Title: The investment return puzzle on the Johannesburg Stock Exchange

Authors: Semnarayan P., Ward M., and Muller C

Affiliation: Gordon Institute of Business Science, University of Pretoria

Contact addresses: Semnarayan P. (pravin108@gmail.com); Ward M. (mchlwrd@gmail.com);

Muller C. (chrism@iafrica.com)

ABSTRACT

Firms that invest into positive net present value projects should outperform firms that do not invest. Surprisingly, several studies on United States data have found a negative relationship between capital investment and subsequent shareholder return. There are conflicting explanations for this negative relationship. The present study also confirmed a significant negative relationship between capital investment and subsequent shareholder returns in the South African developing market conditions. Over the period from 1992 to 2017, shares on the Johannesburg Stock Exchange with lower investment rates consistently outperformed shares with higher investment rates, exhibiting similar behaviour to the US. We find that the negative investment return is significantly associated to the firm's book-to-market value consistent to the rational-based q-theory of investment with real options explanation.

KEYWORDS

capital investment; shareholder return; asset pricing; systematic risk; real options; mispricing, arbitrage.

Introduction

The foundation of capital investment theory is that companies (firms) should invest in positive net present value (NPV) projects, as this should increase the value of the firm for the shareholders by the quantum of the net present value (McCallum, 1992). Therefore, firms that have higher rates of investment should have higher subsequent shareholder returns than firms with lower rates of investment.

Instead, previous studies such as Alti and Tetlock (2014), Anderson and Garcia-Feijóo (2006), Berk, Green, and Naik (1999), Cooper and Priestley (2011), Cooper, Gulen, and Schill (2008), Eric, Lam, and Wei (2011), Li and Zhang (2010), Lipson, Mortal, and Schill (2011), Titman, Wei, and Xie (2004), Titman, Wei, and Xie (2013) and Xing (2008) have found that there is a strong negative relationship between investment by a firm ('capital investment' or 'I' or 'capex') and subsequent shareholder return ('share return' or 'R') on United States of America ('United States' or ‘US’) data. These studies have found that firms that make large investments experience subsequent share returns which are abnormally low, whereas firms with low investment rates experience subsequent share returns which are abnormally high.

These studies have offered contrasting and competing explanations for this negative relationship puzzle. This area of research is still underdeveloped, and there are a number of debates with regards to the nature and direction of the relationship, and with regards to the effect of time, type of investment and financing structures on the relationship. Kumar and Li (2016) propose that the negative investment return relation is a short-term effect, that the negative relationship holds for mature industries, and that investment in ‘innovative capacity’ could make the I–R relationship positive. Kumar and Li (2016) also propose that firms with higher investment levels are associated with higher gearing, shifting risk to lenders.

An analysis of this kind has not been previously done in a developing market such as South Africa, due to the costs and limitations of obtaining suitable data. However, we have a comprehensive database of company financial statements and JSE share prices over the period 1988 to 2017, with buy-and-hold portfolio research software that makes this research possible. The present study therefore sought to determine the existence of the negative I–R relationship in this context.

Literature review

The major disagreement amongst previous studies relates to whether the negative relationship is the result of a rational-based explanation based on the q-theory of investment with real options, or whether it is due to a behaviour-based explanation related to manager hubris, overinvestment and mispricing premised on the limits to arbitrage theory.

Rational-based explanation (q-theory of investment with real options)

The traditional q-theory was initially formulated by Brainard and Tobin (1968) and Tobin (1969), using a consumption-based asset-pricing model (view from the market side), proposing that investment is stimulated when capital is valued more highly in the market than it costs to produce it, and investment is discouraged when the market value of the firm's capital is less than its replacement cost. Investment is positively associated with the market value to replacement costs (q) ratio (Brainard & Tobin, 1968; Tobin, 1969).

Cochrane (1991, 1996) pioneered the investment-based asset-pricing model (view from the firm side), where he relates share returns directly to fundamental firm returns resulting from capital investment. The Cochrane (1991, 1996) q-theory of investment proposes that expected share return is a rational direct function of capital investment, made possible through arbitrage. Mathematically, the investment-based and consumption-based models produce the same results (Cochrane 1991, 1996).

Berk et al. (1999) introduced the concept of 'real options', which they adapted from Myers' (1997) earlier work to the Cochrane (1991, 1996) q-theory, proposing that the firm's future opportunities are based on its current investment decisions. Firms make higher investments on low cost of capital projects, and this leads to lower investment returns and to a lower future risk profile, which then relates to lower future share returns on the market, according to Berk et al. (1999). Lower costs of capital imply higher net present values of new projects, supporting higher investment levels by the firm consistent to the marginal q and discounted cash flow equations. Investing in low-risk assets now reduces the average systematic risk of subsequent cash flows and consequently reduces the average share returns and vice versa (Berk et al., 1999).

According to Berk et al. (1999), firms have two kinds of assets: assets-in-place currently generating cash flows, and options to make positive NPV investments in the future. Capital investment can predict market value and share return, because it alters the growth options versus assets-in-place within the firm. In the Berk et al. (1999) model, "book-to-market" is the characteristic variable of the firm that indicates the firm's risk relative to its assets-in-place (Berk et al.,1999, p. 1554). "Market value" (market capitalisation or size) is the characteristic variable of the firm that indicates the relative importance of the firm's assets-in-place to its growth options (Berk et al.,1999, p. 1555). An investment that has very low systematic risk looks attractive for the firm, and investing in it, leads to a large increase in value. However, as a result, the average systematic risk of the firm's cash flows in subsequent periods is lowered, which leads to lower returns on average. Using this model, we can model the dynamics between capital investment. risk and return, using firm characteristic variables - market value and book-to-market ratio.

Berk et al. (1999) argue that Fama and French's (1992, 1993) empirical observations showing returns to be related to size and book-to-market, are the result of the change in the risk profile of future cash flows as a result of the firm's current investment decisions. There is strong empirical support internationally for the Fama and French (1992, 1993) three-factor model (Fama and French, 2012). Fama and French (1992, 1993) find that share return is related to size premium (SMB or 'small minus big') and value premium (HML or 'high minus low') risk factors. The size premium is the market capitalisation risk factor and measures the additional return from relatively small market capitalisation shares. The value premium measures the additional return from shares with high book-to-market values.

Anderson and Gacia-Feijóo (2006), Xing (2008), Cooper and Priestley (2011) and Titman et al. (2013) investigated and support Berk et al.'s notion (1999) that capital investment changes systematic risk. Li, Livdan and Zhang (2009) and Liu, Whited and Zhang (2009) also agree to this notion.

Behavioural-based explanation (hubris, overinvestment and mispricing premised on the limits to arbitrage theory)

However, behavioural proponents argue that due to Shleifer and Vishny (1997) limits to arbitrage theory, the rational-based explanation for the negative I–R relation cannot hold, and instead the negative relation is due to a mispricing explanation.

Shleifer and Vishny (1997, p. 35) refer to Sharpe and Alexander's (1990) definition of arbitrage as the "simultaneous purchase and sale of the same, or essentially similar, security in two different markets for advantageously different prices". The rational assumption is based on the principle that arbitrage would result in prices being close to its fundamental values, consistent to the efficient market hypothesis of Fama (1970). The role of arbitrage is to bring prices to fundamental values, however this is based on the assumption is that arbitrage entails no risk and requires no capital. Shleifer and Vishny (1997) propose that most arbitrage requires capital and is risky, and therefore effective arbitrage does not take place to correct pricing anomalies. Shleifer and Vishny (1997) show that specialised performance-based arbitrage may not be fully effective in bringing security prices to true values especially in extreme circumstances and may more generally avoid extremely volatile arbitrage positions. Volatility exposes arbitrageurs to the risk of losses that they may want to avoid (Shleifer & Vishny, 1997).

Titman et al. (2004), using United States data from between 1973 and 1996, found that firms with greater investment discretion show a negative I–R relationship, in contrast to firms with less investment discretion which show a positive I–R relationship. They attribute the negative investment relation to managers' inefficient overinvestment decisions and "empire building" (Titman et al., 2004, p. 678). Similarly, Cooper et al. (2008) found that the I–R relationship is less negative with increased corporate oversight as compared to reduced corporate oversight. Since managers have more knowledge about the firm than investors and act as agents (information asymmetry and agency conflict theory), they also control the investment policies of the firm, and this may not ultimately benefit shareholders (Bessler, Drobetz & Grüninger, 2011). Hubris may cause managers in firms that have recently done well to overestimate the expected cash flows or underestimate their cost of capital, resulting in an overinvestment problem (Kruger, Landier, & Thesmar, 2015).

Li and Zhang (2010), Lipson et al. (2011), and Alti and Tetlock (2014) argue that investors overreact or underreact to investment decisions of the firm, and misprice shares relative to risk and return which explain the negative I–R relationship. They argue, based on the Shleifer and Vishny (1997) limits to arbitrage theory, that this mispricing cannot be arbitraged away. Investor biases create divergence of returns from their true values (Alti & Tetlock, 2014; Cooper et al., 2008). Based on the limits to arbitrage theory, it is difficult to close these pricing gaps through arbitrage (Shleifer & Vishny, 1997). Due to the costs of arbitrage, which are higher in high volatile conditions such as the JSE, arbitrageurs don't close mispricing gaps effectively, and prices don't reflect their fundamental values. Therefore, we find a negative relation between investment and share return.

Li and Zhang (2010) and Lipson et al. (2011) also argue that high idiosyncratic volatility and low turnover are necessary conditions for the I–R anomaly. Based on the behavioural-based explanation, we would expect that the negative I–R relation would be applicable in a highly volatile market such as South Africa.

The South African context

South Africa is a developing market that has experienced turbulent political and economic conditions resulting in volatile financial markets over the study period. Arbitrage costs are further related to the level of liquidity, turnover and trading costs, where arbitrage costs are higher under conditions of lower liquidity, lower turnover and higher trading costs (Li & Zhang, 2010; Lipson et al., 2011; Shleifer & Vishny, 1997; Titman et al., 2013). The South African developing market is significantly smaller than the US developed market. There are few market participants, lower liquidity, lower turnover and higher trading costs in the South African context than in the United States (The World Bank, 2016). These characteristics result in higher limits to arbitrage in the South African context as compared to the United States.

The behavioural proponents argue that the negative investment return relation is correlated to volatility and higher limits to arbitrage and therefore we would expect that the negative investment relation would be significant in a highly volatile market such as South Africa. Titman et al. (2013) on the other hand argue that the negative I–R relation is the result of a risk-based explanation and would be stronger in more efficient developed markets. It would also be unlikely that the rational-based explanation assumptions will hold under the volatile South African conditions.

Data and methodology

The South African context provides an attractive opportunity to examine the relationship between capital investment and shareholder return in a developing market context, and to test whether the rational q-theory with real options assumptions hold in this context.

A longitudinal time series analysis was conducted on firms listed on the JSE main board over the period 1992 to 2017 (termed the 'study period'). The unit of analysis was 'the firm', and the theoretical universe of this study was listed firms in a developing market context. There were typically more than 350 firms listed on the JSE over the study period. However, this study only analysed the largest 160 firms, representing approximately 99% of the total market capitalisation of the JSE. Daily share total returns from the JSE, together with financial statement data from INET BFA, were used in the analysis. Financial services and mining firms were excluded from the study, as their working capital to net asset ratio was high and including them will distort the capital investment measure. Capital investment is measured using net asset growth as a proxy. The sample included industrial, consumer services and goods, technology, health care and telecommunications firms.

The methodology comprised a buy-and-hold portfolio strategy, termed a 'style-engine', constructed using the Excel Visual Basic for Applications and database functionality. Buy and hold involves buying the share at a specific time, holding it, and then selling it after a period. The buy-and-hold portfolio research strategy is also referred to "fundamental or portfolio-based style analysis" (Rekenthaler, Gambera, & Charlson, 2006, p. 25). Rekenthaler et al. (2006) describe the buy-and-hold portfolio research strategy as a bottom-up fundamental approach, where the portfolio is classified by an investment style, and the characteristics of the portfolio are derived from the characteristics of the shares it contains. The investment style is the principle variable by which the portfolio is classified. When compared to alternative investment style research strategies, the buy-and-hold strategy is preferred due to its accuracy, consistency and flexibility, however the cost of data is high, according to Rekenthaler et al. (2006). Portfolios are formed based on the ranking of selected style variable(s), and the performance between portfolios is analysed. Portfolios are used to reduce the noise in the data and a time-series approach is used to compound the effect of the style variable selected. The benefit of this methodology is that we can determine the influence of a selected style variable on share return.

The style-engine was built and tested to minimise bias and to ensure the validity, reliability and replicability of the results (see Muller & Ward, 2013 for details).

Changes in share prices, which were a result of share splits or consolidations, were adjusted backwards in the time series data. Where a firm unbundled (spun off) a subsidiary, the returns from the newly listed subsidiary were combined with those of the original holding firm for the remainder of the quarterly review period. Thereafter the firms were treated as separate entities.

Dividend receipts constitute a significant portion of the return an investor receives, and the style-engine therefore included dividends in share reruns using the INET historical time series of cash (and scrip) dividend pay-outs.

Share buybacks were not accounted for, as these were a form of capital reduction, which only affected those shareholders who exited the company over the study period.

Shares granted as compensation to managers were considered immaterial and were ignored. Newly listed shares were included at the start of each quarter, and delisted shares were removed at the end of the quarter based on their last price prior to the cessation of trading. Survivorship bias was therefore effectively eliminated in the data.

Name changes were tracked and followed through in the sample. Data errors were checked and remedied where possible. The (rare) instances where daily returns on shares were less than -40% or greater than +40%, were set to zero.

To test the integrity of the share return data, a simulated market capitalisation weighted index (including dividends) was reconstructed using the data which was then compared to the J203T (the ALSI total return index).

Biases such as the ‘look-ahead bias’ were factored into the style-engine, to take into account the delay in the publication of the firm’s financial results versus its year-end date, by including a three-month delay from company year-end to incorporating the data in the analysis.

Results

Capital investment and share return

We determine the relative share returns of portfolios ranked on capital investment. Refer to Appendix A for the definition of the variables used in the analysis. The steps used in the style-engine for this analysis are summarised below.

The start date for the returns measurement was 31 December 1992. All the shares listed on the JSE on this date were established and ranked by market capitalisation, with the top 160 included in the analysis. Any shares in the financial services or mining sector were then omitted.

Shares were ranked by the style variable (% net asset growth) and allocated into five (quintile) portfolios, equally weighted. Each quintile represented 20% of the sample. Quintile 1 (q1) was the portfolio which contained the shares with the highest % net asset growth, and quintile 5 (q5) was the portfolio which contained the shares with the lowest % net asset growth. The performance of each quintile was then monitored daily, with dividends assumed to be reinvested, and the portfolios rebalanced quarterly.

The parameters of the look-back period were decided. Look-back [-4,-2] was used. The style variable was then calculated for each share in the sample as the percentage net asset growth over the (two-year) investment period (starting 31 December 1988). The sample was then ranked by the style variable, and shares allocated into quintiles accordingly, on an equal weighted basis. The value of each share and the portfolio values were calculated daily from a base of 1.0 (starting 31 December 1992).

At the end of each quarter, the quintiles were rebalanced. Shares entering or leaving the market were identified and the 160 largest shares were selected. The style variable was re-calculated, and shares ranked accordingly and re-allocated into quintiles on an equal weighted basis. This approach is repeated each quarter, accumulating the daily value of each portfolio until the end of the period.

Figure 1 below represent the daily share value (indexed from 1.0) of each of the quintiles over the period December 1992 to August 2017. q1 is quintile 1 and is comprised of those shares with the highest asset growth. q2 is quintile 2 which represents the portfolio of shares with the next highest asset growth. q3 is quintile 3 which represents the portfolio with the third highest asset growth. q4 is quintile 4 which represents the portfolio with the fourth highest asset growth. q5 is quintile 5 which represents the portfolio with the lowest asset growth.

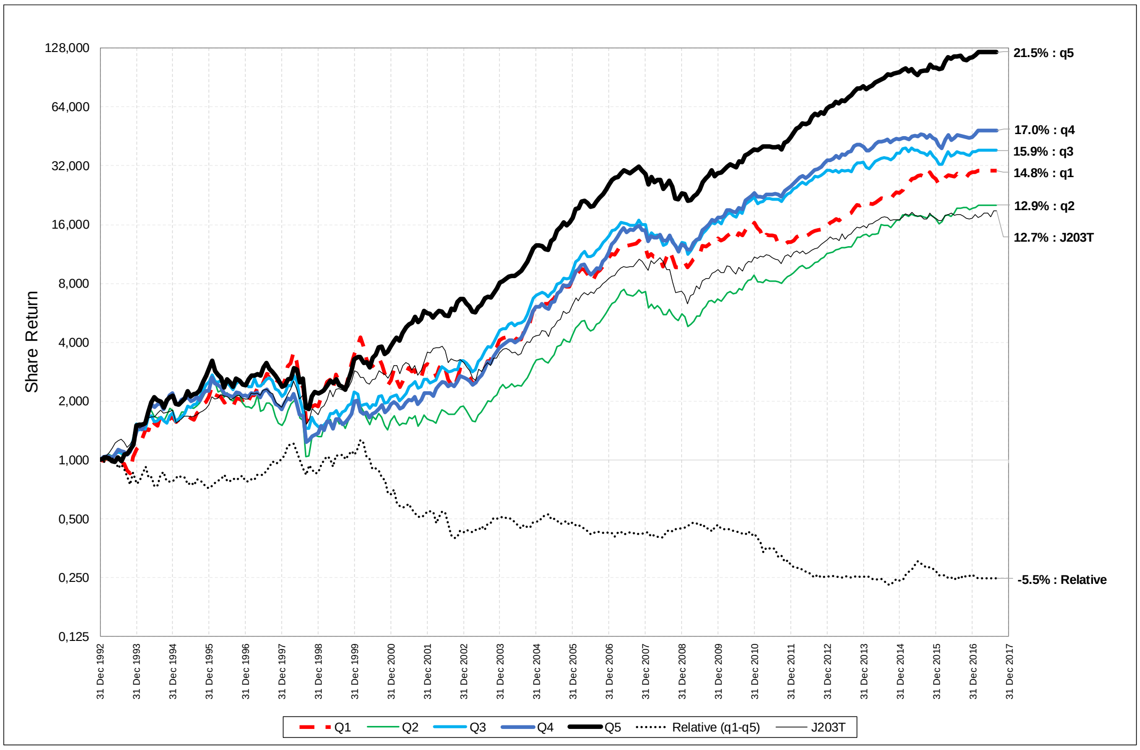

Figure 1: Quintiles ranked on capital investment

From Figure 1, portfolios with lower capital investment result in a higher cumulative share return over the period. The price relative line 'Relative' represents the difference between q1 and q5. There was a persistent negative difference between these two quintiles, culminating in the 5.5% per annum difference in return over the period.

All the quintiles were above the benchmark J203T. This is because financial and mining firms were excluded in our sample but included in the J203T. Furthermore, the quintiles were all equal weighted, whereas the J203T was weighted by market capitalisation, indicating a potential size effect.

We run the analysis again for the highest capital investment with varying look-back periods; and for the lowest capital investment with varying look-back periods. Table 1 show the annualised share returns (over the 10-year period December 2006 to December 2016) for the portfolio with the highest investment in capital, and for the portfolio with the lowest investment in capital, for varying start dates, capital investment and lag periods.

Table 1: Share returns for highest capital investment and lowest capital investment portfolios with varying look-back periods

A. Share returns for highest capital investment

Capex End Year

Capex Start Year	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
-1	x	x	x	x	x	x	x	x	x	13,59%
-2	x	x	x	x	x	x	x	x	12,25%	11,09%
-3	x	x	x	x	x	x	x	13,19%	13,46%	12,58%
-4	x	x	x	x	x	x	13,39%	13,86%	14,46%	13,30%
-5	x	x	x	x	x	18,73%	17,50%	17,17%	15,79%	15,27%
-6	x	x	x	x	18,00%	18,58%	18,21%	18,07%	19,69%	16,64%
-7	x	x	x	13,36%	17,03%	19,51%	19,19%	19,60%	18,76%	18,05%
-8	x	x	17,98%	16,49%	18,21%	20,96%	21,42%	20,78%	18,46%	16,70%
-9	x	19,14%	21,79%	18,41%	18,81%	20,62%	22,00%	21,73%	18,49%	16,59%
-10	21,71%	23,24%	22,42%	20,62%	20,41%	21,05%	22,82%	22,28%	20,21%	18,85%

B. Share returns for lowest capital investment

Capex End Year

Capex Start Year	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
-1	x	x	x	x	x	x	x	x	x	22,76%
-2	x	x	x	x	x	x	x	x	21,28%	20,96%
-3	x	x	x	x	x	x	x	22,35%	22,07%	21,90%
-4	x	x	x	x	x	x	19,44%	20,56%	24,03%	24,30%
-5	x	x	x	x	x	13,47%	18,50%	21,44%	23,32%	23,21%
-6	x	x	x	x	14,62%	12,80%	15,58%	18,39%	21,21%	22,65%
-7	x	x	x	20,44%	18,62%	15,99%	16,35%	19,51%	21,17%	22,25%
-8	x	x	16,75%	20,38%	18,45%	18,08%	17,60%	19,17%	20,02%	20,91%
-9	x	17,26%	17,49%	19,40%	18,70%	18,16%	17,84%	18,53%	20,18%	21,03%
-10	15,50%	15,33%	17,32%	20,04%	18,96%	18,53%	17,79%	19,80%	20,58%	20,90%

C. Difference of share returns (lowest capital investment - highest capital investment)

Capex End Year

Capex Start Year	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
-1	x	x	x	x	x	x	x	x	x	9,17%
-2	x	x	x	x	x	x	x	x	9,03%	9,86%
-3	x	x	x	x	x	x	x	9,16%	8,61%	9,32%
-4	x	x	x	x	x	x	6,05%	6,69%	9,57%	11,00%
-5	x	x	x	x	x	-5,26%	1,00%	4,27%	7,53%	7,94%
-6	x	x	x	x	-3,37%	-5,78%	-2,63%	0,32%	1,52%	6,00%
-7	x	x	x	7,08%	1,58%	-3,52%	-2,84%	-0,09%	2,41%	4,19%
-8	x	x	-1,24%	3,89%	0,24%	-2,89%	-3,83%	-1,60%	1,55%	4,21%
-9	x	-1,88%	-4,30%	0,99%	-0,11%	-2,46%	-4,16%	-3,21%	1,69%	4,44%
-10	-6,21%	-7,91%	-5,10%	-0,58%	-1,45%	-2,53%	-5,03%	-2,49%	0,37%	2,05%

Table 1 Part A shows share returns for firms with different start dates, capital investment and lag period for the highest capex growth. From Table 1 Part A, returns were lower for firms that that invested in capital in later years as compared to firms that invested in capital in the earlier years. The worst (lowest) result from Table 1 Part A is 11,09% per annum. This is for firms with a [-2,0]

look-back period (firms that commenced with capital investment two years ago, with a capital investment period of two years, and no lag). We construct Q1 later using this [-2,0] look-back period. The highest result is 23,24% per annum, which is for firms with a [-10,-8] look-back period (firms that commenced with capital investment ten years ago, with a capital investment period of two years, and an eight-year lag) from Table 1 Part A.

Table 1 Part B shows share returns for firms with different start dates, capital investment and lag period for the lowest capex growth. From Table 1 Part B, returns are higher for firms, which invested the least in recent periods, particularly the last three years, as compared to firms that invested earlier. The highest result from Table 1 Part B is 24,3% per annum. This was for firms with a [-4,0] look-back period (firms that commenced capex four years ago, with a capex period of four years, and no lag). We construct Q5 later using this [-4,0] look-back period. The lowest result from this table is 12,8% per annum, which represents with a [-6,-4] look-back period (firms that commenced with capex six years ago, with a capex period of two years, and a lag period of four years prior to the returns measurement date) from Table 1 Part B.

Table 1 Part C shows the difference in share return between the lowest capital investment and highest capital investment portfolios. From Table 1 Part C, the difference between the cumulative returns between high capital investment and low capital investment portfolios could depend on the capital investment periods and lag periods. For shorter capital investment periods and shorter lag periods, returns are higher for the portfolio with lower capital investment. For longer capital investment periods and longer lag periods, returns are higher for the portfolio with higher capital investment. The relation changes with time. This paper focusses on examining the negative relation in the short term, after the capital investment is made.

We then construct two portfolios, one with highest capital investment and the other with lowest capital investment. Q1 is the portfolio with the highest investment in capital with a [-2,0] look-back period. Q5 is the portfolio with the lowest investment in capital with a [-4,0] look-back period. We plot Q1, Q5, and their price relative using the style-engine. Figure 2 shows the returns of Q1 (highest capital investment portfolio with [-4,0] look-back period) and Q5 (lowest capital investment portfolio with [-2,0] look-back period).

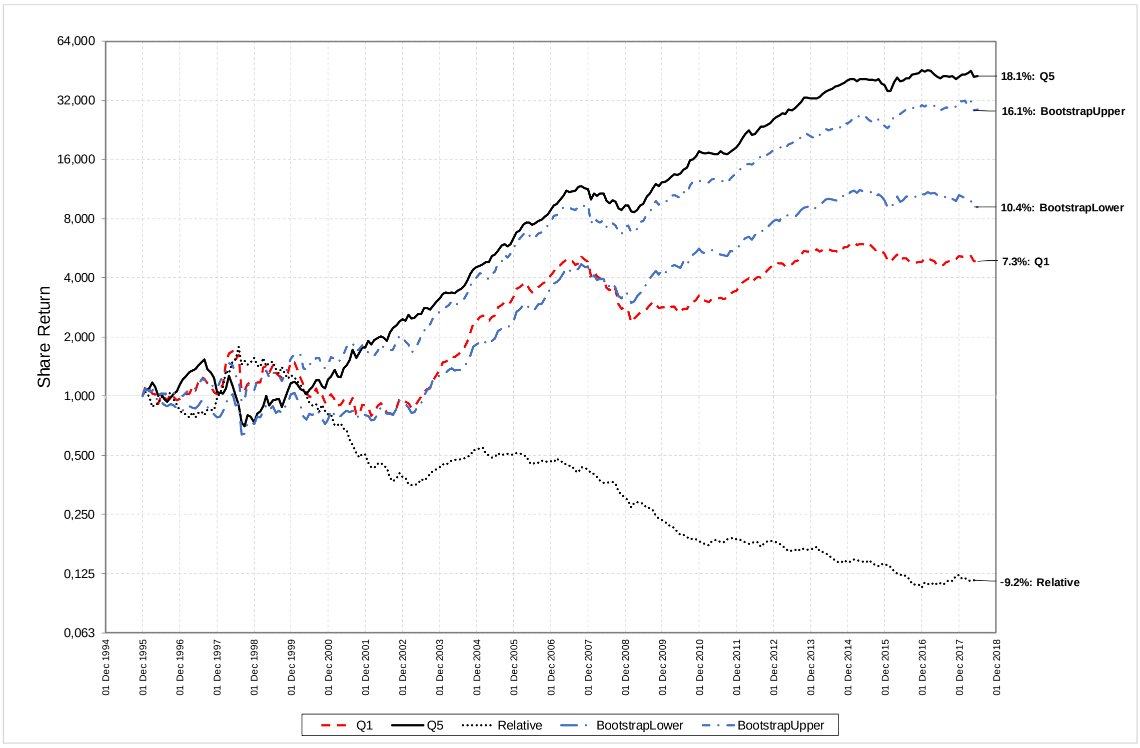

Figure 2: High-investment Q1 and low-investment Q5 portfolios with confidence limits

Q5 shows a 18.1% per annum cumulative return over the period December 1995 to June 2018. Investing in firms, which had the lowest capex over the previous four years gave the highest returns. Q1 shows a 7.3% per annum cumulative return over the period December 1995 to June 2018. Investing in firms, which had the highest capex over the previous two years gave the lowest returns. The price relative (in black) between Q5 and Q1 was continuous and persistently positive over the entire period, culminating in a relative difference of 9.2% between these two portfolios. A long or short position would yield 9.2% per annum fairly steadily over the period.

We determine the significance of the difference of share return between these two portfolios Q1 and Q5, the one with highest capital investment and the other with lowest capital investment. Figure 2 shows the bootstrap results for Q1 and Q5 (‘BootstrapUpper’ and ‘BootstrapLower’).

From a statistical perspective, the power and benefits of the style-engine rest on two main aspects: the use of equal weighted portfolios to reduce the ‘noise’ in the data from individual shares; and the accumulation of the tiny daily differences in returns over a 24-year period (1993 to 2017), which enables one to visualise and measure the impact. Accordingly, we construct a bootstrap distribution, based on one hundred random samples, to test for the statistical significance of the difference between Q1 and Q5, since these series are autocorrelated and cumulative. We construct the bootstrap distribution with the style-engine following the same process and data described above, except that we replace the style variable (% net asset growth) by a random number, drawn from a continuous, uniform distribution. This means that the rank is random, but the companies in the sample at each re-balancing are identical. Although the individual company returns are identical the daily portfolio returns are different, as these are based on randomly constructed equally weighted portfolios. We re-run the style-engine one hundred times, to construct one hundred random cumulative total return indices for each quintile. We then rank these by their final 24-year cumulative return, identify the 5th and 95th percentile cumulative return lines (indices) and plot these confidence limits together with the Q1 and Q5 % net asset growth styles identified earlier. This method is superior to standardised parametric or non-parametric tests, and other statistical software cannot construct a style-based bootstrap distribution which compares with this approach.

The 5^{th} percentile return (BootstrapUpper) is at 16.1% and the 95^{th} percentile return (BootstrapLower) is at 10.4%. Q5 is significantly higher than BootstrapUpper at 18.1% per annum cumulative return over the period, and Q1 is significantly lower than BootstrapLower at 7.3% per annum cumulative return over the period showing these both to be statistically significant.

We also run a paired t-test using bootstrap for autocorrelation. The difference between Q1 and Q5 is significant, shown in Appendix B Table B.2.

We can conclude that the share returns of portfolios with lower capital investment are higher than the share returns of portfolios with higher capital investment. This negative relation between capital investment and share return is statistically significant at the 95% significance level.

This result is consistent to previous literature. Alti and Tetlock (2014), Anderson and Garcia-Feijóo (2006), Berk, Green, and Naik (1999), Cooper and Priestley (2011), Cooper, Gulen, and Schill (2008), Eric, Lam, and Wei (2011), Li and Zhang (2010), Lipson, Mortal, and Schill (2011), Titman, Wei, and Xie (2004), Titman, Wei, and Xie (2013) and Xing (2008) have found that there is a strong negative relationship between investment by a firm and subsequent shareholder return on US data.

Q-theory of investment with real options

We determine whether the firm characteristic variables book-to-market and market value are associated to the capital investment – share return relation, by comparing the higher capital investment & lower share return portfolio, to the lower capital investment & higher share return portfolio.

Q1 is the portfolio with higher capital investment and lower share returns, and Q5 is the portfolio with lower capital investment and higher share returns. We plotted the medians of the firm characteristic variables book-to-market and market value for Q1 and Q5. We then determine whether the means of these selected variables are significantly different, and whether they are higher or lower between Q1 and Q5.

We use paired sample t-test with bootstrap which gives valid results in spite of autocorrelation in the time series data. In time series there is autocorrelation, where each subsequent observation is equal to the previous observation plus a random disturbance, and the observations are random (not independent). Bootstrap uses the actual observations by means of repeated sampling to calculate the significance of the difference.

We describe whether there is a difference in the selected characteristic variables between the Q1 and Q5 portfolios below.

Book-to-market

Berk et al. (1999) uses the firm characteristic variable ‘book-to-market’ as a measure of the firm’s risk relative to its assets-in-place.

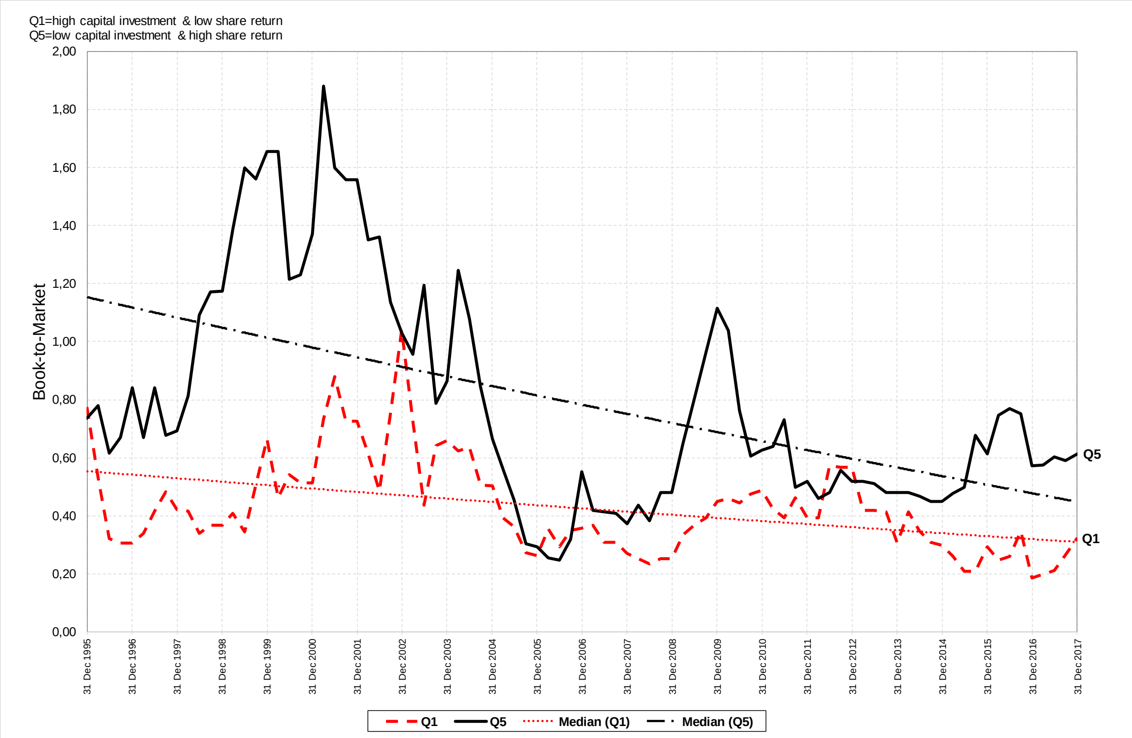

Figure 3: Book-to-market for Q1 and Q5

From Figure 3, the median for Q1 is consistently below the median for Q5, indicating higher levels of investment are associated with lower book-to-market ratios.

The paired t-test (Appendix B Table B.2) shows that the book-to-market for Q1 is significantly lower than the book-to-market for Q5, at the 0.01 significance level.

Appendix C Table C.1 shows the regression analysis where we model the difference in subsequent return between Q5 and Q1 to the difference in book-to-market between Q5 and Q1. The R^2 (the coefficient of determination) of the linear regression model is 0,191 and the linear coefficient for book-to-market is positive 0,437. 19.1% of the variability in the difference between Q5 and Q1 returns can be explained by the variability in the book-to-market difference between the Q5 and Q1 portfolios. The model is significant.

We can conclude from the above, that the higher capital investment & lower share return is significantly associated with lower book-to-market ratio, as compared to the lower capital investment & higher share return portfolio.

Market value

Berk et al. (1999) uses market value (size) as a measure of the relative importance of growth options versus assets-in-place. Size proxies for the exercise of growth options which are riskier than assets-in-place.

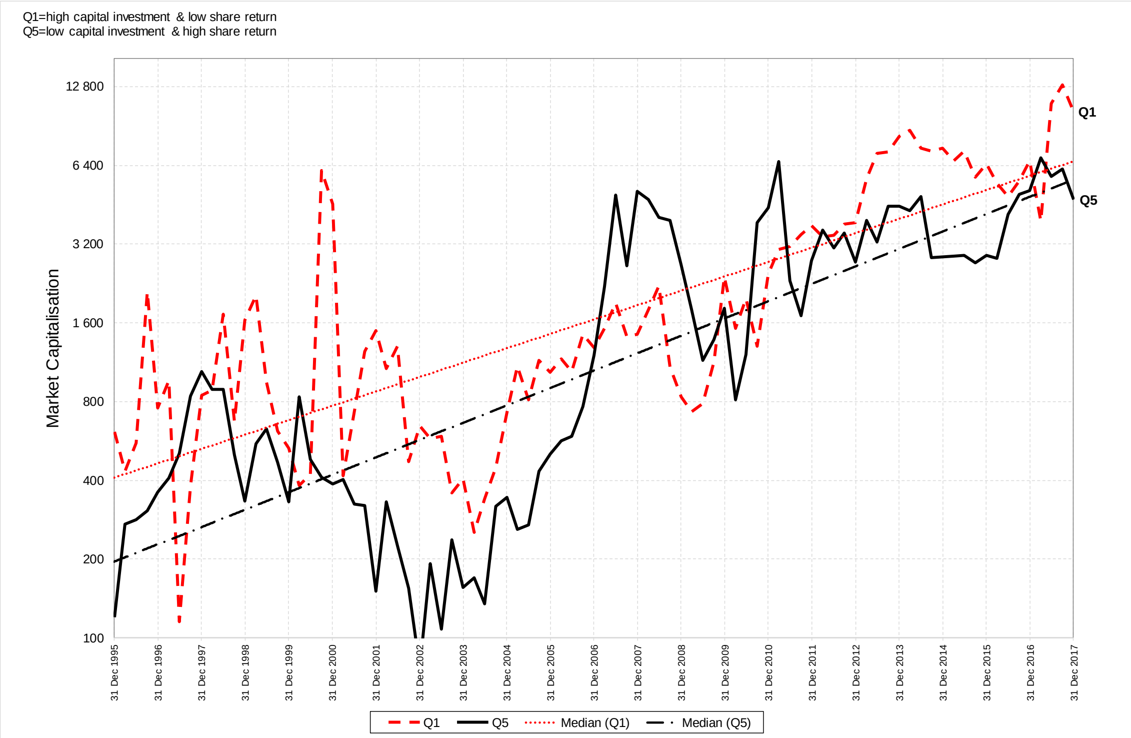

Figure 4: Market capitalisation for Q1 and Q5

From Figure 4, the market capitalisation for Q1 is slightly higher than that of Q5 providing evidence that higher investment is associated with larger firms (higher market value)

The paired t-test (Appendix B Table B.2.) shows that the market capitalisation for Q1 is significantly higher than the market capitalisation for Q5, at the 0.01 significance level.

Appendix C Table C.2. shows the regression analysis where we model the difference in subsequent return between Q5 and Q1 to the difference in size between Q5 and Q1. The R^2 of the linear regression model is 0,001 and the linear coefficient is negative 0,033 for size. However, this regression model is not significant. This weak association could be attributed to South Africa being a relatively small concentrated market, and moreover mining and financial services firms are not included in the sample.

The results of this study are consistent to previous studies by Brainard and Tobin (1968) and Tobin (1969) (traditional q-theory), Cochrane (1991, 1996) investment-based asset pricing model, real options by Berk et al (1999).

Conclusion

Even though South Africa is a developing market with high volatility and high arbitrage limits, we find that the rational q-theory of investment with real options assumptions hold for the negative capital investment–share return relation in this market.

The study found that firms with higher capital investment result in significantly lower shareholder returns than firms with lower capital investment, in the short term. This is similar to previous studies in developed markets. The study finds that the higher capital investment and lower share return is significantly associated with lower book-to-market; and that the lower capital investment and higher share return is significantly associated with higher book-to-market.

The study finds some evidence that the higher capital investment and lower share return portfolio is associated with higher market value, as compared to the lower capital investment and higher share return portfolio. However, the association to size is weak in the South African market.

Research can be undertaken to further understand the capital investment–share return relation from a rational perspective, under developing market conditions.

REFERENCES

Alti, A., & Tetlock, P. C. (2014). Biased beliefs, asset-prices, and investment: A structural approach. *Journal of Finance, 69*(1), 325–361. doi:10.1111/jofi.12089

Anderson, C. W., & Garcia-Feijóo, L. (2006). Empirical evidence on capital investment, growth options, and security returns. *Journal of Finance, 61*(1), 171–194. doi:10.1111/j.1540-6261.2006.00833.x

Berk, J. B., Green, R. C., & Naik, V. (1999). Optimal investment, growth options, and security returns. *Journal of Finance, 54*(5), 1553–1607.

Bessler, W., Drobetz, W., & Grüninger, M. C. (2011). Information asymmetry and financing decisions. *International Review of Finance, 11*(1), 123–154.

Brainard, W. C., & Tobin, J. (1968). Pitfalls in financial model-building. *American Economic Review, 58*, 99–122.

Cochrane, J. H. (1991). Production-based asset-pricing and the link between stock returns and economic fluctuations. *Journal of Finance, 46*(1), 209–237.

Cochrane, J. H. (1996). A cross-sectional test of an investment-based asset-pricing model. *Journal of Political Economy, 104*, 572–621.

Cooper, I., & Priestley, R. (2011). Real investment and risk dynamics. *Journal of Financial Economics, 101*, 182–205.

Cooper, M. J., Gulen, H., & Schill, M. J. (2008). Asset growth and the cross-section of stock returns. *Journal of Finance, 63*(4), 1609–1651. doi:10.1111/j.1540-6261.2008.01370.x

Eric, F. Y., Lam, C., & Wei, K. C. J. (2011). Limits-to-arbitrage, investment frictions, and the asset growth anomaly. *Journal of Financial Economics, 102*, 127–149.

Fama, E. F. (1970). Efficient capital markets: a review of theory and empirical work. *Journal of Finance*, 25(2), 383-417

Fama, E. F., & French, K. R. (1992). The cross section of expected stock returns. *Journal of Finance, 47*(2), 427–465.

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal on Financial Economics, 33*, 3–56.

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

Kumar, P., & Li, D. (2016). Capital investment, innovative capacity, and stock returns. *Journal of Finance, 71*(5), 2059–2094

Kruger, P., Landier, A., & Thesmar, D. (2015). The WACC fallacy: The real effects of using a unique discount rate. *The Journal of Finance, 70(3),* 1253-1285.

Li, D., & Zhang, L. (2010). Does q-theory with investment frictions explain anomalies in the cross-section of returns? *Journal of Financial Economics, 98*, 297–314.

Li, E. X. N., Livdan, D., & Zhang, L. (2009). Anomalies. *Review of Financial Studies, 22*, 4301–4334.

Lipson, M. L., Mortal, S., & Schill, M. J. (2011). On the scope and drivers of the asset growth effect. *Journal of Financial and Quantitative Analysis, 46*(6), 1651–1682.

Liu, L. X., Whited, T. M., & Zhang, L. (2009). Investment-based expected return. *Journal of Political Economy, 117*, 1105–1139.

Muller, C., & Ward, M. (2013). Style-based effects on the Johannesburg Stock Exchange: A graphical time-series approach. *Investment Analysts Journal, 77*, 1–16.

McCallum, J.S., (1992). Using net present value in capital budgeting. *Business Quarterly, 57(1)*, 66-71

Myers, S. (1977). Determinants of corporate borrowing. *Journal of Financial Economics, 5*, 147–175.

Rekenthaler, J., Gambera, M., & Charlson, J. (2006). Estimating portfolio style in U.S. equity funds: A comparative study of portfolio-based fundamental style analysis and returns-based style analysis. *Journal of Investing, 15*(3), 25-33.

Sharpe, W.F, & Alexander, G.J. (1990). *Investments, 4th edition*, Prentice Hall, Englewood Cliffs, N-J.

Shleifer, A., & Vishny, R. (1997). The limits of arbitrage. *Journal of Finance, 52*(1), 35–55.

The World Bank. (2016). *World development indicators*. Retrieved from http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators#

Titman, S., Wei, K. C. J., & Xie, F. (2004). Capital investments and stock returns. *Journal of Financial & Quantitative Analysis, 39*(4), 677–700.

Titman, S., Wei, K. C. J., & Xie, F. (2013). Market development and the asset growth effect: International evidence. *Journal of Financial & Quantitative Analysis, 48*(5), 1405–1432. doi:10.1017/S0022109013000495

Tobin, J. (1969). A general equilibrium approach to monetary theory. *Journal of Money, Credit and Banking, 1*, 15–29.

Xing, Y. (2008). Interpreting the value effect through the q-theory: An empirical investigation. *Review of Financial Studies, 21*, 1767–1795.

Appendices

Appendix A. Definition of variables

INSERT TABLE A.1 ABOUT HERE

Table A.1: Definition of variables

Capital investment	Capital investment is measured as the percentage change in net assets over the previous year. Net assets are the total book value of the assets excluding trade payables and deferred tax (INET code 02010023 (NetFixedAssets))
Share return	Share return is the percentage change in the market equity value of the firm over a period, including dividends. The market value of equity is the closing share price multiplied by the number of shares outstanding.
Capital investment period	The ‘capital investment period’ is the period over which the capital is invested. The ‘lag’ is the delay period after the capital investment period over which no benefit in share return is measured. The share return is measured after the lag period.
Lag	The ‘lag’ is the delay period after the capital investment period over which no benefit in share return is measured. The share return is measured after the lag period.
Look-back	The ‘look-back’ period uses the capital investment period and lag period indicated as [-capital investment commencement, -lag period]. For example [-4,-1] at the 31 December 1992 returns measurement date, means to commence measurement of capital investment four years before the measurement date (which is 31 December 1988 in this example) through to one year before the measurement date (which is 31 December 1991 in this example) (i.e. a three-year period to measure the investment in assets and a one-year lag between the investment in assets and the measurement of subsequent returns).
Book-to-market	Book-to-market ratio is the book value of equity divided the market value of equity.

Market capitalisation	Market capitalisation is the market value of the equity of the firm.
Size	Size is measured as the natural log of market capitalisation

Appendix B. Paired sample statistics and paired sample t-tests for Q1 and Q5

INSERT TABLE B.1 ABOUT HERE

Table B.1: Paired sample statistics for Q1 and Q5

	Mean	N	Std. Deviation	Std. Error Mean
Q5	13,85	283	14,96	0,89
Q1	2,87	283	1,71	0,10
Book to Market (Q1)	0,42737	89	0,164887	0,017478
Book to Market (Q5)	0,78894	89	0,387949	0,041122
Market Capitalisation (Q1)	2764,77964	89	2851,520496	302,260568
Market Capitalisation (Q5)	1967,23741	89	1883,711020	199,672969

INSERT TABLE B.2 ABOUT HERE

Table B.2: Paired samples test for Q1 and Q5

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Q5 - Q1	10,98	13,47	0,80	9,41	12,56	13,719	282	0,000
Book to Market (Q1) – Book to Market (Q5)	-0,361570	0,321222	0,034049	-0,429236	-0,293904	-10,619	88	0,000
Market Capitalisation (Q1) – Market Capitalisation (Q5)	797,542229	2068,046176	219,212456	361,903537	1233,180922	3,638	88	0,000

Appendix C. Regression analysis for subsequent return, book-to-market and market value

INSERT TABLE C.1 ABOUT HERE

Table C.1: Regression analysis for Δ subsequent return and Δ book-to-market

(subsequent return (Q1 – Q5) = coefficient x book-to-market (Q5 – Q1) + constant)

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.437[a]	0,191	0,182	0,2094

a. Predictors: (Constant), B/M(Q5-Q1)

ANOVA[a]

	Sum of Squares	df	Mean Square	F	Sig.
Regression	0,900	1	0,900	20,521	.000[b]
Residual	3,815	87	0,044		
Total	4,714	88			

a. Dependent Variable: Subsequent Return (Q5-Q1)

b. Predictors: (Constant), B/M(Q5-Q1)

Coefficients[a]

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0,001	0,034		0,026	0,979
B/M(Q5-Q1)	0,315	0,069	0,437	4,530	0,000

a. Dependent Variable: Subsequent Return (Q5-Q1)

INSERT TABLE C.2 ABOUT HERE

Table C.2: Regression analysis for Δ subsequent return and Δ size

(subsequent return (Q1 – Q5) = coefficient x size (Q5 – Q1) + constant)

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.033[a]	0,001	-0,010	0,2327

a. Predictors: (Constant), Size(Q5-Q1)

ANOVA[a]

	Sum of Squares	df	Mean Square	F	Sig.
Regression	0,005	1	0,005	0,094	.760[b]
Residual	4,709	87	0,054		
Total	4,714	88			

a. Dependent Variable: Subsequent Return (Q5-Q1)

b. Predictors: (Constant), Size(Q5-Q1)

Coefficients[a]

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0,111	0,028		3,967	0,000
Size(Q5-Q1)	-0,009	0,029	-0,033	-0,307	0,760

a. Dependent Variable: Subsequent Return (Q5-Q1)