overreacted to the greatest degree should experience the highest trading volumes. Page et al. (2013) argue that as the market under-reacts to positive news, the increased demand for high momentum stocks begins to drive up stock prices. Consequently, a highly liquid stock is easily bought and therefore has a high upside from the buying pressure. Similarly, as the market realizes the overreaction and that stock has been overbought, more liquid stock will begin to experience the long-term reversal at a higher rate.

3. Data and methodology

3.1 Data

The historical stock data spanning from December 2000 to December 2016 was obtained from the Findata@Wits database. This data base contains data for every share listed on the JSE over a period from January 1990 to date. The JSE All Stock Index (ALSI) returns and the T-bill yields was obtained from the Morningstar database. The data included in this study contains the top 100 stocks by market capitalisation listed on the Johannesburg Stock Exchange (JSE) from December 2000 to December 2016. Delisted stocks were included and considered for their listed period to remove the survivorship bias. Just like McLean (2010), Arena et al. (2008), this study used monthly data including the date, adjusted stock price, total number of outstanding stocks, and the monthly JSE

All Stock Index (ALSI) returns. This study only included stocks with at least 36 months of return track record.

3.2 Methodology

This study follows the methodology used by McLean (2010) which stems from a Markowitz (1952) portfolio optimization problem that is studied in both Treynor and Black (1973) and Pontiff (2006). In this model, the arbitrageur decides how to optimally allocate her investments among a market portfolio with the expected return r_m, a risk free asset with return r_f, and a mispriced security of which all systematic risk has been hedged, hence the returns are equal to sum of mispricing alpha and the risk free rate. The market portfolio has variance of $\sigma^2{}_m$, and each mispriced asset has idiosyncratic variance of σ^2, that is, all of the assets can be shorted. The arbitrageur has risk aversion of λ and faces the following utility maximization problem:

$$U = \sum_{k=1}^{n} w_i(\alpha_i + r_f) + w_m r_m + (1 - \sum_{i=1}^{n} w_i - w_m) r_f - \frac{1}{2}\lambda \sum_{i=1}^{n} w^2{}_{ie}\sigma^2{}_{ie} - \frac{1}{2}\lambda w^2{}_m \sigma^2{}_m \qquad 1$$

Where:

w_i is the weight in each mispriced asset and w_m is the weight in the portfolio and for equation 1 to be maximized, the arbitrageur is supposed to choose between the two weights. The resulting portfolio weights for the arbitrageur positions are:

$$w_i = \frac{\alpha_i}{\lambda \sigma^2{}_{ie}} \qquad 2$$

According to equation 2, the total that an arbitrageur will allocate to a specific asset is a result of the asset's alpha, its idiosyncratic risk, and the arbitrageur's risk aversion. While one might expect that idiosyncratic risk will only prevent arbitrage if the arbitrageur is not diversified, equation 2 shows that the total invested in a mispriced asset does not depend on the arbitrageur's level of diversification, as it does not vary with *n*, the number of stocks in the arbitrageur's portfolio. McLean (2010) argued that the benefit of each position is its alpha, while each position's cost is a product of its idiosyncratic risk and the arbitrageur's level of risk aversion. In that case, *n* does not affect any of the parameters, so it should not affect the arbitrageur's investment in the position.

3.3 Portfolio formation: Long-term reversal, Price momentum and Idiosyncratic risk Quartile formation.

McLean (2010) estimated idiosyncratic risk as monthly return variance that is statistically independent to the S&P500 over a period of 36 months for long term reversal portfolio and 6 months for momentum portfolios. Their second estimations of idiosyncratic risk is the standard deviation of residuals from the Fama-French 3 factor and 4-factor model. Theoretically, idiosyncratic risk equals the return innovation`s standard deviation above what is expected, given that period`s market return. In order to capture the four risk factors (market, size, value and momentum), this study considers that the Carhart (1997) four-factor model will be more appropriate to estimate the expected returns. This study estimates idiosyncratic risk as the standard deviation of residuals from the Carhart (1997) four-factor model regressions.

$$R_i - r_t = \alpha i + \beta i(Rm_t - r_t) + S_i SMB_t + h_i HML_t + U_i UMD + \varepsilon_i t \qquad 3$$

Where:

$R_i - r_t$ = the excess returns,

αi = intercept in month *t*.

βi =Coefficient of the stock market minus risk free rate

Rm_t = return of stock market

SMB_t = Small (cap) Minus Big

S_i = Coefficient of *SMB*

HML_t = High (book/price) Minus Low

h_i = Coefficient of *HML*

UMD = Up Minus Down

U_i = Coefficient of UMD

$\varepsilon_i t$ = indicates the residual

The four systematic risks are the market effect (excess returns to the market), the size effect (the difference in returns between small firms and large firms), the value effect (the difference in returns between firms with high book to market (B/M) ratios and firms having low B/M ratio) and momentum effect (winners that went up minus the losers that lost value).

In support of this study`s choice of idiosyncratic risk estimation method, McLean (2010) show that the correlation between idiosyncratic risk and total variance is 0.99, and the correlation between idiosyncratic risk and 5-factor idiosyncratic risk is 0.94. Their results are consistent with a study by Wurgler and Zhuravskaya (2002) which examined whether arbitrage flatten demand curves for Stocks. Wurgler and Zhuravskaya (2002) used a matching firm method to estimate idiosyncratic risk. For each stock, they construct a portfolio of three firms in the same industry and have similar size. After forming these portfolios, they regress each stock's return on the matching portfolio's returns. The authors then used standard deviation of the residuals as their idiosyncratic risk measure. After that, they analysed the correlation between their model and the market-model measure (standard deviation of residuals from Fama French 3 factor model) and find a 0.98 correlation. This suggests that different measures of idiosyncratic risk are highly correlated; therefore, the choice of idiosyncratic risk measure is not important in studies such as this one.

McLean (2010) show that the correlation between past and future idiosyncratic risk ranks is 0.80, and the correlation between past and future idiosyncratic quintiles is 0.76. In this regard, it is a reasonable assumption that a high idiosyncratic risk stock will remain a high idiosyncratic risk stock in the future, although estimating an actual value of idiosyncratic risk is challenging. The results reported in this study rely on the assumption that past and future idiosyncratic risk is highly correlated.

Following McLean (2010)'s model, long term reversal and price momentum will be reported as follows:

The long-term reversal quartiles are formed each month by sorting stocks on past returns from month t-36 through t-7. The measurement ends at month t-7 to avoid overlap of the momentum measure. Following McLean (2010), this study will use the standard deviation of residuals and the monthly return variance as estimations of idiosyncratic risk for each month from t-36 through t-7.

The price momentum quartile are formed each month by sorting stocks on past returns from t-6 through t-1. Following McLean (2010), this study will use the standard deviation of residuals and the monthly return variance as estimations of idiosyncratic risk for each month from t-6 through t-1.

4. Results

4.1 Summary Statistics and Portfolio Characteristics for equally weighted momentum portfolio

Table 1 Portfolio Characteristics for equally weighted momentum and reversal portfolio

Table 1 reports summary statistics for the arbitrage costs variables in this study. Panel A reports statistics for the entire sample, Panel B reports mean values on the momentum portfolio and Panel C reports the mean values of the reversal portfolio. The 4-factor model (ER) is the expected return estimated by the Carhart (1997) 4-factor model. Idio_Risk is the standard deviation of residuals from the 4-factor regression model. Variance is the monthly return variance measured over the past 36 months for reversal portfolios and 6 months for price momentum portfolios.

			Summary Statistics			
			Panel A			
Variable	N	Mean	Std. Dev	25th Percentil	Median	75th Percentile
Idio_Risk	100	7,16	12,83	1,87	5,9	9,31
Variance	100	2,98	82,56	0,21	0,5	1,1
4-factor model	100	7,07	13,1	2,03	5,87	9,3
Size	100	0,09	20,72	-6,92	0	6,32
BM	100	0,36	31,98	-8,08	0,5	9,92
			Momentum Portfolio Chracteristics: Mean Values			
			Panel B			
Past 6-Months Return	Loser	2	3	Winner		W-L
Return	-1,32	-0,46	0,32	1,29		2,61
Idio_Risk	8,79	8,75	8,30	9,41		
Variance	1,11	1,20	0,96	1,31		
4-factor model (ER)	6,77	7,86	8,33	9,30		2,53
P-value	0,028	0,030	0,032	0,027		
			Reversal Portfolio Chracteristics: Mean Values			
			Panel C			
Past 36-Months Return	Loser	2	3	Winner		L-W
Return	0,17	-0,36	-0,53	-0,47		0,64
Idio_Risk	7,29	7,56	8,14	9,78		
Variance	0,75	1,22	0,94	6,44		
4-factor model (ER)	0,40	0,14	-1,12	-1,23		1,63
P-value	0,0015	0,0000	0,0019	0,0156		

Panel B of Table 1 shows that both the price momentum winner and loser quartiles have higher idiosyncratic risk than do the other past return quartiles. Like McLean (2010), this study shows that there is a good deal of variation in idiosyncratic risk across the stocks in this sample. This study shows that the average idiosyncratic risk in the low idiosyncratic risk quartile is 8.79, while the average idiosyncratic risk in the high idiosyncratic risk quintile is 9.41.

The results estimated by the Carhart 4-Factor model show that winner stocks have higher expected returns and loser quartiles have lower expected returns. The results also show that the price momentum winner have higher idiosyncratic risk than do the other past return quartiles. The results of this study are consistent with the findings of Arena et al. (2008) which shows that momentum profits can be attributed to firm specific information with idiosyncratic risk limiting arbitrage of the momentum effect. The authors also find a positive time series relationship between momentum returns and total idiosyncratic risk. This shows that idiosyncratic risk plays an integral role in the momentum effect and helps explain its persistence and increase in markets.

These results are also consistent with the findings of Di Lorio and Lu (2016) which shows strong evidence to support that idiosyncratic risk is a substantial pricing factor for returns of equity funds suggesting that investors should consider idiosyncratic risk when evaluating performance of funds. The authors also find strong evidence highlighting that idiosyncratic risk is predominantly related with momentum effect of Australian equity pension funds as equity pension funds with high idiosyncratic risk display a high momentum effect.

Pontiff (2006) argues that arbitrageurs are not able to avoid idiosyncratic risk, and thus they must strike a balance between the expected returns from a position and the idiosyncratic risk to which the position exposes them. The author shows that risk-averse arbitrageurs will allocate lesser portfolio weights to stocks with higher idiosyncratic risk. Hence, idiosyncratic risk is likely to put off arbitrage. The empirical studies that have followed the limits of arbitrage topic shared a common theme; idiosyncratic risk seems to be the only prevalent impediment to market efficiency.

These preliminary results provide strong evidence to support that the high momentum effect (both winners and losers) are related with high idiosyncratic risk for South African stocks Listed on the

JSE. This finding is consistent with Arena et al. (2008) as they report similar findings by using US stocks. The authors argue that momentum profits result from under reaction to firm-specific information, for which idiosyncratic risk can be regarded as a proxy. Their results are also consistent with the hypothesis that idiosyncratic risk represents an important limit of arbitrage. The preliminary results of this study for equal weighted portfolios shows that momentum returns are highest among stocks with the highest idiosyncratic risk, consistent with the momentum effect being more easily arbitraged away for stocks with less idiosyncratic risk. Hence, momentum effect persists over time for stocks with high idiosyncratic risk.

This study also confirms that mispricing continues whenever the cost of arbitrage is above the benefit which is consistent with the findings of McLean (2010), Pontiff (2006), Shleifer and Vishny (1997) who highlighted that idiosyncratic risk as a limit to arbitrage. The authors argue that the functionality of markets where well skilled arbitrageurs invest the money of outside investors is debatable because the performance based arbitrage may not be entirely effective in getting security prices to its fundamental values, particularly in the extreme cases. In general, well skilled, professional arbitrageurs may shun extremely volatile or risk arbitrage positions. Even though such positions deliver attractive average returns, the volatility also exposes the arbitrageurs to high potential losses and may lead to portfolio liquidations caused by undue pressure from the investors in the fund. Therefore, it is this avoidance of volatility by arbitrageurs that cause the persistence of excess returns in stock prices.

Panel C of Table 1 shows that the winner (high past return) quartile have relatively high idiosyncratic risk. The idiosyncratic risk of the winner quartile is 9.78, and for the loser quartile it is 7.29. The idiosyncratic risk measured by variance also confirms that the winners has more risk 6.44 compared the loser quartile which is 0.75. The idiosyncratic risk of the other 2 quartiles are 1.22 and 0.94. Contrary to McLean (2010), both variance measures show that holding long-term reversal stocks requires holding less volatile stocks. This suggests that in equilibrium, mispricing should be more in high versus low idiosyncratic risk stocks. Considering idiosyncratic risk as the only holding cost, the low idiosyncratic risk in the reversal loser quartile might suggest that these loser stocks have less mispricing. However, the mispricing in the loser portfolio might be high, but idiosyncratic risk might not be the explanatory factor. Page and Way (1992), Wongchoti and

Pyun (2005), Bhave and Libertini (2013) argue that the mispricing in reversal stocks is more explained by the overreaction and under reaction to news by investors not by idiosyncratic risk.

Figure1 displays the growth of R100 invested for 36 months in price momentum portfolios. The results illustrate that a R100 invested in a momentum winner portfolio would have grown to R102.07 in six months and R106.91 in 12 months. When the period is extended to over 12 months, the momentum portfolio declined to R87.08 over a 36 months period. This is consistent with the study of Britten et al. (2016) which document that momentum profits are eroded if the holding periods exceed 12months. The momentum loser portfolio continued to lose to R94.59 in 6 months' time and R89.35 over 12 months. However, after the period has been extended to 36 months the loser portfolio rallied to R107.08.

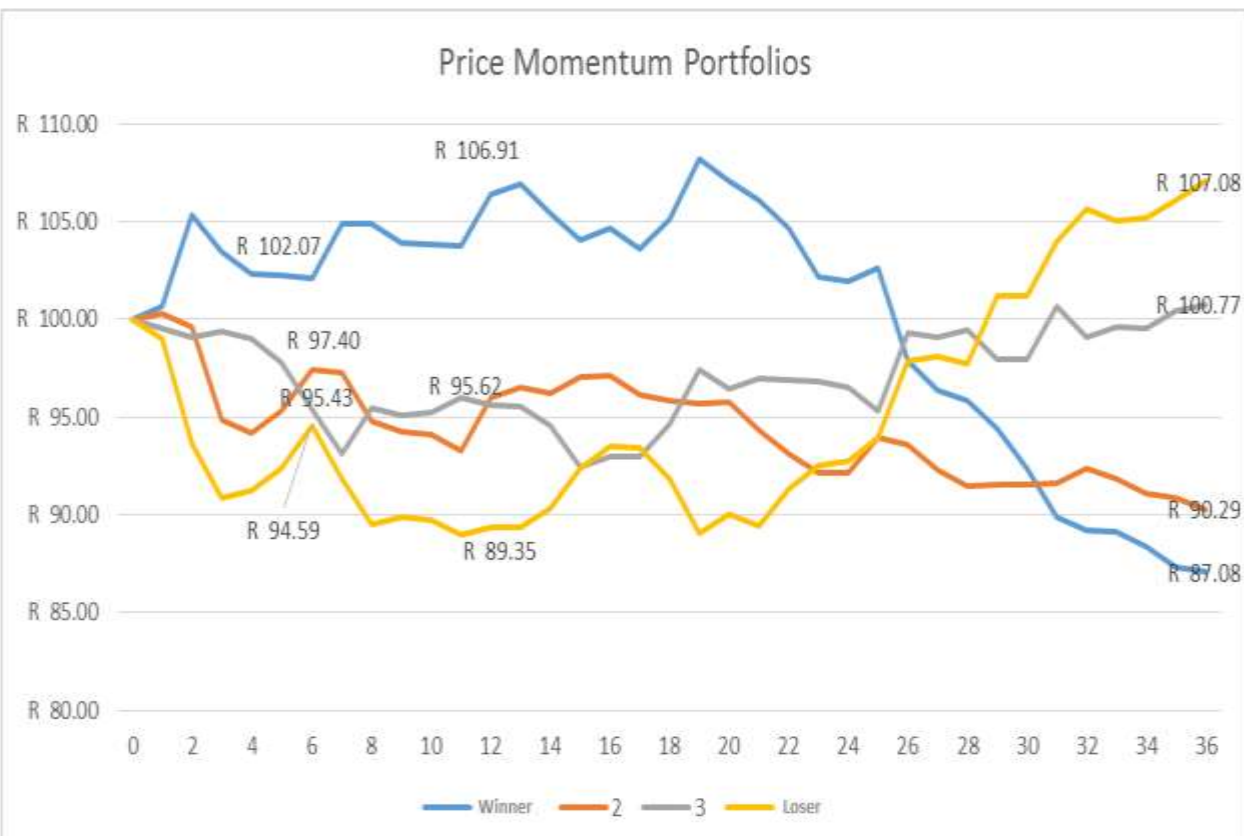

Figure 1 Price Momentum Portfolios

The R100 invested in the reversal winner portfolio would have rallied to R107.89 in 6 months while the other four portfolios would have declined with the loser portfolio down to R94.36. However, after extending the holding period to 36 months, the data shows that the reversal loser portfolio would have outperformed the winner portfolio by over 36%. This is consistent with Page and Way (1992) `s findings that on average portfolios of prior losers outperform prior winners by between 10% to 20% for both 2 years and 3 years formation periods. Chopra, Lakonishok and Ritter (1992) show that portfolios formed on the basis of prior five-year returns, extreme prior losers outperform extreme prior winners by 5 to 10% per year during the subsequent five years.

Figure 2 Long-Term Reversal Portfolios

This study also illustrated the growth of a R100 invested in momentum and reversal by an arbitrageur who employ the two strategies for 13 years, Figure 3 shows that an active arbitrageur can make more money by employing a momentum strategy as compared to the reversal strategy. This study assumed that the arbitrageur would have rebalanced the momentum portfolio after every

6 months, (buying winners and selling losers). The study also assumed that the arbitrageur would have rebalanced the reversal portfolio after every 36 months (buying losers and selling winners). While both the portfolios have grown, the momentum strategy would have grown materially to about R2 400.00 while the R100.00 invested in the reversal strategy would have grown to R414.00

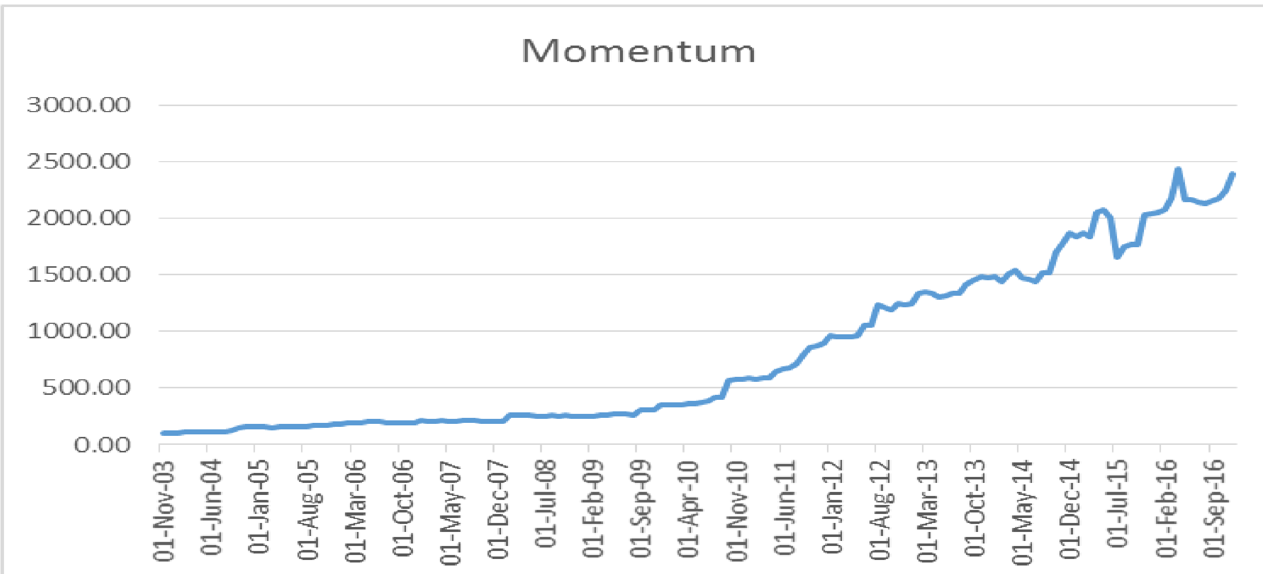

Figure 3 displays the growth of R100 invested for 154 months in the momentum portfolios.

Figure 4 displays the growth of R100 invested for 154 months in the reversal portfolios.

4.2 Portfolio returns measured via different weighting schemes

In an effort to determine how arbitrage costs can affect the returns of the long term reversal and price momentum portfolios, this section uses different weighting schemes. Still following McLean (2010), the portfolio's returns are computed using equal weights, value weights and idiosyncratic risk weights. McLean (2010) argues that adequate condition of limited arbitrage is that each effect will be strongest in the portfolio that give larger weights to positions that are more costly to transact and hold. In that case, an adequate condition of limited arbitrage is that equal-weighted and idiosyncratic risk weighted portfolios should yield the highest returns.

Stock idiosyncratic risk is estimated by the standard deviation of residuals over the prior 36 months. The reversal (momentum) quartiles are formed each month by sorting stocks on past returns from t−36 through t−7 (t−6 through t −1). The measurement ends at month t-7 to avoid overlap of the momentum measure. The reversal portfolios' returns are calculated by buying the low past return quintile (losers) and selling the high past return quintile (winners). The momentum portfolios' returns are calculated by buying the high past return quintile (winner) and selling the low past return quintile (loser).

Panel A of Table 2 displays the results for the momentum portfolio. The monthly return of the equal-weighted portfolio averages 1.65% per month (t-statistic =12.29), above the return which was found by McLean (2010). The value-weighted portfolio's returns average 2.71% per month (*t*-statistic = 5.64), which is larger than that of the equal-weighted portfolio. While most of the studies in price momentum and reversals used deciles and quintiles, this study used quartiles due to data limitations.

However, the results of this study are consistent with those in Korajczyk and Sadka (2004), who show that the momentum winner effect is similar in equal and value-weighted portfolios, but that the momentum loser effect is resilient in value-weighted portfolios. This study shows that the loser portfolio returns are (-1.0%) in equally weighted momentum portfolio and (-1.94) in the value weighted momentum portfolio.

4.3 Price Momentum Portfolio Results

Table 2 Momentum Portfolios via Different Weighting Schemes

Table 2 reports the average month returns and the Carhart 4-factor alphas of momentum and long-term reversal portfolios via different weighting schemes. The weightings schemes include the equal weights (column 2), value weights (column 3), idiosyncratic risk (idio-risk) weights (column 4) and idiosyncratic risk based on portfolio variance (idio-risk) weights (column 5). Panel A reports these different weighting schemes on price momentum portfolio while Panel B reports the same weighting schemes on the long-term reversal portfolio. The tstat and P-value are calculated based on the momentum or reversal return (L-W or W-L). The values presented on the portfolio returns are percentages while the values presented in column 4, 5 and the tstat and P-values are numbers.

	Equial	Value	Mom Idio_Risk/ Reversal (Standad Deviation of residuals)	Mom Idio_Risk/Reversal (Var)
Panel A		Price momentum portfolios		
Winner	0,650	0,770	11,960	5,230
2	0,320	-0,380	6,980	0,740
3	-0,460	-1,090	7,070	0,810
Loser	-1,000	-1,940	8,820	1,500
L-W	1,650	2,710	3,140	3,740
alpha	0,760	1,440	7,070	3,100
Tstat	12,285	5,635	2,557	2,094
P-value	0,025	0,002	0,018	0,029
Panel B		Long term reversal portfolios		
Winner	-0,476	-1,224	8,662	6,437
2	-0,458	-0,295	8,041	0,937
3	-0,540	0,496	7,870	1,222
Loser	0,452	0,221	8,230	0,752
W-L	0,929	1,445	-0,432	-5,685
alpha	0,456	1,527	12,794	10,868
Tstat	1,290	3,656	1,289	2,077
P-value	0,129	0,001	0,134	0,021

Moreover, Hong et al. (2000) show that the momentum effect is weak in their sample and Lesmond et al. (2004) find that momentum is weak both in very small stocks and in stocks with the more transaction costs (both Lesmond et al. (2004) and Hong et al. (2000) show that momentum increases in transaction costs and falls with size once one moves past the smallest and highest cost stocks).

The results also confirm the propositions of Pontiff (2006) that mispricing exists to the level that arbitrage costs avoid rational traders from fully removing inefficiencies. In that regard, risk-averse arbitrageurs will allocate lesser portfolio weights to stocks with higher idiosyncratic risk. Hence, idiosyncratic risk is likely to put off arbitrage.

The findings of this study are also consistent with Arena et al. (2008) who finds that returns to momentum investing are more among high idiosyncratic risk. However, unlike Arena et al. (2008) who finds that highest idiosyncratic risk is in loser stocks, this study finds the opposite even though both winners and loser quartiles have higher idiosyncratic risk, the winner quartile have the highest idiosyncratic risk. The findings are consistent with momentum profits being attributable to idiosyncratic risk limiting arbitrage of the momentum effect.

Shleifer and Vishny (1997) asserts that in general, well skilled, professional arbitrageurs may avoid extremely high risk arbitrage positions even though such positions has the potential to deliver high average returns, the volatility also exposes the arbitrageurs to high potential losses and my lead to portfolio liquidation caused by pressure from panicking and nervous investors in the fund. Therefore, it is this avoidance of volatility by arbitrageurs that cause the persistence of excess returns in price momentum.

The results also show that idiosyncratic risk is highest in the winner quartile compared to the loser quartile. This shows that arbitrageurs` ability might be limited to exploit the excess returns opportunity created by the momentum strategy. These findings are consistent with Sonmez (2013) and Cao and Han (2016) who find that stock returns are high in stocks with high idiosyncratic risk. Cao and Han (2016) argued that this pattern[5] is strong to a number of subsamples and industries, and cannot be described by risk factors or firm features. In addition to that, Cao and Han (2016)

[5] The pattern that stock returns are high in stocks with high idiosyncratic risk.

asserts that transaction costs, short-sale limitations and information uncertainty cannot explain the role of idiosyncratic risk.

The findings of this study are not consistent with McLean (2010) who posits that price momentum is not related to idiosyncratic risk. Their results suggest that a risk averse arbitrageur would invest less of their wealth in a single low idiosyncratic risk-momentum portfolio stock, making limited arbitrage due to idiosyncratic risk a less credible explanation for the persistence of the effect. McLean (2010) did not specifically highlight whether the risk averse arbitrageur would invest more of her wealth in a high idiosyncratic risk momentum stock or not. However, the author suggests that momentum may still be the result of mispricing, but transaction costs may be the binding costs that limit arbitrage. This argument is supported by the findings of Lesmond et al. (2004), who show that there is a cross-sectional relationship between transaction costs and momentum profits.

4.4 Long-Term Reversal Portfolio Results

Panel B of Table 2 reports the results for the reversal portfolio. The returns of the reversal portfolio are positive and significant on value weights. However, on the equal weighted portfolio the returns are positive but insignificant. These findings are not consistent with limited arbitrage on which idiosyncratic risk will be holding cost. The limited arbitrage states that for mispricing to persist, arbitrageurs should somewhat be limited in their ability to take advantage of the opportunities presented by the mispricing.

Unlike McLean (2010) who finds the highest reversal portfolio returns from the idiosyncratic risk weightings which yields an average monthly return of 1.386% (*t*-statistic = 4.19). This study finds a negative insignificant average return of (-0.432%) per month on idiosyncratic weighted portfolio as measured by the standard deviation of residuals (t-statistic =1.3). In addition, the idiosyncratic risk is less in the loser portfolio than in the winner portfolio. This shows that that reversal returns in this study are not explained by idiosyncratic risk.

The long term reversal returns might still be a result of mispricing but idiosyncratic risk lacks the explanatory power of these returns. De Bondt and Thaler (1985, 1987), Page and Way (1992), Chopra, Lakonishok and Ritter (1992), Bhave and Libertini (2013) argue that behavioural factors such as (overreaction and under reaction) might better explain this anomaly.

4.5 Momentum and Reversal Portfolios Sorted into Idiosyncratic Risk Quartiles

Following McLean (2010) methodology, equal-weighted average monthly returns and Carhart 4-factor alphas of price momentum and long term reversal portfolios that are cross-sorted into idiosyncratic risk quartiles, the returns are measured over a 6-month estimation period for price momentum portfolios and 36-month estimation period for long term reversal portfolios, and are reported in percentages. Firm idiosyncratic risk is estimated by the standard deviation of residuals over a 36-months estimation period for long-term reversal portfolios and over 6-month estimation period for the price momentum portfolios. The reversal (momentum) portfolios are formed each month by sorting stocks on past returns from t − 36 through t – 7 (t − 6 through t − 1). The measurement ends at month t-7 to avoid overlap of the momentum measure. The reversal portfolios' returns are calculated by buying the low past return quartile (losers) and selling the high past return quartile (winners). The momentum portfolios' returns are calculated by buying the high past return quartile (winner) and selling the low past return quartile (loser). The t-statistics is reported in parentheses.

4. 6 Momentum-Idiosyncratic Risk Portfolios Results

The results in Panel A of Table 3 are consistent with those in Panel A of Table 2, which show that price momentum does strengthen with idiosyncratic risk limiting arbitrage (refer to Figure 3, Graph A below). The difference between the high and low idiosyncratic risk quartiles in the Carhart 4-factor alpha is 1.253 (*t*-statistic = 3.616). The momentum portfolio's returns are significant in all idiosyncratic risk quartiles, and the effect is weakest in the second lowest idiosyncratic risk quartile.

The findings of this study affirm that risk averse arbitrageur would place a smaller amount of their wealth in a high idiosyncratic risk-momentum portfolio. Hence, if arbitrageurs are prevented by idiosyncratic risk, then it would be a fair assumption that low idiosyncratic risk-momentum stocks should be expected to get more arbitrage resources than the high idiosyncratic risk-momentum stocks, which should result in smaller mispricing. These results are in line with the results of Pontiff (1996), (2006), which shows that closed-end funds are subject to mispricing, and idiosyncratic risk is the main arbitrage cost that avoids the mispricing from dissipating.

Shleifer and Vishny (1997), argue that well skilled arbitrageurs may avoid very volatile arbitrage positions. Even though such positions offer better average returns, the volatility similarly exposes the arbitrageurs to risk of losses and may lead to portfolio liquidation as investors in fund puts pressure on the arbitrager. Therefore, this avoidance of volatility by arbitrageurs that cause the persistence of excess returns in stock prices.

In support of this study results that risk-averse arbitrageurs would place less of their wealth in a high idiosyncratic risk-momentum portfolio, Ben-David and Roulstone (2005) indicate that managers compete with outside arbitrageurs in trying to take advantage of mispricing. They argue that when stocks have high idiosyncratic risk, outside arbitrageurs have inadequate ability to participate in arbitrage trades, as these trades are not risk-free. In this case, insiders and firms have the capacity to delay trades while mispricing aggravates due to the restraints on outside arbitrageurs. The tendency of delaying trades while mispricing increases has a direct impact on the persistence of price momentum in stock markets including the JSE.

Consistent with idiosyncratic risk limiting arbitrage trades by non-insiders, Ben-David and Roulstone (2005) show that insiders and firms trade more profitably in stocks with high idiosyncratic risk than in stocks with low idiosyncratic risk. Ben-David and Roulstone (2005) results implies that when arbitrage risk is high the price of a stock may substantially deviate from its fundamental value unlike when arbitrage risk is low. The authors pointed out that the lack of trades intended to profit from mispricing on high arbitrage risk stocks might be the reason for this substantial price deviation. Therefore, if arbitrageurs limited by idiosyncratic risk, then it would be expected that the low idiosyncratic risk stocks should get more arbitrage resources than the high idiosyncratic risk stocks. This will then result in smaller mispricing in low idiosyncratic risk stocks.

Table 3 Momentum and Reversal Portfolios Sorted into Idiosyncratic Risk Quintiles

Table 3 reports the equal-weighted average monthly returns and the Carhat 4-factor alphas of price momentum and log-term reversal portfolios, which are cross-sorted into idiosyncratic risk quartiles. Panel A reports the price momentum idiosyncratic risk sorts and Panel B reports the long-term reversal sorts.

	Idiosyncratic Risk Quartile				
Portfolio	Low	2	3	High	H-L
Panel A. Momentum-Idiosyncratic Risk Portfolio: Monthly Equal Weighted Returns					
Winner	1,889	1,117	1,713	3,391	1,502
t-statistic	2,411	2,364	2,364	2,081	2,271
P-value	0,018	0,034	0,031	0,021	0,027
Loser	-1,203	-1,291	-1,304	-0,964	0,239
t-statistic	2,758	2,871	3,390	3,300	3,616
P-value	0,025	0,005	0,001	0,004	0,005
W-L	3,092	2,408	3,017	4,355	1,263
Alpha	4,911	3,543	4,760	7,437	1,253
Panel B. Long-Term Reversal-Idiosyncratic Risk Portfolio: Monthly Equal Weighted Returns					
Loser	0,387	0,226	-0,016	1,004	0,617
t-statistic	1,984	2,081	2,081	2,364	2,413
P-value	0,025	0,021	0,017	0,031	0,023
Winner	-0,508	-0,339	-0,423	-0,660	-0,152
t-statistic	3,174	2,333	2,626	2,364	3,305
P-value	0,001	0,018	0,005	0,002	0,001
L-W	1,512	0,565	0,407	1,047	-0,465
Alpha	1,898	-0,300	-0,616	0,360	-1,538

In line with the findings of this study on the momentum-idiosyncratic risk portfolios results which shows that idiosyncratic risk is high among winners, Arena et al. (2008) argue that momentum returns are higher among high idiosyncratic risk stocks. Cao (2009) and Cao and Han (2016) find similar results consistent with the prediction of the limits to arbitrage theory. The authors find that average stock returns consistently increase with idiosyncratic risk for undervalued stocks and consistently decrease with idiosyncratic risk for overvalued stocks. Di Lorio and Lu (2016) also indicate that there is a strong positive relationship between idiosyncratic risk and momentum.

However, the overall results of McLean (2010) are not consistent with this study. McLean (2010) finds no relationship between momentum and idiosyncratic risk. The author`s results suggest that a risk-averse arbitrageur would invest a smaller amount of her wealth in a single low idiosyncratic risk-momentum portfolio stock making limited arbitrage as a result of idiosyncratic risk a less likely explanation for the persistence of the effect. The author did not precisely indicate whether the risk averse arbitrageur would invest more of her wealth in a high idiosyncratic risk portfolio. However, they did show that the mispricing in price momentum is not a result of idiosyncratic risk. McLean (2010) acknowledged that price momentum might still be an effect of mispricing; however, transaction costs may be the binding costs that limit arbitrage. This argument is supported by the findings of Lesmond et al. (2004), who show that there is cross-sectional relationship between transaction costs and momentum profits.

This study supports the argument that idiosyncratic risk prevents arbitrage among momentum portfolio stocks. The results show that alphas are 51.4% greater in the high idiosyncratic portfolio as compared to the low idiosyncratic risk-momentum portfolios. Therefore, if the limit of arbitrage argument holds, the results of this study suggest that mispricing is greatest in high idiosyncratic risk portfolios.

4.7 Momentum and Reversal Portfolios Alpha and Raw Returns

Figure 5 displays the average monthly returns of the momentum portfolios, each sorted into idiosyncratic risk quintiles. The returns are measured over a 6-month holding period as both raw returns and Carhart 4-factor alpha. The returns are reported in percentages.

Figure 5 Idiosyncratic risk quartile (1 low idiosyncratic risk and 4 high idiosyncratic)

Figure 6 displays the average monthly returns of the long-term reversal portfolios, each sorted into idiosyncratic risk quintiles. The returns are measured over a 36-month holding period as both raw returns and Carhart 4-factor alpha. The returns are reported in percentages.

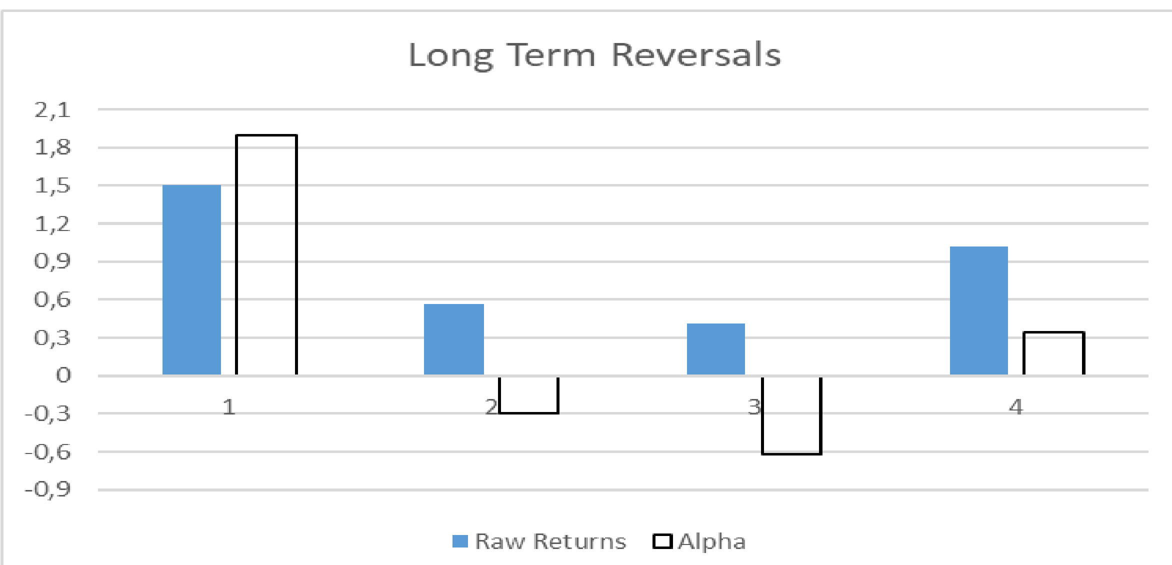

Figure 6 Idiosyncratic risk quartile (1 low idiosyncratic risk and 4 high idiosyncratic)

4.8 Long Term Reversal-Idiosyncratic Risk Portfolios Results

Long term reversal-idiosyncratic risk portfolios panel B of Table 3 shows that reversals are greatest in low idiosyncratic risk firms (refer to Figure 6). The reversal effect is significant in all the idiosyncratic risk quartiles. The reversal portfolio returns are 1.512 (t-statistic = 1.98) in the first idiosyncratic risk quartile. The difference in monthly returns between the high and low idiosyncratic risk quintiles is -0.47 (t-statistic = 3.31).

Like the raw returns, the Carhart 4-factor alphas also produce a pattern that is not consistent with idiosyncratic risk limiting arbitrage. The alphas are positive and significant in the highest and lowest idiosyncratic risk quartiles, and they are negative and significant in the second and third idiosyncratic risk quintiles. The difference between the high and low idiosyncratic risk quintiles' alphas is -1.54 (t-statistic = 3.31). Just like the results in Table 1 and 2, the results presented in Table 3 are not consistent with McLean (2010) and might imply that idiosyncratic risk does not explain the long-term reversal returns. The results also suggest that idiosyncratic risk does not act as a limit of arbitrage on reversal portfolios considering the finding that returns are greatest in the low idiosyncratic risk quartile. The returns of long-term reversal might be explained by other factors like overreaction and under-reaction. Page and Way (1992) suggest that stock markets over-react and that investors give more consideration to recent dramatic news. Over their sample period, portfolios of past losers, on average, significantly outperform portfolios of past winners over a 36-month period by between 10% to 20% for both 2 years and 3 years formation periods.

Chopra, Lakonishok and Ritter (1992) estimated the event-varying betas for the CAPM in calculating excess returns for winners and losers and show that an adjustment for beta risk explains a big amount, but not all, of the overreaction effect. Their results show overreaction effect even after adjusting for size and beta. In portfolios formed on past five-year returns, extreme past losers outperform extreme past winners by 5 to 10% per annum during the following five years. Bhave and Libertini (2013) argue that the attractiveness of lower prices as a significant cause of mean reversion in stocks.

5 Robustness check: Regression Analysis of Idiosyncratic Risk

In the same manner as McLean (2010), the methodology used in this section is the Fama and MacBeth (1973) regression framework. The regressions include variables that measure firm size, market-to-book ratio, momentum, reversal, and idiosyncratic risk. To determine the betas, both the momentum and reversal portfolio returns were regressed against the risk factors (size, market-to-book ratio, momentum and reversal). To determine the risk premiums for each factor, both the momentum and reversal portfolios were regressed against the betas estimated on the first regression.

The firm`s market capitalization is used as proxy for firm size. Market-to-book ratio will be the ratio of market value of equity to book value of equity. The book value of equity is from previous year's annual report. Following McLean (2010), momentum proxy will be the buy and hold return measure from t-6 through t-1. Reversal will be the buy and hold return measured from month t-36 through to t-7. The measurement ends at month t-7 to avoid overlap of the momentum measure. The beta estimation will be over 6 months rolling periods for momentum and 36 months rolling periods for long-term reversal portfolios. Idiosyncratic risk is the standard deviation of the residual from a regression of monthly firm returns on the monthly returns of the ALSI over the past 36 months. The following equation is used to estimate the relationship between idiosyncratic risk, price momentum and long-term reversals.

$$\boldsymbol{Ret} = \boldsymbol{\alpha i} + S_i\boldsymbol{SIZE} + H_i\boldsymbol{MB} + M_i\boldsymbol{MOM} + R_i\boldsymbol{REV} + D_i\ \boldsymbol{IDIO\_RISK} + \varepsilon_i t \qquad 4$$

Where:

MB = the market to book value of equity

MOM = is the momentum proxy

REV = the long term reversal proxy

IDIO_RISK = the idiosyncratic risk proxy

αi = intercept in month t.

S_i = Coefficient of size

H_i = Coefficient of market to book

M_i = Coefficient of price momentum

R_i = Coefficient of long term reversion

D_i = Coefficient of idiosyncratic risk

5.1 Price Momentum Regression Results

The results show that the momentum effect is greatest in high idiosyncratic risk stocks and that the reversal effect have the lowest idiosyncratic risk. With respect to price momentum, the results are consistent with idiosyncratic risk limiting arbitrage. Table 4 confirms the results in Tables 2 and 3, and shows that price momentum is resilient in high idiosyncratic risk firms.

The coefficients for size and market-to-book ratios are both negative and significant for price momentum portfolios. The regression shows that price momentum is limited to high idiosyncratic risk stocks, which is consistent with the results in Tables 2 and 3. The regression shows that the momentum portfolio has a high idiosyncratic risk as estimated by the standard deviation of the residuals. This result is consistent with idiosyncratic risk limiting arbitrage, and therefore supports the limited arbitrage interpretation of the results in the previous tables.

Table 4 Fama-Macbeth Regressions

Table 4 reports the results of Fama and Macbeth (1973) cross-sectional regressions. The dependent variable is the average monthly return measured over a 6-month holding period for price momentum portfolio and over 36 months holding periods for long-term reversal portfolio. The independent variables include firm market value (SIZE), the market-to-book ratio (MB), the past 6-month stock return (MOM), and the past 36-month stock return (REV).

Fama-Macbeth Regression	
Momentum Results	
Variable	Regression
Intercept	0,58
t-stat	(+4.71)
SIZE	-0,25
t-stat	(-1.3)
MB	1,04
t-stat	(-1.38)
MOM	7,03
t-stat	(+2.36)
Idio_Risk	2,64
Long term Reversal Results	
Variable	Regression
Intercept	0,009
t-stat	(+1.77)
SIZE	0,002
t-stat	(-0.48)
MB	0,004
t-stat	(+0.05)
MOM	0,042
t-stat	(-1.16)
Idio_Risk	0,05

5.2 Long-term Reversal Regression Results

With respect to long-term reversals, the results are not consistent with idiosyncratic risk limiting arbitrage. Table 4 confirms the results in Tables 2 and 3, and shows that long term reversals is not resilient in high idiosyncratic risk stocks. This is not consistent with both idiosyncratic risk and transaction costs serving as limits to arbitrage. This might imply that other factors like overreaction and under-reaction might explain this phenomenon in a better way (Bhave and Libertini, 2013).

5.3 Summary of results

In summary, the evidence presented in this study supports the limits to arbitrage theory on the price momentum stocks, but not on the long-term reversal stocks. This study shows that idiosyncratic risk indeed prevents arbitrageurs from employing the price momentum strategy since idiosyncratic risk is high among winner stocks. This is mainly because risk-averse arbitrageurs will assign lesser portfolio weights to stocks with higher idiosyncratic risk. The other reason is that arbitrageurs avoid very volatile arbitrage positions even though such positions offer attractive average returns. The volatility similarly exposes the arbitrageurs to risk of losses and may lead to portfolio liquidation as investors pull their funds in the face of large losses (Shleifer and Vishny 1997). Therefore, this avoidance of volatility by arbitrageurs that cause the persistence of excess returns in stock prices.

The results of this study are similar the finding of Arena et al. (2008) that momentum returns are higher among high idiosyncratic risk stocks. Cao (2009) and Cao and Han (2016) find similar results consistent with the prediction of the limits to arbitrage theory. The authors find that average stock returns consistently increase with idiosyncratic risk for undervalued stocks and consistently decrease with idiosyncratic risk for overvalued stocks. Di Lorio and Lu (2016) also indicate that there is a strong positive relationship between idiosyncratic risk and momentum.

However, the results of this study indicate that idiosyncratic risk does not explain the long-term reversal returns and that there is no relationship between idiosyncratic risk and reversal portfolios, since the returns are higher in the low idiosyncratic risk quartiles. Therefore, other factors like overreaction and under-reaction might have a better explanatory power of the long-term reversal effect in stock markets.

6 Conclusion

The limits to arbitrage argument suggest that mispricing can continue each time when the costs of arbitrage is above the benefits (McLean, 2010). The arbitrage cost that this study focuses on is idiosyncratic risk, which is a holding cost to any risk-averse arbitrageur. The study tests to what extent idiosyncratic risk can explain the persistence of the momentum and reversal effects.

This study finds that price momentum is stronger in high idiosyncratic risk firms. This is consistent with an equilibrium in which arbitrageurs attempt to correct mispricing, but only to the extent that the marginal benefit of each position is equal to its cost (McLean, 2010). The findings of this study are also consistent with Shleifer and Vishny (1997), Brandt et al (2001), Malkiel and Xu (2006), Arena et al (2008), Sonmez (2013), and Di Lorio and Lui (2016) who assert that rational alternatives particularly idiosyncratic risk can give a better explanation towards the real sources of price momentum.

This study finds no relationship between long-term reversal and idiosyncratic risk. The results suggest that a risk averse arbitrageur would invest more of their wealth in a low idiosyncratic risk-reversal portfolio stock, making limited arbitrage due to idiosyncratic risk a less than credible explanation for the persistence of the effect. However, long-term reversal may still be the result of mispricing, but overreaction and under-reaction may have more explanatory power. This argument is supported by the findings of Bhave and Libertini (2013) who argued that, psychologically it is better to purchase something at a discount and it is painful to purchase something at a premium. This is one reason why portfolio managers at times increase their exposure to underperforming positions and reduce their exposure to outperforming positions. These psychological biases naturally increase buying pressure for underperforming stocks and selling pressure for outperforming stocks, leading to a cycle of mean reversion in equities.

The findings of this study fail to reject the null hypothesis on price momentum and accepts the null hypothesis on long-term reversals. Therefore, this study suggests that the persistence of price momentum on the JSE is a result of idiosyncratic risk. Considering the high correlation between past and future idiosyncratic risk (McLean, 2010), this study suggests that there will be a positive relationship between idiosyncratic risk and expected market returns. This study also asserts that idiosyncratic risk does limit arbitrage on price momentum on the JSE.

6.1 Study Limitations and Recommendations for future study

Most of the research papers underpinning this study, used daily and weekly data, which this study could not employ due to data availability limitations. Using daily and weekly a data might give different results. The study also excluded stocks that had return data for less than 36 months; this limited the sample size of this study. McLean (2010) considers the correlation between idiosyncratic risk and transaction costs, which this study did not investigate. It would be informative to examine whether this relationship exists on the JSE and whether it will be a fair assumption to say high idiosyncratic stocks are found among high transaction cost stocks. Academic literature has documented that, measures of idiosyncratic risk are highly correlated; and therefore, the choice of idiosyncratic risk measure is not important. However, it will be more interesting to see if the use of different methodology like the GARCH and EGARCH to investigate whether idiosyncratic risk derive price momentum and long term reversal on the JSE will give different results.

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