Liquidity and Mean Reversion on the JSE

A Research Report
Presented to

The Graduate School of Business
University of Cape Town

in partial fulfilment
of the requirements for the
Masters of Business Administration Degree

by
Greg Bailey
December 2006

Supervisor: Dr Evan Gilbert
Preface

Acknowledgements:
I would like to thank the following people who have been instrumental to this research report:

- Dr Evan Gilbert for his continued support and counsel throughout the entire research report process.
- Michael Eidne from Investec Asset Management for his insight and knowledge sharing surrounding mean reversion on the JSE.
- I-Net Bridge for the use of their facilities and their help with regard to data integrity.

Declaration:
A recognised convention for citation and referencing has been used. Each significant contribution and quotation from the works of other people has been attributed, cited and referenced.

It is certified that this submission contains work only undertaken by the author, unless otherwise stated.
This report is not confidential and may be used freely by the Graduate School of Business.

Signed:
Greg Bailey

________________________________
December 2006
Liquidity and Mean Reversion on the JSE

ABSTRACT

This paper investigates the effect of share liquidity on mean reversion on the JSE (Johannesburg Stock Exchange) for the period 1983-2005 using a dataset corrected for survivorship bias. A new liquidity measure – the liquidity cap - is formulated and tested. There is conclusive evidence that liquidity does reduce the abnormal returns attributable to the presence of mean reversion. However abnormal returns still remain even when adjusting for the effects of liquidity.

KEYWORDS: Mean Reversion, Liquidity, JSE, Behavioural Finance, Investor over/under reaction, Trading Rules
# Table of Contents

Preface ............................................................................................................................................ i

ABSTRACT .................................................................................................................................. ii

Table of Contents ........................................................................................................................iii

List of Figures .............................................................................................................................. iv

List of Tables ................................................................................................................................ iv

1. Introduction .......................................................................................................................... 1

2. Problem Definition ............................................................................................................... 2

2.1. Research Hypothesis ...................................................................................................... 3

3. Literature review .................................................................................................................. 4

3.1. Efficient market hypothesis (EMH) ............................................................................... 4

3.2. Investor behaviour within the stock markets ................................................................. 5

3.3. Mean Reversion .............................................................................................................. 6

3.4. Explanation for Loser portfolio phenomenon ............................................................... 7

3.4.1. Evidence of Mean Reversion on Global Stock Markets ........................................ 8

3.4.2. Mean Reversion on the JSE ..................................................................................... 8

3.5. Liquidity ......................................................................................................................... 9

3.5.1. Measuring Liquidity ............................................................................................. 10

3.5.2. Liquidity on the JSE ............................................................................................. 11

3.5.3. Share Liquidity Cap ............................................................................................. 12

4. Research Methodology ....................................................................................................... 14

4.1. Background .................................................................................................................. 14

4.2. Data Collection ............................................................................................................. 14

4.3. Data Storage ................................................................................................................. 15

4.4. Portfolio Formation ...................................................................................................... 16

4.4.1. Investment Size .................................................................................................... 16

4.5. Calculating procedure .................................................................................................. 19

5. Findings ............................................................................................................................... 21

6. Conclusion ........................................................................................................................... 25
Liquidity and Mean Reversion on the JSE

7. References ........................................................................................................................... 26
   7.1. Web Site References .................................................................................................... 30

8. Appendices .......................................................................................................................... 31

List of Figures
Figure 1: Regression of Monthly JSE Traded Volume vs 12 Month Moving Average............. 12
Figure 2: Percentage Shares on the JSE Meeting Liquidity Requirement For Various Investment Sizes .................................................................................................................. 17
Figure 3: Number of Portfolios held ..................................................................................... 19
Figure 4: Average Winner and Loser Portfolios Cumulative Performance Relative to the ALSI21
Figure 5: Compound Average Returns for Loser and Winner Portfolios for the 7 Investment Sizes ........................................................................................................................................ 22
Figure 6: Loser Portfolios - Average Monthly Portfolio Returns Relatively to the ALSI........ 23
Figure 7: Winner Portfolios - Average Monthly Portfolio Returns Relatively to the ALSI....... 23

List of Tables
Table 1 Portfolio Returns ............................................................................................................. 21
1. Introduction

It has long been the dream of many an investor to be able to profit off the back of historical share prices using technical analysis. This dream has often been shattered by claims that the stock markets are efficient and consequently share prices fully reflect all the currently available information in the market. Fama (1965) was the first to produce evidence supporting the efficient market hypothesis (EMH), claiming that share prices are equal to their intrinsic values. These values are calculated by summing the present values of all future expected dividend cash flows. Taking this into account share prices are therefore unpredictable and follow a random walk. (Roberts, 1959)

The presence of the mean reversion of share returns, however, suggests that markets are not entirely efficient through. Basu (1977) was first to discover this anomaly by showing that PE (price earnings) ratios were potential indicators of future performance. He showed that low P/E shares tended to outperform high P/E shares due to investors pushing share prices above and below their respective intrinsic value. De Bondt and Thaler (1985) further demonstrated mean reversion on a stock exchange (NYSE) with the creation of their winner/loser portfolio scheme which showed that investors overreacted to information in the short term thus moving share prices away from their intrinsic values. However over longer periods of time these prices eventually revert or re-adjust back towards their intrinsic value or mean. Thus share prices at certain points in time do not represent their intrinsic value and therefore a potential arbitrage opportunity exists in the market.

There is empirical evidence of the existence of mean reversion on numerous stock markets around the world. Following the seminal work of De Bondt and Thaler (1985) on the New York Stock Exchange (NYSE) it has also been shown to exist on the Japanese stock exchange by Chaio and Hueng (2005) the London stock exchange by Power and Lonie (1993) and Page and Way (1992) on the Johannesburg Stock Exchange. The study of mean reversion on the JSE has been further investigated by Muller (1999) and Cubbin, Eidne, Firer and Gilbert (2006).

Why does mean reversion still exists on stock markets today? One would think that as knowledge of this phenomenon spread, smart investors would seize this opportunity to close this gap or arbitrage and make the market efficient. This paper will explore one particular factor that may inhibit investors from exploiting this arbitrage opportunity – the effects of (il) liquidity.
This will be achieved by introducing a liquidity constraint into the portfolio formation process in Cubbin et al (2006) mean reversion study on the JSE. This liquidity constraint will be formulated from a fund manager’s perspective. The effect of this constraint on the range of shares available for investment and the consequent abnormal returns of the portfolios will be established. The Cubbin et al (2006) methodology of portfolio selection and relative performance will be adopted for comparative purposes.

2. Problem Definition

The majority of mean reversion studies have shown that abnormal profits can be made by exploiting investor over reaction. However most of these studies have not taken into account the many practical problems that would be incurred while trying to achieve these abnormal profits. In particular they do not take into account transactional cost for setting up these portfolios and secondly they assume the market is infinitely liquid i.e. shares can be traded at any given time at an infinite volume at the current share price.

It has been shown by Diamond and Verrechia (1991) that liquidity has an effect on the firms cost of capital where increased liquidity increases the share prices and therefore lowers the cost of capital. Amihud and Mendelson (1986b) found a price discount on illiquid shares of 33, 33 percent. This suggests that the shares that make up the loser portfolio in Cubbin et al (2006) study may have a liquidity risk discount factored into their price (Damadodaran, 2002). If this is the case the abnormal returns may just be due to the markets willingness to pay extra due to the reduced liquidity risk in the future and not an over reaction as suggest by mean reversion.

This research looks at the effect that liquidity has on the portfolios returns. Cubbin et al (2006) original methodology will be used as a basis for this study. Liquidity will be introduced as a filtering factor in the decision making process ahead of PE ranking at portfolio formation date. The liquidity factor will depend on fund or portfolio size and the average volume of shares traded. The approach developed in the paper will, it is proposed, give a realistic view of the impact of liquidity from a fund manager’s point of view. Thus if mean reversion still exist with a liquidity factor included and the loser portfolio still out performs the market then there is potential to use this study as trading rule to exploit the arbitrage that exists in the market.
2.1. Research Hypothesis

**Hypothesis 1**: The cumulative excess returns of the loser portfolio (low PE shares) shown to exist in Cubbin et al (2006) study will be reduced as liquidity constraints that are dependant on investment size are introduced into the selection process at portfolio formation date.

The logic behind this hypothesis is based on the small firm effect which has been shown to influence mean reversions abnormal returns Zarowin (1989). The loser portfolio tends to consist of smaller firms and these are generally less liquid than that those of large firms.

The key contributions towards the concepts of the efficient market hypothesis, investor over reaction and mean reversion are reviewed in the next section. Alternative liquidity measures will then be discussed along with the development of a new liquidity constraint – the liquidity cap – that is used to filter the range of shares available for the formation of the various portfolios. The methodology used in Cubbin et al (2006) previous study will be adapted for the introduction of the liquidity constraint. The analysis of the findings will then be discussed and conclusion drawn.
3. Literature review

There has been extensive research into the behaviour of markets and how to potentially exploit them. The question most people ask is, “are markets efficient?” A market is said to be “efficient” if its prices adjust quickly and correctly when new information is released into the market.

3.1. Efficient market hypothesis (EMH)

The efficient market hypothesis (EMH) claims that regulated capital markets such as NYSE, LSE, and JSE are for all practical purposes efficient. It has been accepted over the last 50 years that most stock markets around the world are efficient and follow the efficient market hypothesis.

It is common to differentiate EMH into 3 forms of market efficiency, weak form efficient, semi strong form efficient and strong form efficient. The difference between the 3 is the type of information that is reflected in the price.

- **Weak form efficient** implies that at a minimum the current price of a share is reflected by its own past price performance.
- **Semi strong form efficient** implies that all public information available is reflected in the share price
- **Strong form efficient** market is when all information of every kind is reflected in the share price. There is no such thing as inside information

(Source: Firer, Ross, Westerfield, Jordan 2004)

It is generally accepted that most markets are at least weak form efficient. This was supported by Fama (1965) who was able to show strong evidence in support of the EMH. Weak form efficiency has also been shown on the JSE by Brandt, Muller and Macnab (1997). If markets are weak form efficient, it should be impossible to formulate trading rules from a shares historical performance to allow for abnormal profits. This however assumes investors make rational decisions based on the information available to them and that prices follow a random walk. These two assumptions are imperative to markets been efficient. Thus no arbitrage opportunities exist unless investors are privy to information not known by the market.
“It is however important to note that EMH does not require all participants in the market to be efficient and well informed. There can be a set of irrational or ‘noise traders’ in the market who do not quote the prices equal to the fundamental value. All EMH requires is that there are sufficient ‘smart money’ traders who recognise that the price will eventually equal the fundamental value. These smart traders will recognise these incorrect priceings by the so called noise traders and move the share price back toward is fair value.” (Cuthbertson and, Nitzsche 2004:425)

3.2. Investor behaviour within the stock markets

The assumption of rational behaviour amongst investors has been under much scrutiny in the last couple decades. This has come about due to a number of financial theories been based upon the assumption that investors are rational, Modern portfolio theory, Capital asset pricing model (CAPM), arbitrage pricing theory and EMH are to name a few.

Thomas Bayes proposed a rule though which decision makers incorporate new information into the decision making process (Groener and Shannon, 1981). He claims people make tentative decisions in a non-repetitive dynamic decision making environment. They gather new information and use this information to update the decision until the time comes around to execute the decision. When the time comes to execute the decision they follow the course of action dictated by the decision criteria.

De Bond and Thaler (1985) showed that when new information arrived in the market investors did not react according to Bayes theorem thus making them poor Bayesian decision makers. They tended to overweight new information and underweight historical information. This overweighing of information or overconfidence is heavily documented in behaviour biases. This has been supported by (Kahneman and Tversky, 1973) who showed people have a tendency to overweight recent events. De Bondt and Thaler (1990) also supported this by comparing analyst’s forecasts to actual numbers to determine the level of accuracy of their forecasts. They concluded that “analyst’s forecasts were too optimistic, too extreme, and even more extreme for 2 year forecasts than for one year forecasts”. According to (Griffin and Tversky, 1992) experts are more over confident than relatively inexperienced individuals.
This overconfidence results from investors putting too much emphasis on information they collect themselves as they tend to overestimate the accuracy of the information (Daniel, K.D., Hirschleifer, D. and Subrahmanyam, A. 1998). This is supported on the short side by Odean (1998) who claims that investors are unwilling to sell their losers as this would mean they were admitting to making a mistake. Cuthbertson and, Nitzsche (2004:425) call these investors ‘Noise traders’. Behavioural psychology has shown with empirical evidence that individuals tend to make systematic (i.e. non random) mistakes where subjects are found to overreact to new information as they tend to extrapolate past price trends. This overconfidence leads them to take on excessive risk (Cuthbertson and, Nitzsche, 2004).

From the above it is clear that if investors do not behave in a rational way in accordance with Bayes rule and tend to overreact instead. Therefore markets cannot be entirely efficient and thus the EMH could be false, indicating that stock prices can be predicted from historical prices. Mean reversion which has been shown to exist on numerous stock markets around the globe indicates this inefficiency.

3.3. **Mean Reversion**

Fama’s (1965) produced evidence that stock prices followed a random walk and were therefore unpredictable, thus supporting the efficient market hypothesis. This however was scrutinised by (De Bondt and Thaler 1989). They claimed Fama’s focused on short run correlations whilst using a small data set was statistically incorrect. A review of Fama’s work using larger data sets and extended periods lead to very different results been achieved.

Basu (1977) showed that buying shares with low P/E ratio’s yielded abnormal returns whilst shares with high P/E ratio’s yielded below normal returns. This was attributed to the hypothesis that companies with low P/E’s are temporarily undervalued because the market is over pessimistic about current or future earnings. This result confirms the findings by (Kahneman and Tversky, 1973) that individuals tend to overweight recent data in making forecasts.

De Bondt and Thaler (1985 and 1987) were the first so show the existence of mean reversion on a stock exchange. They used monthly return data from the US from 1926 to 1982. They created winner/loser portfolios using the top 35 and bottom 35 shares. The ranking of the shares was done by taking their cumulative abnormal returns over the 36 months period prior to portfolio
formation. The holding period of each portfolio was for 5 years. They repeated this by incrementing the start date by a year. Their results showed that for the period 1926 to 1982 the loser portfolio outperformed the market by 30 percent 5 years after formation whilst the winner portfolio lost 5 percent to the market during the same period. They went further to vary the number of shares held in the portfolio using 35, 50 and 83 shares in the respective portfolios whilst at the same time changing the holding periods between 3 and 5 years. The results were conclusive the loser portfolio always outperformed whilst the winner portfolio underperformed the market index. This phenomenon was attributed to the returns to the shares in the respective portfolios reverting back towards the mean (i.e. that of the market) over the respective holding periods i.e. ‘mean reversion’.

3.4. **Explanations for Loser portfolio phenomenon**

There have been numerous explanations for the loser portfolio’s phenomenal performance relative to the market. Firm size has often been highlighted as a cause. This is due to the fact that loser firms tend to be small in size. Zarowin (1989) supports this by showing that small firms earn abnormally high returns. Clare and Thomas (1995) showed that data which supported mean reversion on the UK market was reversed when firm size was controlled. These studies all support the so called ‘small firm effect’ as small firms are perceived as been more risky and therefore investors require a high rate of return to offset the risk.

Another factor that is considered to explain the loser portfolio phenomenon is the fact that loser firms are perceive to be more risky by the market and therefore higher rates of return are also expected to offset the risk.

Chopra, Lakonishok and Ritter. (1992) support De Bondt and Thaler with evidence of mean reversion even when controlling for size and beta (risk), however the effects are reduced slightly. Bremer and Sweeny (1991) found that the results discovered by De Bondt and Thaler (1985) also held for stock in shorter time periods. However the loser portfolio consisted of shares of large firms only, where the one day price fall had been greater than 10% and the holding period was 5 days. The returns were found to be 3.95%. This avoided the ‘small firm effect’.
3.4.1. Evidence of Mean Reversion on Global Stock Markets

The have been numerous studies on stock markets around the world in support of mean reversion.

- Chan, Hamao and Lakonishok (1991) - Japanese Stock Exchange
- Bauman, Conover, Mitchell and Miller (1999) found evidence of overreaction in 20 stock markets around the world.
- Otchere and Chan (2003) showed that the Hong Kong stock market does overreact and that the overreaction is more pronounced for winners than losers.

From the above it is clear that stock markets are not as efficient as everyone likes to think they are and that investors behave irrationally, thus moving share prices away from their intrinsic values. Thus the saying that there is no “free lunch” may not be entirely true. The opportunities are they but what is inhibiting investors from exploiting them.

3.4.2. Mean reversion on the JSE

Plaistowe and Knight (1986) were the first to test for mean reversion on JSE. There results were inhibited by a small data set which comprised of 35 shares with a historical period of 7 years only from 1973 to 1980. They used weekly data and a holding period of 1 year. They used market to book ratios to rank their shares for the respective winner/loser portfolios. However they compared the average cumulative weekly returns to winner and loser portfolios over a period of a year after the portfolio formation date. Their results were not conclusive as the loser portfolios did not show abnormal returns relative to the market whilst the winner portfolios however did show significant losses.

Page and Way (1992) tried to replicate De Bondt and Thaler (1985) study on the JSE. They used monthly share returns of 204 shares traded between 1974 and 1989. They ranked shares for the respective winner loser portfolios using cumulative historical relative returns in the formation period. For a 36 month holding period loser portfolios on average out perform the winner portfolios by almost 15%. They conclude that there was ‘clear evidence of investor over-reaction on the Johannesburg Stock Exchange’ (Page and Way, 1992:43).
Muller (1999) also produced evidence of mean reversion on the JSE. However he used a dataset from 1985 to 1998. Muller’s study differed in approach to that of Page and Way (1992) as he tried to optimise the phenomenon by varying the following variables: start date, formation date, number of shares, holding period and winner or loser portfolio strategy. Muller calculated returns short of dividends thus capital returns not total returns. He found that there was evidence of over reaction on the JSE. Loser portfolios yielded positive abnormal returns with increasing holding period, while winner portfolio yielded negative abnormal returns with increasing holding period.

The above 3 studies all suffered from survivorship bias i.e. they only used shares that were listed through the entire period of the dataset and not share that may have de-listed. However Cubbin et al (2006) were able to use a dataset that did not suffer from survivorship bias and also produced evidence of mean reversion on the JSE. They used a dataset that spanned from 1983 to 2005 and they ranked their shares for the winner/loser portfolios by their respective price to earnings (P/E) ratios. They used a holding period of 5 years. Loser portfolios outperformed the market by 46% while winner portfolios underperformed by 16%. The methodology used by Cubbin et al (2006) will be used as the basis for this research report.

One of the key assumptions in all the current research surrounding mean reversion is that the market is infinitely liquid. Therefore investors in these portfolios can buy and sell any volume of shares at the current price and at a specific time. This obviously is not represent a fair model of what exactly a fund manager or trader would be able to do in the real world. Thus a measure of liquidity is needed in order or create real world practical portfolios.

3.5. **Liquidity**

Liquidity is what makes financial markets function smoothly, without it friction exists in the market which can potentially cause adverse effects on an asset values (Chordia,T, Shivakumar, L and Subrahmanyam, 2004). Liquidity is defined as how easily an asset can be traded at short notice without incurring a loss (De Villers, 1996). “Liquidity is an important characteristic of shares because a lack of liquidity will increase the liquidity risk of a share, increase its required return and lower its price. A firm with illiquid shares will therefore have a higher cost of capital
and lower real investment than a firm with liquid shares.” De Villers (1996:4).

3.5.1. Measuring Liquidity

Liquidity is a complex concept that is extremely difficult to determine a standard measure. This is supported by Makower and Marchak (1938) who considered liquidity to not be a measurable concept. The reason been is that it consists of 3 dimensions, namely price, time and volume. The complexity comes in where one tries to define the interrelationship between the 3 variables into a single measure. Academics have tried to come up with measurement for liquidity but very few agree on any. Below are a number of potential measures of liquidity:

Bid – Ask Spread

The bid-ask spread is used as a method of measuring liquidity, focusing on the price dimension (De Villers, 1996). It is defined as the difference between the price offered by buyers and the price asked by sellers for an asset. Demsetz (1968:35) defined it as “the mark-up that is paid for predictable immediacy of exchange” this is supported by Amihud and Mendelson (1986b:223) who define illiquidity as the “cost of immediate execution”. Bid ask spread was not used as a measure of liquidity in this study as the information was not available for shares on the JSE from the respective data sources for the entire period in which the study took place.

The Volatility Ratio

The volatility ratio is another method of measuring liquidity, focusing on the price dimension. The volatility ratio focuses on comparing short term volatility to long term volatility (Hasbrouck and Schwartz, 1988). “The rationale for the volatility ratio as a proxy for liquidity is that illiquidity would increase the volatility of short term returns buts its effect on long term returns would be less marked” (De Villers, 1996 :10).

Hasbrouck and Schwartz (1988) used this method defining short term as 2 hour intervals and long term as 2 day intervals. Once again this method would not be able to be used as the JSE does not have intra day trading data available for the entire period of this study.

Volume of trade

Volume of trade is defined as the amount of shares changing hands over a specific period of
time. Volume of trade is probably the most common measure of liquidity focusing on the volume dimension of liquidity. There have been numerous academics that have argued that trading volume is associated with liquidity. Kyle (1981) showed that the amount of trade by informed investors was positively correlated to the liquidity of the market and that the liquidity of the market depended on the volume of trade performed by noise traders.

**The Liquidity Ratio**

The liquidity ratio is defined as the volume of trade divided by the absolute percentage change in price (Bernstein, 1987). A high liquidity ratio means that a large volume of shares have been traded within a small price range. Thus a large volume of shares could be sold without moving the share price by a significant amount (De Villers, 1996).

Bernstein (1987) however has also condemned the liquidity ratio as a measure of liquidity. He demonstrates in his paper that the liquidity ratio always rises as average trade size increases. This criticism is supported by Grossman and Miller (1988) as they argue high variability in share price is not only due to illiquidity but maybe due to new information arriving to market.

De Villers (1996) evaluation of the above ratios on the JSE found that the liquidity ratio was the most appropriate to use.

3.5.2. **Liquidity on the JSE**

There have been a limited number of studies regarding liquidity on the JSE. The research has shown no significance relationships between the liquidity of shares and their required return. De Villers (1996). De Villers, Lowings, Pettit and Affleck-Graves (1986) discovered no correlation between number of shares traded and returns of shares. This may indicate that the loser portfolio’s abnormal returns of Cubbin et al (2006) was not due to the shares having a liquidity premium been priced into the shares over the portfolios holding period (Amihud, Y and Mendleson, H, 1986a).

From the above it is clear that liquidity is a fairly ambiguous measure and there is no hard evidence of a robust measure for it in a stock market. Thus a measure was formulated using logic and practical sense in terms of how it fits in to mean reversion on a stock market...
3.5.3. Share Liquidity Cap

The liquidity constraint applied in this research was developed through discussion with academics, equity traders and fund managers. The rule came about by looking at what constrains fund managers from buying shares with regard to liquidity. Fund managers tend to invest lump sums of money into the market; however they are constrained through available liquidity as to how many shares they are able to buy or sell at certain prices. Common sense (and their risk management models) does not allow them to take positions that they cannot liquidate relatively quickly. Following discussions with portfolio managers at several local asset management companies we identified the 15 day rule which is: asset managers would only be happy to invest in a share if they could liquidate their position in 15 days given historical levels of market volumes traded.

Thus a liquidity constraint can be derived from share price and volume traded.

![Regression of JSE Monthly Volume of Trade vs 12 Month Moving Average JSE Volume of Trade](image)

It was decided that multiplying the 12 month moving average of monthly data for both the volume traded and the closing share price, would result in a good indication of the expected total value traded of a share in the subsequent month. Moving averages were used as this would eliminate any short term fluctuations. Figure 1 shows a high R squared coefficient of 0.96 for the volume of trade on the JSE versus its 12 month moving average. This supports our assumption, that the 12 month moving average for volume of trade is a good indication of the volume of trade for the following month. Similar analysis for a six month moving average showed similar levels of predictive capacity. Using moving averages for periods below 6 months lead to a significant deterioration in the predictive capacity.
Through further discussion it was agreed that portfolio/fund manager’s view their portfolios in terms of their ability to liquidate them within 15 days or 50% of a month’s trade. Thus taking 50% of the expected total value traded in a month was used as the capacity constraint. This was called a shares liquidity cap and was used to determine whether a share could absorb a required amount invested into the market. The required investment amount was determined by the size of the portfolio. Each share was equally weighted in the portfolio and so the investment in each share had to be below the liquidity cap for the share to be considered. For example if a share had a liquidity cap of R1 million rand and a R100 million fund was looking to invest R100m/35 or R2.85 million into each share then this share would be filtered out due to its lack of liquidity for an investor of this size. However if the investor had a portfolio of R10m then this share would be considered available for investment (R10m/35 = R0.285m holding per share which is less that the R1m liquidity cap).

It is clear from the literature review that stock markets are not as efficient as we think and that investors still overreact to information. Thus mean reversion is still in existence and this arbitrage opportunity has not been priced out of the market. What is inhibiting investors from exploiting this free lunch? One of the major implicit assumptions of all the studies discussed above is that the market is infinitely liquid. The methodology describe below will incorporate the liquidity cap measure developed above into the methodology used by Cubbin et al (2006) study to remove this assumption. This will allow for the identification of the effect it has on the abnormal returns produce by mean reversion.
4. Research Methodology

4.1. Background

It was decided that in order to carry out a comparable test, the Cubbin et al (2006) methodology would be simulated as far as possible. However at the portfolio formation date, the liquidity constraint (Share Liquidity Cap) would be introduced into the share selection and ranking process. The share ranking and portfolio selection would thus be applied to a reduced investment universe.

Cubbin et al (2006) attempted to follow De Bondt and Thaler (1985) original approach but this was not entirely possible due to the relatively short data set. Therefore they were unable to use De Bondt and Thaler methodology of non overlapping portfolios. A second key difference is that De Bondt and Thaler (1985) used cumulative historical abnormal returns to rank their share where Cubbin et al (2006) used PE ratios. The Cubbin et al (2006) approach is followed in these regards.

4.2. Data Collection

It was decided that historical share data would be sourced from I-Net Bridge who were also used as the provider for the Cubbin et al (2006) study. I-Net Bridge is a market data provider that is based in South Africa. They maintain a database of all historical data published by the JSE Johannesburg Securities Exchange. This data is updated regularly to keep consistency among prices, especially when it comes to share splits and unbundling. I-Net Bridge also maintains historical data of shares that have de-listed or have under gone some form of corporate action. Thus the data set was not influenced by survivorship bias which was one of the key advances in the Cubbin et al (2006) study on the JSE.

The data was downloaded from an I-Net station located at the I-Net Bridge regional offices in Cape Town. This was achieved using their I-Connect add-in function for Microsoft Excel. I-Connect utilises a DDE (dynamic data exchange) link to I-Net Bridges main frame system in order to import data via Microsoft Excel. A batching process was implemented as not all the required data could be downloaded at once. The following attributes per share were included in the download.
Liquidity and Mean Reversion on the JSE

- Closing Price
- Dividend Yield
- Price Earnings Ratio
- Volume Traded

Monthly share data was downloaded for the above attributes for the period spanning between the 31 October 1982 and 31 December 2005. This period was chosen to keep consistency with Cubbin et al (2006) study and thus provided 278 monthly data points. However the period of study does span one year prior to that Cubbin et al (2006). This was required for the liquidity cap calculation which needed to calculate the 12 month moving average for both share price and volume of trade prior to portfolio formation date.

Once the data was extracted from I-Net Bridge’s system it was mined for errors and cleaned where possible. Shares that did not contain complete data and thus failed in terms of data integrity were removed from the dataset (Cubbin et al 2006). As mentioned earlier I-Net Bridge adjusts share prices, PE ratios and dividend yields for corporate action so that they could be compared over the entire life span of the shares listing.

The JSE ALSI (All Share Index) was also downloaded from I-Net Bridge. As mention in Cubbin et al (2006) study the ALSI was changed in July 2002 when the JSE became part of the FTSE. However I-Net Bridge have now restated the index all the way back to 1960 where in the Cubbin et al study the index had only been restated 7 years back and thus they had to splice the index themselves to get the required period of data.

The CPI index for South Africa for the entire period of the study was downloaded from International Financial Statistics website which is run by the IMF (Internal monetary fund). This extract was required in order to adjust the investment amount for inflation at portfolio formation date. This will be explained later on under portfolio creation.

4.3. Data Storage

Due to the size of the data downloaded a Microsoft Access database was created to store the data. A program was written to transfer the date from the various Microsoft Excel extracts into
the Microsoft Access database. 1345 shares where downloaded into the database between the 31 October1982 and 31 December 2005. There were over 130 000 data points for the entire dataset, each consisting of a share code, date, closing share price, dividend yield, PE ratio and trading volume.

4.4. Portfolio Formation

The Cubbin et al (2006) portfolio formation method was replicated. This was achieved by selecting the top and bottom 35 shares (De Bondt and Thaler, 1985) according to PE ratios. Cubbin et al (2006) argued that PE's were forward looking where by historical returns were backward looking and thus represented “investor’s contemporaneous attitude towards individual shares” Cubbin et al (2006:4).

In this study however an investment size was introduced before the ranking procedure to eliminate shares that did not meet liquidity requirements set by the liquidity cap.

4.4.1. Investment Size

Seven investment sizes were used in the study to see their relative effects on mean reversion:

- R0 (no liquidity constraint)
- R100,000
- R1,000,000
- R10,000,000
- R100,000,000
- R1,000,000,000
- R10,000,000,000

These investment sizes represent the nominal investment value invested by a fund manager on the 31/12/2005. These values were then adjusted (discounted) for inflation to represent a fair value of the investment at the portfolio formation dates.

Discount factor

As mentioned earlier South African CPI data was extracted and used as the inflationary adjustment. A monthly consumer price index (CPI) was extracted via the International Financial Statistics website. This monthly figure represented the percentage change in prices over the previous years figure. Thus an effective month on month CPI was required in order to calculate
the necessary discount factors for the various portfolio formation dates. This was achieved using discounting techniques. The investment values were then multiplied by these discount factors, resulting in true nominal investment values at the portfolio formation dates.

**Liquidity elimination**

These true nominal investment values were then divided by the number of shares in the portfolio i.e. 35. This resulted in the amount that was to be invested per share in order to create an equally weighted portfolio. This amount was then used as the minimum criteria that a shares liquidity cap need to exceed in order to meet the liquidity requirement. Shares that did not meet this criteria were eliminated from the ranking and selection process.

![Figure 2: Percentage Shares on the JSE Meeting Liquidity Requirement For Various Investment Sizes](image)

Figure 2 shows the percentage of the total shares that are listed on the JSE which are available for selection at portfolio formation due to meeting liquidity requirements. It is interesting to note that the liquidity of the all the shares on the JSE dropped off significantly in 1992. This could be due to lack of market activity due to political uncertainty in South Africa at the time. Appendix 7 shows the number of shares listed on the JSE over the period investigated for this research.
**Final share selection**

Once all shares that did not meet the liquidity requirement were removed the shares were rank in descending order by PE ratio. The top and bottom 35 ranked shares represented the shares that would be allocated to both winner portfolio and loser portfolio respectively at portfolio formation date. If there were shares with equal PE ratios at the end positions of the top and bottom 35 shares, shares were then selected in alphabetical order according to share code.

Although the data set consisted of over 26 years of data from the JSE it was still relatively small. This problem was also faced by Cubbin et al (2006). This inhibited their ability to replicate the De Bondt and Thaler (1985) methodology of no overlapping portfolios. They solved this problem by creating portfolios at the end of each month (Portfolio formation date) with holding period of 5 years throughout the entire period of the data set. This enabled them to create over 200 winner and loser portfolios between the 31 October 1983 and 31 December 2005.

**Calculating Portfolio Returns**

The returns for each individual share within a portfolio was calculated using the capital gains/loses over the month. Added to this was a twelfth of the annualised dividend. “The annualised dividend was calculated from the share’s dividend yield published at the end of each month” Cubbin et al (2006:4). Portfolios were equally weighted and share returns were calculated relative to the ALSI index returns. This resulted in above or below market returns for each share during that month. The average return for the portfolio was calculated by taking the sum of all the share returns during the month and dividing this by the portfolio size. This was done for each month over the entire portfolios holding period.

It is important to note that if a share was de-listed during the portfolio holding period it remained within the portfolio producing zero returns, thus still influencing the returns of the entire portfolio. Thus a potential under bias could exist as this liquidated cash could have been invested somewhere else.

**Number of Portfolios**

From the 31 of October 1983 to the 31 of December 2005, 207 portfolios were produced for each investment size. This was achieved by incrementing the portfolio formation date by 1
month each time over this period. For each portfolio formation date 60 months worth of returns were calculated for the 5 year holding period. The process repeated up until 5 years from the end date of the entire period. This was due to the last portfolio requiring a 5 year holding period. In the case of this study the last portfolio formation date was the 31 December 2000.

Over the entire period 414 portfolio were created for each investment size, 207 winner and loser portfolios respectively. “The monthly returns for each winner and loser portfolio were then combined and averaged on a restated basis to give the final average relative returns for each category. What this means is that the returns for month 1 of all the winner portfolios were combined to give the average winner portfolio return for month 1. The same exercise was conducted for the loser portfolios to give the average returns for each month for these portfolios.”(Cubbin et al, 2006:4)

4.5. Calculating procedure

Due to the substantial amount of data and numerous iterations required to calculate the portfolios returns a computer program was written. This was done in VBA (Visual Basic for Applications) in Microsoft Access. This program was very similar to that of JAM used in the Cubbin et al (2006) study. The basic steps of the procedure were:
Liquidity and Mean Reversion on the JSE

1. Calculate the number of portfolios to be created between start and end date.
2. Select the top and bottom 35 shares for Winner/Loser portfolios using liquidity rule and PE ranking
3. Calculate monthly returns for each portfolio over the entire holding period
4. Group all the portfolio returns by month i.e. 60 months of returns.

This was repeated for each of the 7 investment sizes. The results were stored in tables in the database which were then exported into excel to do the relevant analysis.
5. Findings

The results from the methodology described above are discussed below. Figure 4 shows the cumulative market returns relative to the ALSI, for both the winner and loser portfolios for the seven investment sizes. It is clear from the figure that for all seven investment sizes the loser portfolios outperform their respective winner portfolios over the 60 month holding period. These results are congruent to that of Cubbin et al (2006) study with regard to the existence of mean reversion on the JSE.

![Average Winner and Loser Portfolios Cumulative Performance Relative to the ALSI](image)

**Figure 4: Average Winner and Loser Portfolios Cumulative Performance Relative to the ALSI**

<table>
<thead>
<tr>
<th>Investment Size</th>
<th>Winner Portfolio</th>
<th>Loser Portfolio</th>
<th>Relative Outperformance</th>
<th>Compound Average Returns 60months</th>
<th>Per Annum Average Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-1.40%</td>
<td>34.88%</td>
<td>36.28%</td>
<td>Win: -0.28%</td>
<td>Loser: 6.17%</td>
</tr>
<tr>
<td>100,000</td>
<td>-2.36%</td>
<td>35.20%</td>
<td>37.56%</td>
<td>Win: -0.48%</td>
<td>Loser: 6.22%</td>
</tr>
<tr>
<td>1 Million</td>
<td>-2.33%</td>
<td>35.39%</td>
<td>37.72%</td>
<td>Win: -0.47%</td>
<td>Loser: 6.25%</td>
</tr>
<tr>
<td>10 Million</td>
<td>-2.63%</td>
<td>35.62%</td>
<td>38.25%</td>
<td>Win: -0.53%</td>
<td>Loser: 6.28%</td>
</tr>
<tr>
<td>50 Million</td>
<td>-6.12%</td>
<td>33.27%</td>
<td>39.40%</td>
<td>Win: -1.26%</td>
<td>Loser: 5.91%</td>
</tr>
<tr>
<td>100 Million</td>
<td>-4.01%</td>
<td>26.46%</td>
<td>30.47%</td>
<td>Win: -0.82%</td>
<td>Loser: 4.81%</td>
</tr>
<tr>
<td>500 Million</td>
<td>-8.29%</td>
<td>19.94%</td>
<td>28.23%</td>
<td>Win: -1.72%</td>
<td>Loser: 3.70%</td>
</tr>
<tr>
<td>1 Billion</td>
<td>-10.23%</td>
<td>16.39%</td>
<td>26.63%</td>
<td>Win: -2.14%</td>
<td>Loser: 3.08%</td>
</tr>
<tr>
<td>10 Billion</td>
<td>-15.79%</td>
<td>5.59%</td>
<td>21.39%</td>
<td>Win: -3.38%</td>
<td>Loser: 1.09%</td>
</tr>
</tbody>
</table>

**Table 1 Portfolio Returns**
Table 1 lists both the compound average returns and per annum average returns for both winner and loser portfolios for the seven investment sizes. Investment size R0 is the base case, representing the portfolio where no liquidity constraint has been factored in. This investment size should yield similar results to that Cubbin et al (2006) study. The loser portfolio has a compound annual return of 34.88% and a per annum average return of 6.17%. This is in contrast to Cubbin et al (2006) result, whose loser portfolio relative to the ALSI produced a compound annual return of 74.3% and a per annum average return of 11.75%. This difference is most probably due to the restating of the ALSI in July 2002. Cubbin et al (2006) as mentioned earlier had to splice the ALSI index together themselves as no data provider at the time of their study had back dated the ASLI more than 7 years. However in this study a fully restated index was provided by I-NET Bridge and implemented into the study.

![Compound Average Returns over 60 Months](image)

**Figure 5: Compound Average Returns for Loser and Winner Portfolios for the 7 Investment Sizes**

Figure 5 graphs the compound average returns for the various investment sizes which are representative of the liquidity constraints. It is clear from the graph that investment sizes from R100,000 to R10 Million have very little impact on the returns of both the loser and winner portfolios relative to the base portfolio. In fact the loser portfolios show a minor improvement in returns for an increase in investment size over this range. However from R50 Million upwards the excess returns of the loser portfolio start to diminish as one increase the investment size as the share liquidity constraints take effect.
Figures 6 and 7 illustrate the average returns for each portfolio month in the post portfolio formation period for both the loser and winner portfolios respectively. It is clear from these two figures that the returns for the investment sizes ranging between R100,000 and R10 million track the base case portfolio fairly closely. Once investment size extends over 10 million the returns start moving away from that of the base case. This is especially apparent in the case of the loser portfolio.
In summary, the results show conclusive evidence that mean reversion exists on the JSE and that portfolios with investment sizes above R50 million have a noticeable reduction in their abnormal returns relative to the base case. These results are supportive of the original hypothesis that liquidity reduces the abnormal returns of the loser portfolio. However, the liquidity constraint or portfolio investment size needs to be in excess of R50 million before noticeable reduction is observed. It is also important to note that while the loser portfolios' excess market returns are being eroded away as the liquidity requirement is increased, the respective winner portfolios' excess losses are increasing at a similar rate.
6. Conclusion

There is empirical evidence that mean reversion exists on the JSE (Cubbin et al 2006). It has been demonstrated in this research, that when liquidity constraints were put on certain portfolios the abnormal returns that resulted from mean reversion on the JSE were reduced. However when investing R10 billion (the largest liquidity constraint in the study) into a portfolio there were still abnormal returns to be made over a 5 year period. These returns may be reduced significantly from that of the base case but never the less they are still in existence.

For investment sizes below R10 million the liquidity factor has had no significant impact on the respective portfolios abnormal returns relative to the base case. What is inhibiting investor in this range of funds from exploiting this 6% above market per annum returns. Are these investors constrained by transactional costs? This is potentially an area that could be looked into to see what effect transactional costs have on the abnormal returns of the loser portfolio.

These results indicate that even when taking liquidity into account mean reversion still exists on the JSE. Thus a trading rule could be devised to exploit these opportunities. The question must still be asked, why are these abnormal returns not been exploited by smart investors? What else is inhibiting them from utilising these arbitrages? Liquidity is one factor that has been shown to have an impact on these abnormal returns but other factors like transactional costs and investor sentiment could also be impacting these returns.
7. References


Cubbin, E, Eidne, M, Firer, C and Gilbert, E, 2006 “Mean Reversion on the JSE securities Exchange” *Investment Analysts Journal, no 63*

Cubbin, E and Eidne, M, 2003 “Mean reversion and analysts over/under reaction on the JSE securities exchange SA” University of Cape Town, Cape Town


De Villers, P, Lowing, A, Pettit, T and Affleck-Graves, J (1986) An Investigation into the Small
Firm Effect of the JSE the South African Journal of Business Management, 17, 191-195


Makower, H and Marschak, J Assets, Prices and Monetary Theory, Economica, 5:261-287


Liquidity and Mean Reversion on the JSE


Saville, A ,2006 “Super Dogs” Cannon Asset Managers


7.1. **Web Site References**


8. Appendices

Appendix 1: Results of Investment Sizes R0
Appendix 2: Results of Investment Sizes R100,000

Average Monthly Returns for Winner and Loser Portfolio Relative to the ALSI
Investment Size = R100000

Average Monthly Returns
-0.8% -0.6% -0.4% -0.2% 0.0% 0.2% 0.4% 0.6% 0.8% 1.0% 1.2%

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59
Portfolio Month

Average Winner Portfolio - Average Loser Portfolio

Average Winner Portfolio
Average Loser Portfolio

Average Winner and Loser Portfolio Cumulative Performance Relative to the ALSI
Investment Size = R100000

Cumulative Returns
80.0% 90.0% 100.0% 110.0% 120.0% 130.0% 140.0%

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59
Portfolio Month

Average Winner Portfolio - Average Loser Portfolio
Appendix 3: Results of Investment Sizes R1 Million

Average Monthly Returns for Winner and Loser Portfolio
Relative to the ALSI
Investment Size = R1 Million

Portfolio Month

Average Winner Portfolio
Average Loser Portfolio

Average Winner and Loser Portfolio Cumulative Performance Relative to the ALSI
Investment Size = R1 Million

Portfolio Month

Average Winner Portfolio
Average Loser Portfolio
Appendix 4: Results of Investment Sizes R10 Million

Average Monthly Returns for Winner and Loser Portfolio Relative to the ALSI
Investment Size = R10 Million

Average Winner Portfolio
Average Loser Portfolio

Average Winner and Loser Portfolio Cumulative Performance Relative to the ALSI
Investment Size = R10 Million
Appendix 5: Results of Investment Sizes R100 Million

Average Monthly Returns for Winner and Loser Portfolio Relative to the ALSI
Investment Size = R100 Million

Average Monthly Returns

Portfolio Month

Average Winner Portfolio
Average Loser Portfolio

Average Winner and Loser Portfolio Cumulative Performance Relative to the ALSI
Investment Size = R100 Million

Cumulative Returns

Portfolio Month

Average Winner Portfolio
Average Loser Portfolio
Appendix 6: Results of Investment Sizes R1 Billion

Average Monthly Returns for Winner and Loser Portfolio Relative to the ALSI
Investment Size = R1 Billion

<table>
<thead>
<tr>
<th>Average Monthly Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.2%</td>
</tr>
<tr>
<td>-1.0%</td>
</tr>
<tr>
<td>-0.8%</td>
</tr>
<tr>
<td>-0.6%</td>
</tr>
<tr>
<td>-0.4%</td>
</tr>
<tr>
<td>-0.2%</td>
</tr>
<tr>
<td>0.0%</td>
</tr>
<tr>
<td>0.2%</td>
</tr>
<tr>
<td>0.4%</td>
</tr>
<tr>
<td>0.6%</td>
</tr>
<tr>
<td>0.8%</td>
</tr>
<tr>
<td>1.0%</td>
</tr>
</tbody>
</table>

Portfolio Month

Average Winner Portfolio

Average Loser Portfolio

Average Winner and Loser Portfolio Cumulative Performance Relative to the ALSI
Investment Size = R1 Billion

<table>
<thead>
<tr>
<th>Cumulative Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>80.0%</td>
</tr>
<tr>
<td>85.0%</td>
</tr>
<tr>
<td>90.0%</td>
</tr>
<tr>
<td>95.0%</td>
</tr>
<tr>
<td>100.0%</td>
</tr>
<tr>
<td>105.0%</td>
</tr>
<tr>
<td>110.0%</td>
</tr>
<tr>
<td>115.0%</td>
</tr>
<tr>
<td>120.0%</td>
</tr>
</tbody>
</table>

Portfolio Month

Average Winner Portfolio

Average Loser Portfolio
Appendix 7: Results of Investment Sizes R10 Billion

Average Monthly Returns for Winner and Loser Portfolio Relative to the ALSI
Investment Size = R10 Billion

<table>
<thead>
<tr>
<th>Portfolio Month</th>
<th>Average Monthly Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-1.2%</td>
</tr>
<tr>
<td>3</td>
<td>-1.0%</td>
</tr>
<tr>
<td>7</td>
<td>-0.8%</td>
</tr>
<tr>
<td>9</td>
<td>-0.6%</td>
</tr>
<tr>
<td>11</td>
<td>-0.4%</td>
</tr>
<tr>
<td>13</td>
<td>-0.2%</td>
</tr>
<tr>
<td>15</td>
<td>0.0%</td>
</tr>
<tr>
<td>17</td>
<td>0.2%</td>
</tr>
<tr>
<td>19</td>
<td>0.4%</td>
</tr>
<tr>
<td>21</td>
<td>0.6%</td>
</tr>
<tr>
<td>23</td>
<td>0.8%</td>
</tr>
<tr>
<td>25</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

Average Winner and Loser Portfolio Cumulative Performance Relative to the ALSI
Investment Size = R10 Billion

<table>
<thead>
<tr>
<th>Portfolio Month</th>
<th>Cumulative Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80.0%</td>
</tr>
<tr>
<td>3</td>
<td>85.0%</td>
</tr>
<tr>
<td>7</td>
<td>90.0%</td>
</tr>
<tr>
<td>9</td>
<td>95.0%</td>
</tr>
<tr>
<td>11</td>
<td>100.0%</td>
</tr>
<tr>
<td>13</td>
<td>105.0%</td>
</tr>
<tr>
<td>15</td>
<td>110.0%</td>
</tr>
</tbody>
</table>
Appendix 8: Number of Shares on the JSE Meeting Liquidity Requirement For Various Investment Sizes