UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Gordon Institute of Business Science
University of Pretoria

The benefits of adding a cost function to Tobin's *q* as an investment style on the JSE

Jurie Geldenhuys

23056950

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

10 November 2014

“Believe those who are seeking the truth. Doubt those who find it.”

Andre Gide

ABSTRACT

Tobin's *q* ratio employs a fundamental principle that enterprise values cannot deviate excessively from, namely the replacement value of the assets required to generate the future cashflow of the business. This ratio formed the cornerstone of this research that investigated whether an index based on the ratio would indicate time periods of market missed valuations; determined whether the *q* effect exists and the probability of its persistence over a 24 year period across different ranked quintile portfolios. Finally the research examined a new supply approach valuation technique that altered the *q* ratio, and could improve the spread in the *q* effect to improve investment yields.

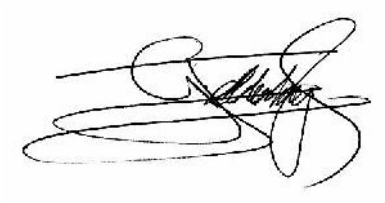
The Tobin's *q* index was compiled using the most recent estimate and the index included the top 160 shares by market capitalisation, excluding the resources and financial sector for firms listed from 1990, to create a representative index for the Johannesburg Stock Exchange. Tobin's *q* long term average was 1,83 at December 2013, indicating a consistent upward bias mainly due to share valuations.

A time serious approach was followed to compare cumulative returns between different ranked quintile portfolios, ranked by Tobin's *q* to analyse for style effects. Tobin's *q* displayed style characteristics, although it was not as prominent as other value indicators. The adjustment from the supply approach could not improve investment yields.

Keywords: Tobins'*q*, Investment Styles, Supply Approach to Valuation, Cost Function.

DECLARATION

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



Jurie Johannes Geldenhuys

10 November 2014

ACKNOWLEDGEMENTS

First and foremost, I am grateful to the creator for providing me with an opportunity to receive education at an institution of this stature.

To my loving and caring wife, Shani: Thank you for your unfailing support during these two years. It is lovingly appreciated.

I dedicate this research to the time that was invested in my studies, often times at the expense of my family and friends. In this regard, I would like to especially thank my supportive family members.

To Chris Muller, my research supervisor: Without your guidance and input this dissertation would not have achieved the intended scope. Thank you for giving me one of the most precious commodities in life, your time; and thank you for more than the guidance in the thesis but for priceless lessons in life.

To Hannelie van Huyssteen of BFA-McGregor: Your prompt, comprehensive answers to my questions assisted me in finalising the correct method for determining Tobin's *q*.

And finally, I am indebted to my employer, Sasol (Pty) Ltd.: Thank you for the bursary that has afforded me the opportunity to complete my MBA studies.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION TO THE RESEARCH PROBLEM

This chapter introduces the reader to the research topic and provides substance for the research. This primary chapter also introduces the corner stone variable, Tobin's *q*, and outlines the aims of the research.

1.1 Research title

The benefits of adding a cost function to Tobin's *q* as an investment style on the Johannesburg Stock Exchange (JSE).

1.2 Investment styles

Unsurprisingly, the idea of consistently being able to outperform the market to increase wealth has initiated an array of different views, risk appetites and consequently different investment styles. An investment style is defined as an predominant and agreed upon strategy or theory for capital allocations by fund managers or individuals (Investment Style Definition, 2014). A selected style typically has expected investment returns, based on historical performance, and has an associated estimated risk.

A wealth of literature is available regarding the empirical testing of different investment styles, both abroad and in South Africa. Frazzini and Pedersen (2014) found evidence for a "significant positive risk adjusted return" for investing in low *beta* assets; Moskowitz, Ooi and Pedersen (2012) concluded that global "time series momentum" exists; Asness, Moskowitz and Pedersen (2013) combined a value and momentum strategy and concluded that the two strategies are negatively correlated. A South African study by Muller and Ward (2013) found excess returns for momentum, cashflow-to-price and earnings yields. Collectively, empirical research concerning investment styles across different global markets has proved the existence of investment styles that outperform the market in some instances.

1.3 Tobin's *q* defined

In 1969, a ratio was developed by James Tobin, a Nobel laureate in economics from Yale University. Tobin (1969), defined *q* as "the value of capital relative to its replacement cost" and hypothesised that the combined value of the equities listed on the stock market should be equivalent to the replacement cost of the assets of the listed companies (Tobin's Q Ratio Definition, 2014).

Mathematically, Tobin's *q* can be presented as (Sturgess, 2012):

$$Tobin's\ q = \frac{Market\ value\ of\ firm}{Replacement\ value\ of\ assets}$$

Therefore, a *q* value of more than one suggests that the whole market is overvalued because the replacement costs of the assets are less than the capital value. Conversely, a *q* value of less than one suggests that the replacement costs of the assets are more than the capital value, concluding that the market is undervalued. Tobin's concept of determining fair asset value serves as the foundation for this research.

1.4 Motivation for the research

1.4.1 Relevance

Smithers and Wright (2000) in their book "Valuing Wall Street" opposed the general Wall Street consensus at that time by indicating that the market was overvalued and a correction was imminent. Shortly after the release of the book, the market value decreased by 50%. From 2005 to 2008 Smithers warned against the increased risk of over valuation and while some ridiculed him as a fool, the market again lost significant value in 2008 (Arends, 2014).

Again, on 31 December 2013, the United States of America's (U.S.) non-financial equities were overvalued by 73%, according to Smithers, as cited by Arends (2014). This indicator has provoked intense debate, especially since other majority widely accepted market indicators, such as price earnings (PE) were demonstrating the exact opposite.

In his latest report, Smithers (2014) has revealed that the historic and future PE multiples are "almost comically inadequate." In support of their claims, Smithers and Wright further developed a proprietary value indicator called a "*pseudo* indicator" or hindsight value

(Authers, 2014). Hindsight value is a statistical index presenting past times when the U.S. market was over- and undervalued based on subsequent returns at a range of different investor horizons (Wright et al., 2011). Smithers compared investment returns according to different market indicators and found that over the past century, Shiller's Cyclically Adjusted Price Earnings (CAPE) had a correlation coefficient, R^2, to succeeding returns of 0.52, the "pseudo indicator" had a correlation coefficient of 0.61 and Tobin's *q* had an astonishing correlation coefficient 0.79. It is interesting to note that Harney and Tower (2003) had previously demonstrated that "*q* is the most reliable way to predict stock market returns over the short, medium, and long term." (p. 68), therefore Smithers' research served to confirm these findings.

Thus, if Tobin's *q* ratio is above the average, expected returns from investing will likely be poor and if Tobin's *q* has lowered below the average, expected returns have been excellent. According to Smithers (2010) historic guidance has therefore demonstrated that Tobin's *q* has been the most accurate measure when considering stock market valuations.

1.4.2 Motivation and aim

Tobin's *q* as an indicator for market valuation has warned U.S. investors in the past and yet in South Africa there is neither an index nor a company that performs sell-side research based on *q*. A Tobin's *q* index for the South African stock market could potentially provide valuable insight into historic market fluctuations and calculate future times of "irrational exuberance". Furthermore, the index has the ability to function as the relative measure between the overall market and a specific firm on the stock market.

Badrinath and Kini (1994) performed a study from 1671 until 1981, in which low *q*-formed portfolios outperformed high *q*-formed portfolios by an average of 8,17% per annum, eloquently labelled the *q* effect. Badrinath and Kini (1994) referred to the results as "stock market anomalies", and concluded that on average, the "low Tobin's *q* ratio stock outperformed stocks with high Tobin's *q* ratios." (p. 1). However, the method used to estimate Tobin's *q* has since been refined and the Lindenberg and Ross *q* estimation method, used by Badrinath and Kini (1994), was criticised by Lewellen and Badrinath in 1997, and by Lee and Tompkins in 1999 as being systematically high, and again received critique by Erickson and Whited in 2006. Lewellen and Badrinath (1997) concluded that the "extant procedures for estimating *q* are flawed in design, are unstable in application, produce

downward-biased measures, and are prone to rank incorrectly and thereby misclassify firms by their *q*'s." (p.2).

In this research companies need to be clustered according to the *q* ratio. Therefore, a refined estimation method can significantly alter the outcome of the formed portfolios. To the best of the researcher's knowledge a range of investment styles have been identified and examined, nonetheless an investment style applying the latest *q* estimation and following a time series approach has not yet been researched.

This research therefore contributes to the body of knowledge by aiming to create a Tobin's *q* index for the South African stock market. Subsequently, the research sought to determine whether an investment style based on Tobin's *q* for selected portfolios exists and is persistent. If the style exists, the cumulative return must be determined, and it must be proved that the style is able to compete with other investments styles. Assuming the style exists, in order to possibly improve the yields a sector specific cost function was added to the sorting variable *q* for alternative portfolio construction.

1.5 Research purpose

The purpose of the research was subsequently constructed in three sequential steps, namely to:

1. Create an annual Tobin's *q* index for the shares that constitute the All Share Index (ALSI), calculate the long-term average (LTA) of Tobin's *q* index and present it graphically, relative to the ALSI.
2. Test Tobin's *q* as an investment style, against the ALSI, Price Earnings (PE) and Price to Book (PB) as benchmarks, by defining *q* as the variable for portfolio construction, while testing different holding periods and portfolio sizes for optimal yields.
3. Add the Cobb-Douglas production function as performed in Belo, Xue and Zhang's (2013) research to construct adjusted *q* portfolios with the aim to improve investment return relative to Tobin's *q* selected portfolios.

The prospective Tobin's *q* index was limited by the sample size. Therefore, an index was not created for the JSE but for the ALSI.

CHAPTER 2: THEORY AND LITERATURE REVIEW

Investors are concerned with a firm's ability to generate future earnings, given the firm's current installed capital asset base. This chapter describes quotients that range from simple to more complex ratios that are used by analysts to form a perspective concerning a firm's ability to generate future earnings. Different estimates for Tobin's *q* were explored to establish the most appropriate method to determine Tobin's *q* for this study. Different ways in which to interpret the ratio were also examined. This chapter concludes with a description of the adjustments that were made to Tobin's *q* for this particular study.

2.1 Price Earnings ratio

For decades investors and stock market analysts have made use of the PE multiple, also known as the PE ratio, because it is a reasonable price indicator for stock valuations. Essentially, a PE ratio is a multiple of share price divided by earnings per share (EPS). In the case of a firm, the PE ratio is equivalent to the price of a share divided by the EPS of the firm. Similarly for the whole market, the average share price of the firms are divided by the average earnings, per share, of the firms in the market (Shen, 2000). A PE of 17 for example indicates that the cost to purchase the share will take 17 years' worth of earnings to repay.

Shen (2000) revealed that when the PE ratio falls below its long-term average it has the tendency to return to its long-term average or even surpass it. Conversely, when the PE ratio is well above its long-term average, it has the tendency to return to its long-term average and reduce even further. This means that reversion can be explained by either slower growth in stock prices or by increased growth in earnings. A study by Campbell and Shiller (2001) that examined stocks in the Standard & Poor's 500 (S&P 500) determined that investments made in higher than long-term average PE ratios stocks were usually succeeded by lower share price growth for the following decade. Campbell and Shiller (2001) concluded that the primary catalyst for mean reversion is slower share price growth rather than earnings growth.

Before the "dot com" technology stock market collapse, analysts argued the unprecedented rise in equity value during the 1900s was due to increased expected economic growth on

the back of the information revolution, demographic changes, reduction in transaction costs, and a decline in inflation (Balke & Wohar, 2001).

However, in March 2000, Shiller published a book titled *"Irrational Exuberance"* where he argued that it was investor optimism that motivated high equity values instead of market fundamentals. Shiller proved to be correct using the CAPE ratio as part of the argument (Sturgess, 2012).

Thus, an important concept has emerged that an investor would not want to invest in a market that is overvalued because subsequent returns would likely reduce due to slower share price growth. In addition, the validity of the concept on portfolio level is brought into question. This concept was investigated by Muller and Ward (2013), who sought to determine what the subsequent returns would be if an investor invested in a portfolio of different PE ratios.

2.1.1 PE performance as an investment style

In Muller and Ward's (2013) research, the inverse of PE, known as Earnings Yield (EY) was used. Their findings proved that a low PE portfolio (value stocks) has a substantial premium relative to a high PE portfolio (growth stocks). Figure 1 displays what would have been the annual average return if an investor invested in different ranked quintile portfolios formed based on EY. Note that Figure 1 is an updated investment style analysis from the original study done by Muller and Ward's (2013).

Figure 1: Ranked earnings yield quintile portfolio returns

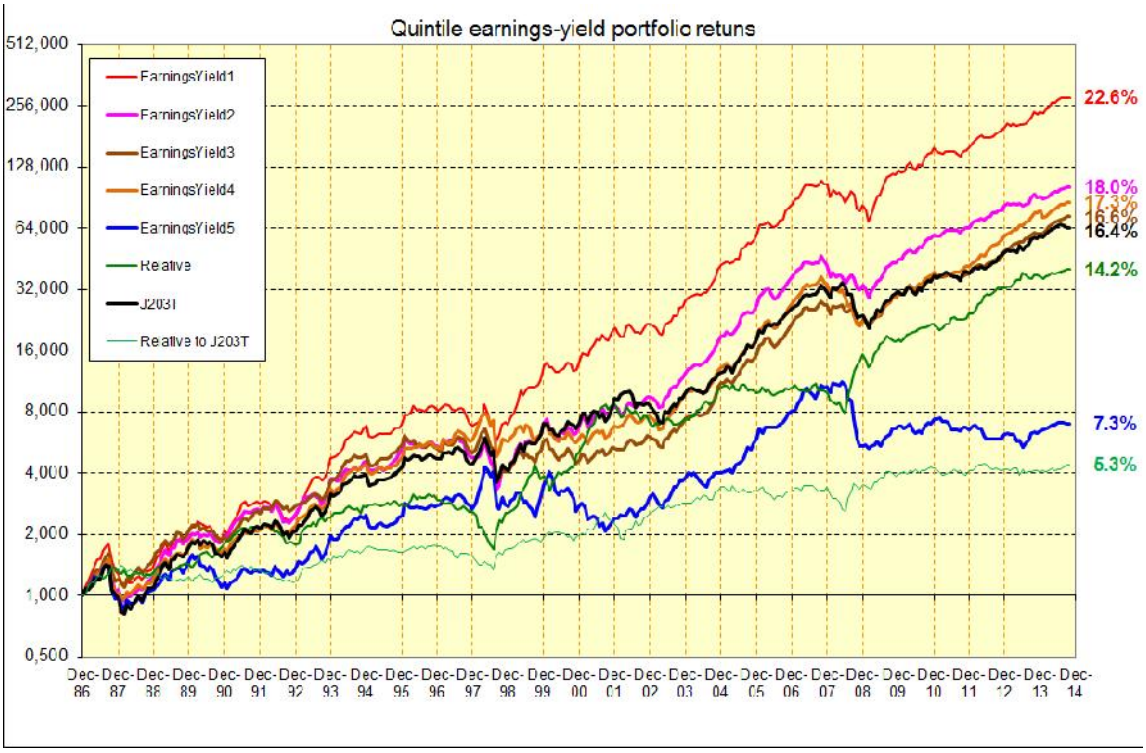


Figure 1 indicates that the high EY portfolio consistently outperformed the low EY portfolio over the time period by an annual relative difference of 14,2%. Muller and Ward (2013) concluded the study with supporting evidence of similar research performed in other global markets that proved that a persistent PE investment style exists. The concept thus holds true on market level as well as on portfolio level.

2.2 Cyclically Adjusted Price Earnings (CAPE) ratio

CAPE is an adjusted PE ratio and the difference between the PE ratio calculation and CAPE is that the average annual trailing earnings, usually ten years and adjusted for inflation, becomes the denominator. This process adjusts for short durations of business cycles (Sturgess, 2012), which is illustrated in Figure 2. Figure 2 displays the value of the PE ratio, Shiller's PE (CAPE), EPS and the real price of the S&P 500 from 1st December 1999 to the 1st March 2014.

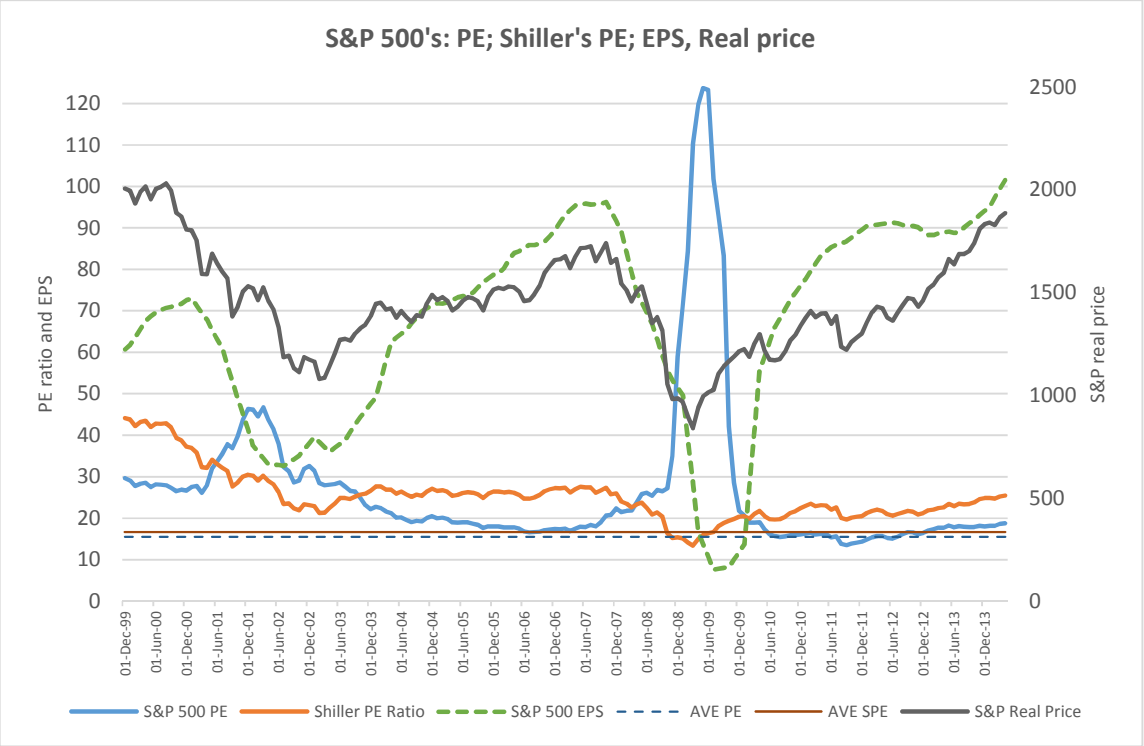
When the economy is growing companies generally have higher growth rates and higher profit margins, leading to higher than average earnings and artificially reducing the PE ratio

below its long-term average. During times of contracting economies, profit margins are pressurised, leading to declining earnings and consequently high PE ratios. Because of these economic cycles the PE ratio can rapidly increase, leading to inaccurate conclusions about the market value, as illustrated by Figure 2 for the early 2000s and the period between 2008 and 2009.

Sturgess (2012) suggested that Shiller's PE smooth out the short-term economic expansions and contractions. When the same time frames as illustrated in Figure 2 are considered and Shiller's PE is compared to PE, Shiller's PE clearly responds as a longer term indicator relative to the PE ratio. The period commencing in September 2008 was the start of the subprime loan and credit default swap crisis that caused global financial institutions to file for bankruptcy. The PE ratio rapidly increased to unrealistic values with meaningless interpretations as a result of the decline of S&P 500 earnings per share.

An investment style can be periodically rebalanced; however if the sorting variable responds unrealistically to changes in the economy it could potentially select suboptimal firms for the portfolio. Conceptually, a sorting variable with a more stable response would be preferred by style investors. Therefore, for stock market valuations, Shiller's PE was considered to be a more stable and realistic value indicator relative to PE, although Shiller's PE was shadowed by Tobin's *q.* According to Wright *et al.* (2011) Tobin's *q* is the "preferred indicator" for overall stock market valuation. Still, the argument is conceptual and empirical evidence on portfolio level has to prove the concept.

Figure 2: S&P's 500 PE ratio and Shiller's PE ratio comparison ("S&P 500 PE Ratio," 2014)

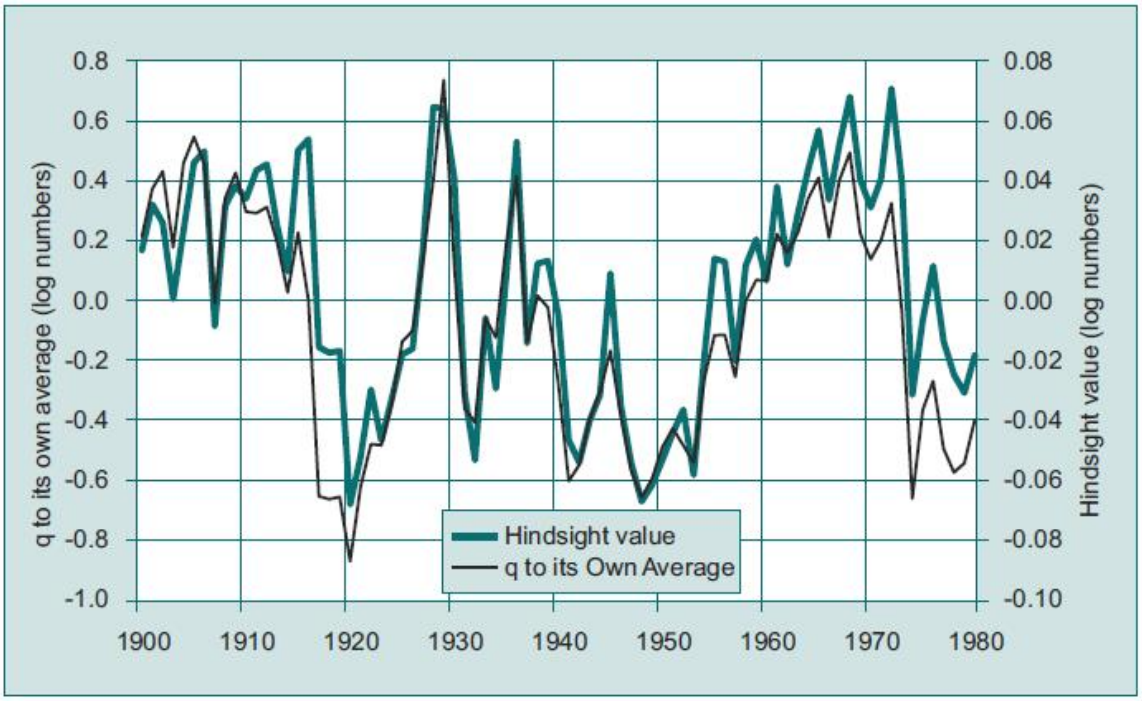


2.3 Tobin's *q*

Wright *et al.* (2011) calculated Tobin's *q* for U.S. equities and determined that *q* followed the US equities in terms of proprietary hindsight value so closely it was almost considered to be sceptical. Figure 3 presents the calculated Tobin's *q* and hindsight value relative to their respective averages. In comparison to PE and Shiller's PE, Tobin's *q* has been an accurate measure for U.S. stock market return predictions in the past and is considered to be an excellent indicator of market value. This phenomenon contributes largely to the selection of *q* as the portfolio sorting variable in this particular research.

For Tobin's *q* to be used as an investment style, it has to display a characteristic of mean reversion. Mean reversion is associated with the power of prediction because the probability of returning to the mean increases with both time and magnitude further away from the mean. As presented in Figure 3, Tobin's *q* reversion around the mean is indicative that an investment style similar to PE might exist on portfolio level.

Figure 3: q and hindsight value (Wright et al., 2011)



2.3.1 Interpreting *q*

The literature study revealed slightly diverse interpretations for Tobins'*q* ratios from different authors. Collectively the different interpretations provide conceptual understanding and interpretation insight. Unfortunately, some of the interpretations might be rather conflicting; however, the investment style analysis would empirically reveal which interpretation is the most appropriate. Inasmuch, three different interpretations have been considered.

Stocks present a claim of the owners on the assets and future cashflow generation capacity of these assets in the company. In an effective market and competitive economy these assets should be fairly priced. Thus, the market value of the stock should be equivalent to the current replacement value of all revenue generating assets in the company. According to Wright *et al.,* (2011) *q* could typically be interpreted as comparing assets in different markets. If *q* is high or low the implication is that the stock market prices are high or low relative to purchasing the assets directly.

The *q* value is influenced by the stock market valuation of the firm, the amount of corporate debt and the inflation adjusted replacement value of the revenue generating assets. Smithers and Wright (2002) concluded that the *q* ratio is mainly influenced by the market

valuation of the stocks relative to the other variables of the ratio. Thus, theoretically a high or low *q* value indicates that the stock market or specific firm might be overvalued or undervalued. For an investor an accurate *q* value could potentially be an immensely valued overall market sentiment indicator and be considered as a valuable investment portfolio selection variable.

q Can also be interpreted as a wealth indicator in the sense that value is created or destroyed because the enterprise is able to utilise the installed asset base and unlock unique value, thereby creating a competitive advantage that the market recognises. Consequently, when adjusting the *q* ratio of a firm according to market analysis, it must be considered whether value would be generated. Therefore, a high *q* value would indicate that the market identified the value creation ability of the firm and increased the *q* value. The contrary is true for a low *q* value, which is classified as destroying value (INET BFA Research Domain, 2014b).

2.3.2 Difference between Price to Book and Tobin's *q*

Important differences exist between PB and Tobin's *q* ratio. The numerator can be referred to as enterprise value because it comprises of all interest bearing debt and not only ordinary shareholders' equity. The denominator includes all inflation adjusted productive assets of the company instead of a PB value that is based on shareholders' interest and funds (INET BFA Research Domain, 2014b).

Table 1 presents the *q* ratio and the PB ratio of a franchise restaurant chain in South Africa, Spur (Pty) Ltd., from 1992 until 1995. During this period Spur managed to create value for its shareholders. The *q* ratio increased above the PB value from 1994 to 1995 while the PB ratio decreased below *q*. This could be attributed to an increase in market value, gearing or assets' adjustment due to inflation. Conversely, on occasion the PB was higher than *q,* possibly due to a reduction of corporate debt or asset valuation differences because PB is not annually adjusted for inflation.

Table 1: Price to Book value compared to Tobin's q (INET BFA Research Domain, 2014b)

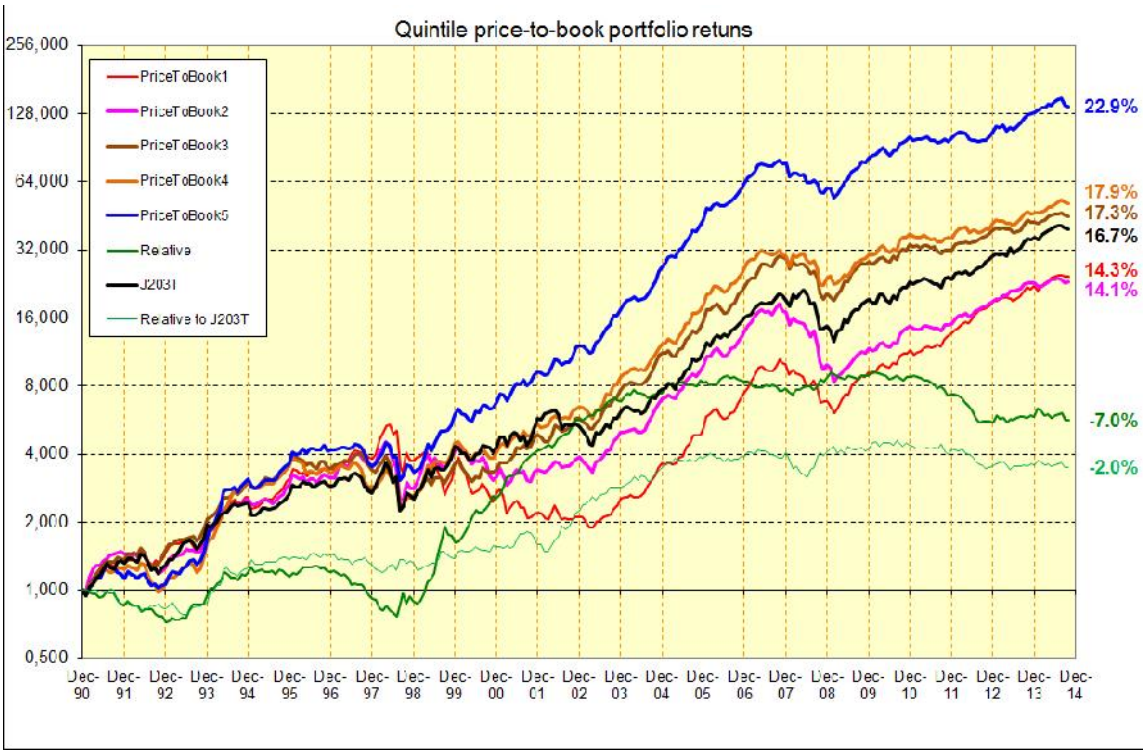
	1995		1994		1993		1992	
Enterprise	**Q**	**PB**	**Q**	**PB**	**Q**	**PB**	**Q**	**PB**
Spur	13,15	9,51	10,80	12,80	9,12	15,57	3,81	6,19

This example illustrates the importance of adjusting for inflation in company analysis and using replacement cost to determine whether a company is creating value rather than using historic asset values. The *q* ratio therefore provides a more realistic value creating perspective relative to PB (INET BFA Research Domain, 2014b).

2.3.3 Price to Book as an investment style

Muller and Ward (2013) investigated the PB value indicator as an investment style and an updated result is displayed in Figure 4. Similar to PE discussed in Section 2.1.1, "PE performance as an investment style". PB demonstrates that quintile portfolios selected based on PB yields different results, concluding that an investment style exists. In this case, a quintile portfolio consisting of low PB valued companies outperformed a quintile portfolio comprising of high PB valued companies by an annual relative difference of 7,0%.

Figure 4: Price to book quintile portfolio returns



PB however does not demonstrate the same consistency as PE, because from approximately 2004 the different ranked portfolios failed to continue to display the significant difference in returns as presented by the relative line in Figure 4. One of the objectives of this research was to investigate whether Tobin's *q* is a better value indicator than PB, and

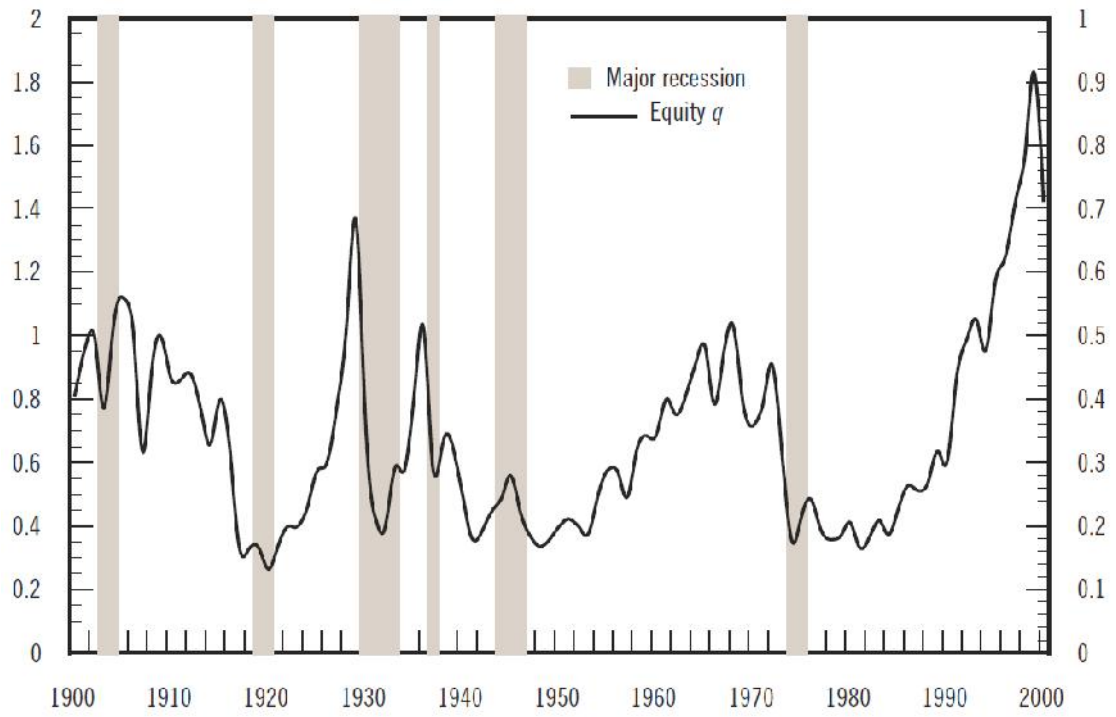
whether the *q* ranked portfolios yielded different results and displayed the necessary consistency to classify it as an investment style.

2.3.4 Tobin's *q* as an index

The Efficient Market Hypothesis has been a topic of widespread debate. Smithers and Wright (2002) argued from statistical evidence that there is a degree of predictability in stock markets. One of the dominant features that support their theory is the evidence of overall market mean reversion. Historically high stock market returns were followed by periods of low returns. Valid value indicators like Tobin's *q* cannot methodically deviate excessively from the fundamental values, thus enabling the ratio to indicate time periods were the probability of a market correction has increased significantly. Thus, conceptually investing in a time period were the overall market *q* ratio is high might lead to disappointing future returns dependent on the investment horizon.

Figure 5 illustrates the major market recessions and equity *q* ratios. Equity *q* moved corporate debt to the denominator as opposed to the numerator. Wright *et al.* (2011) argued that the original Tobin's *q* has a restrained response to market fluctuations with debt as the numerator. Figure 5 has four clear equity *q* peaks before major recessions in 1906, 1929, 1937 and 1968. With the benefit of hindsight the "dot com" technology stock market collapse followed in 2000 after the highest historic equity *q* ratio.

Figure 5: q and major US recessions (Smithers & Wright, 2002)



Conversely, there are also years in which the equity *q* ratio was high and a recession did not follow, as evidenced in 1968. The peak of 1906 occurred shortly after the recession and 14 years elapsed before the recession of 1920. It must also be considered that the data integrity in the yearly 1900s was not as comprehensive as current data, as the predictive power appears to improve as the centuries progress.

The fundamental argument remains that the market value of the enterprise cannot deviate excessively from the replacement value of the underlying assets that generate the future cashflow. In such an event a market correction ultimately follows due to the inaccurate pricing, albeit late. One of the objectives of this research was to calculate a Tobin's *q* index for the JSE to determine whether market corrections followed after high Tobin's *q* values.

2.3.5 Tobin's *q* criticism

The concept of *q* in a competitive economy is that the market fairly values equities such that the market value is equivalent to the cost of production or the replacement value (Wright et al., 2011). In principle Tobin's *q* can be determined, in practice however it presents many challenges (Erickson & Whited, 2006). According to Erickson and Whited (2006), accounting

does not keep instantaneous records of debt and replacement value of assets, especially intangible assets, thereby rendering it impossible to determine the true Tobin's *q* but rather accounting provides an estimate thereof.

For this reason, Tobin's *q* was calculated on aggregate level for the ALSI over a period of 24 years to establish the mean value for Tobin's *q* in South Africa. The calculated mean was considered to be the comparative long-term average value. In addition, this concern was further addressed as the research sought to establish the most appropriate manner in which to calculate Tobin's *q* on firm level from financial statement information.

2.4 Different estimates for *q*

Tobin's *q* ratio formed the foundation of the research and it was absolutely imperative to employ the correct method used to calculate Tobin's *q.* The true value of *q* can only be estimated because the real replacement value to all assets needed to generate revenue cannot be accurately established on an instantaneous basis. The replacement value can however be estimated for a specific firm at a particular point in time. This section of the literature review therefore investigated different methods for calculating Tobin's *q* to select the most appropriate method for the research.

2.4.1 Initial Tobin's *q* estimate

A simplistic *q* estimate defines the numerator "market value of firm" as the sum of market capitalisation and total liabilities. The replacement value is defined as the total assets, including intangible assets. The problem with the simple estimate is that the replacement value of the assets is inaccurate because the value is not adjusted for inflation. Conceptually the only difference between this simplistic *q* and PB is that liabilities are included in the numerator.

In order to determine whether or not a more accurate *q* is needed for the research, the actual *q* values were calculated using the simplistic method. The results are comprehensively discussed in Section 5.2 of this research report entitled "Simple Tobin's *q* portfolio returns~~Simple Tobin's *q* portfolio returns~~". However, the empirical test illustrated that the calculated *q* values were sporadic and a pertinent investment style does not transpire. The initial research concluded that a more sophisticated method is required to estimate *q* values.

2.4.2 Lewellen and Badrinath's (1997) method

In the response to different *q* estimation methods, Erickson and Whited (2006) compared different *q* estimates by associating the replacement cost determined by the *q* proxy with the net known actual capital expenditure per year for a sample of firms. A measure of one would then indicate a perfect approximation. The study concluded that the best estimate is the Lewellen and Badrinath (1997) method, with a value of 0.616. The authors concluded that even the most sophisticated method is still an approximation and that "other elaborated methods for calculating the replacement value of assets and the actual market value of liabilities appear to add little in the way of measurement quality beyond the use of simple balance sheet figures" (Erickson & Whited, 2006, p3).

Lewellen and Badrinath (1997) were concerned about the different methods used to estimate Tobin's *q* especially because the ratio is used to measure firm performance. The authors investigated the presence of a downward bias in the calculation methods because book values were used to determine *q* values. Secondly, the authors wanted to improve the current methods by constructing a model whereby a more realistic asset replacement value was determined. The authors concluded that current methods had an inherent downward bias ranging between 10% and 20%.

In order to accurately determine the firm's debt obligation, the company-specific coupon and maturity structures are required to be known, as well as the firm's credit quality. These requirements cannot be retrieved from standard data sources; therefore alternative estimation methods have been developed. Lewellen and Badrinath (1997) followed the United States National Bureau of Economic Research estimation, initially suggested by Brainard, Shoven, and Weiss (1980), that estimated the market value of long-term debt by assuming the debt maturity structure, yield and a coupon rate. It is assumed that all firms issue debt commensurate with each other, have a debt maturity of 20 years and a coupon rate equivalent to the yield of a newly issued bond with a Baa rating from Moody's. The evolving Baa rating is used to determine the estimated market value of long term debt. The market value of short-term debt is assumed to be equivalence to book value, (Lewellen & Badrinath, 1997).

Lewellen and Badrinath (1997) developed a method to determine the different vintages of the installed assets in a particular financial year in order to calculate Tobin's *q*. The vintage is the specific year in the economic life cycle of the asset that needs to be used in the

calculation. For instance, two identical assets purchased at different time periods have a different vintage and consequently different remaining life when *q* is calculated. The vintages therefore allow the method to determine what percentage of the previous year's assets is still usable.

Lee and Tompkins (1999) used the following numeracy to describe Lewellen and Badrinath's *q* (L-B-Q) as:

$$L-B-Q = \frac{Total\ market\ value\ of\ outstanding\ securities}{Total\ replacement\ cost\ of\ net\ assets}$$

$$= \frac{MV(CS)+MV(PS)+MV(LTD)+BV(STD)}{BV(TA)-BV(FA)-BV(INV)+RV(FA)+RV(INV)-[BV(TL)-BV(LTD)-BV(STD)]}$$

where: $MV(CS)$: market value of common stock

$MV(PS)$: market value of preferred stock

$MV(LTD)$: market value of long term debt

$BV(STD)$: book value of short term debt

$BV(TA)$: book value of total assets

$BV(FA)$: book value of fixed assets

$BV(INV)$: book value of inventory (FIFO method)

$RV(FA)$: replacement value of fixed assets

$RV(INV)$: replacement value of inventory

$BV(TL)$: book value of total liabilities

$BV(LTD)$: book value of long term debt

$BV(STD)$: book value of short term debt

Essentially the major adjustments in the L-B-Q method seek to determine a better replacement value for assets, estimate inventories using FIFO and to adjust long-term debt.

2.4.3 McGregor BFA's Tobin's *q* estimate and adjustments

McGregor BFA estimated Tobin's *q* in an almost identical manner to the L-B-Q method. The numerator comprised of: market capitalisation; minority interest; preference share capital; total long-term loan capital; short-term borrowings; and bank overdraft. The denominator consisted of total fixed assets at book value; inflation adjustment to the book value of other fixed assets (excluding land and buildings); net current assets; market value listed investments; directors' valuation of unlisted investments; shares in unconsolidated subsidiaries; balance sheet Last In First Out Inventory (LIFO) adjustment; cost of control of subsidiaries and intangible assets, (INET BFA Research Domain, 2014b). The differences and adjustments to the values used to estimate the ratio have to be understood before a method can be selected. These differences are elaborated on below.

Minority Interest is the interest of the outside shareholders in the subsidiaries. It is calculated using the paid-up ordinary share capital, the outside shareholders' portions in the distributable and non-distributable reserves, and the interest in any preference shares of subsidiaries (INET BFA Research Domain, 2014a). It therefore increases the market value of equity and should be included in the numerator.

Long-term loan capital includes that all funds obtained that are not repayable within an annual period. It is the sum of secured long-term borrowings, debentures and other long-term borrowings. Debentures include all classes of debentures. Other long-term loans include all long-term group loans and loans from fellow subsidiaries (INET BFA Research Domain, 2014a). Although there is not an adjustment the line represents the firm's total book value.

Bank overdraft refers to the total bank overdrawn amount determined from current assets, (INET BFA Research Domain, 2014a), which is not included in the L-B-Q method but influences corporate debt.

Inflation adjustment other fixed assets denotes the exclusion of land and buildings. Due to constant inflation, the replacement value of fixed assets is understated in the statement of financial position. As a result a standardised method was established by McGregor BFA to rectify this understatement by determining the replacement value of the other fixed assets. The method considers two important factors; the average age of the assets and a non-electrical machinery adjustment index for the time period under consideration. The average age is determined by dividing accumulated depreciation by current depreciation. McGregor

has found that this method works effectively (INET BFA Research Domain, 2014a). This method does not back date annual investment to determine replacement value, but is nonetheless considered to be a fair average method.

Market value listed investment presents the listed value of investments on a public exchange. If no value is available the book value is used (INET BFA Research Domain, 2014a). It is another line item not included in the L-B-Q method that influences replacement value because this is a holding generating income in some form. The argument holds true for *Directors' valuation of unlisted investments* and *Investments in unconsolidated subsidiaries*.

Cost of control of subsidiaries includes the excess difference between cost of the shares of subsidiaries and the value on the acquisition date. The nature of this line item is classified as intangible assets (INET BFA Research Domain, 2014a). In addition to cost of control, intangible assets are included in the McGregor BFA method. Although intangible assets are excluded in many analyses, McGregor BFA included it for the *q* estimate, to have a value consistently included effectively alters the base from which comparisons are made.

In comparison, McGregor BFA does not have significant differences to the L-B-Q method. More financial line items are included, thereby improving the estimates for replacement cost and corporate debt. Assets are adjusted on estimating average depreciation and inflation for a more realistic replacement value. The only difference is that McGregor BFA does not alter the long-term debt value, even though more line items are included.

2.4.4 Method selected for calculating Tobin's *q* in research

The literature study concluded that the method used by McGregor BFA has a fundamental sound theoretical base because the necessary adjustments are made to the simplistic *q* estimate. The adjustments are made in two forms; (i) financial statements used for analysis are standardised to have consistent assumptions when analysing companies; (ii) the necessary line items are included for a sophisticated *q* estimate.

For this reason, the study employed McGregor BFA's estimate for Tobin's *q*. Both formats of financial statement line items were examined to determine the reporting formats that yield the most desired results, if any. An elaborated explanation of the standardised format used is discussed in Section 4.2.4, entitled "Standardised financial statement format of dataStandardised financial statement format of data."

2.5 Adjusted *q*

Once the correct method was established to determine an appropriate *q* the current study augmented the method to include a production cost function to estimate *q* in a different manner, similar to the method employed by Belo *et al*. (2013). The main purpose for Belo *et al.'s* (2013, p1) decision was to use input variables or "managers' supply of capital assets." to value a frim. The only variables utilised were current investment relative to capital but these were adjusted by historic determined cost function variables.

2.5.1 The Adjusted *q* estimate

It was assumed that managers would behave to maximise firm profits by adjusting the supply of capital assets in response to changes in the environment and market valuation of equity. Theoretically, investment increased until the marginal benefit of one additional unit of asset was equivalent to the marginal cost of supplying the extra unit. The marginal benefit was the present value of the future cashflow generated by the additional unit, defined as marginal *q* (Belo et al., 2013).

Marginal cost of investment can be inferred with an adjusted cost function by analysing actual investments made by the firm relative to current installed assets. Because of the assumption regarding managers' behaviour, marginal *q* can be inferred from marginal cost. Assuming constant returns to scale, marginal *q* is used to estimate the firms effective asset base (Belo et al., 2013). Thus, the approach provides an alternative method to estimate the enterprise value of the firm or the numerator of Tobin's *q*.

Operating profits of a firm at any point in time can be mathematically presented by a Cobb-Douglas production function, as defined by Belo *et al*. (2013):

$$Q(NA_{it}, X_{it})$$

with: i : a specific firm

t : beginning of time period

NA : net assets

X : vector of exogenous and firm specific shocks

The marginal product of the Cobb-Douglas production function selected by Belo *et al*. (2013) with respect to *NA* is differentiated as:

$$MPK = \frac{\partial Q}{\partial NA} = \frac{kY_{it}}{NA_{it}}$$

with: k : the capital's share of the output

Y_{it} : revenue

Annual *NA* growth is a function of the capital expenditure during the financial year, *CAPEX,* and the depreciation percentage of the year, *Dep*, expressed as, according to Belo *et al.* (2013):

$$NA_{it+1} = CAPEX_{it} + (1 - Dep_{it})NA_{it}$$

When a firm invests in new assets, it has different operational costs which are expressed in the adjustment cost function. The function selected by Belo *et al*. (2013) is exponential, has constant returns to scale, increasing and convex in *CAPEX* and decreasing in *NA*. Thus, marginal cost of investment as a function of *CAPEX* and *NA* is expressed as:

$$MCI(CAPEX_{it}, NA_{it}) = \frac{1}{v}\left(\eta \frac{CAPEX_{it}}{K_{it}}\right)^{v} NA_{it}$$

with: n : slope parameter of the adjustment cost function

v : is the curvature parameter of the adjustment cost function

It is assumed that the debt to finance the investment has to be repaid at the end of the financial year. Belo *et al.* (2013) then expressed the dividend of the firm after the financial year as:

$$Div_{it} \equiv (1 - TaxRate)[Q(NA_{it}, X_{it}) - MCI(CAPEX_{it}, NA_{it})] - CAPEX_{it} + Debt_{t+1} - IntExp_{iit} + DepTaxShield_{it} + IntTaxShield_{it}$$

with: $TaxRate$: the corporate tax rate

$Debt$: debt of the firm

$IntExp$: interest expense

$DepTaxShield$: depreciation tax shield

$IntTaxShield$: interest tax shield

Given the assumption regarding managements' behaviour, the firm chooses the optimal capital structure to maximise the after-dividend equity value. The model is dynamically optimised subject to a transversality condition and finally expressed as, according to Belo *et al*. (2013):

$$Equity_{it} + Debt_{it} = \left[1 + (1 - TaxRate)\eta^{\nu}\left(\frac{CAPEX_{it}}{NA_{it}}\right)^{\nu-1}\right] NA_{it+1}$$

Equity and debt is the enterprise value, or the numerator used to calculate Tobin's *q*. Therefore, adjusted *q* is expressed as done by Belo *et al.* (2013):

$$q = \left[1 + (1 - TaxRate)\eta^{\nu}\left(\frac{CAPEX_{it}}{NA_{it}}\right)^{\nu-1}\right] \frac{NA_{it+1}}{A_{it}}$$

with A : total assets

From the expression above it is apparent that rather different *q* values are determined for firms as opposed to the previous expressions for Tobin's *q*. The slope parameter and curvature parameter of the adjustment cost function is inferred from Tobin's *q* and is used to estimate adjusted *q.* Belo *et al.'s* (2013) expression for adjusted *q* remains attractive

because it is a recent alternative estimation for enterprise value and consequently share valuations.

The chapter revealed that Tobin's *q* is regarded by many as a superior overall market value indicator because of its sound fundamental principles. An index based on an accurate estimate of Tobin's *q* ratio could therefore provide investors with a general market valuation, leading investors to alter investment decisions. Because Tobin's *q* index does not exist for the JSE, this research contributed to the investment community's body of knowledge by constructing a new value index. Value indicators, PE and PB, display overall market valuation characteristics and portfolio level style effects. Due to Tobin's *q* esteem, this research investigated whether Tobin's *q* provided superior and consistent style effects on portfolio level over a 24 year period. Finally, this research paper investigated whether the adjusted *q,* developed by Belo *et al.* (2013) valued the firms differently, consequently altering the portfolio selection to examine whether the investment returns improved.

CHAPTER 3: RESEARCH HYPOTHESES

Based on the literature review, the following hypotheses were tested in order to answer the established research objectives.

3.1 Research hypotheses

3.1.1 Tobin's *q* index for the ALSI

The first part of the research aimed to identify time frames where the ALSI based on Tobin's *q* index was above or below the long-term average of Tobin's *q*, representing times of possible over and under valuations.

The null hypothesis states therefore that Tobin's *q* is a representative measure of market value. The alternative hypothesis consequently states that Tobin's *q* is not a representative measure of market value.

H_{10}: Tobin's *q* is a representative measure of market value.

H_{1A}: Tobin's *q* is not a representative measure of market value.

3.1.2 Tobin's *q* as an investment style

In order to establish whether an investment style exists, based on simulated investment portfolios using calculated Tobin's *q* as the portfolio selector, there had to be a clear cumulative return difference between the highest and lowest ranked portfolios. The exact methodology is explained in Chapter 4 of the research report. Thus, the second null hypothesis states Tobin's *q* displays a significant and persistent investment style. The alternate hypothesis therefore states Tobin's *q* does not display a significant and persistent style.

H_{20}: Tobin's *q* displays a significant and persistent investment style.

H_{2A}: Tobin's *q* does not display a significant and persistent investment style.

In order to establish relative performance, the resultant cumulative investment returns were compared to the ALSI, PE and PB selected portfolios.

3.1.3 Adjusted *q* as an investment style

The final part for the research established whether the Cobb-Douglas production function can improve the portfolio selection and consequently investment returns. Assuming that Tobin's *q* displays an investment style similar to other market based styles, the null hypothesis states that adding a Cobb-Douglas production function improves investment returns using portfolios constructed by adjusted *q*. The alternate hypothesis thus states that adding a Cobb-Douglas production function does not improve investment returns.

H_{30}: Adding a Cobb-Douglas production function improves investment returns.

H_{3A}: Adding a Cobb-Douglas production function does not improve investment returns.

3.2 Research Objectives

Table 2~~Table 2~~ presents the specific research objectives for each of the sequential steps discussed.

Table 2: Research objectives

Research purpose	***Research objectives***
1. Tobin's *q* index for the ALSI	Identify time periods where the market was either overvalued or undervalued based on the calculated Tobin's *q*.
	Calculate the long-term average of Tobin's *q* for the ALSI as a long-term value indicator for the JSE.
2. Tobin's *q* as an investment style	Develop a style engine modeller in Microsoft Excel that determines the cumulative investment returns for hypothetically Tobin's *q* created portfolios.
	Compare the relativeness between the different *q* portfolios to determine whether an investment style exists.
	Compare the returns against benchmark indices such as the ALSI, PE and PB constructed portfolios.
3. Adjusted *q* as an investment style	Add the Cobb-Douglas production function to Tobin's *q* and use the newly constructed variable, Adjusted *q*, to construct hypothetical investment portfolios.
	Compare the returns against benchmark indexes, in this case Tobin's *q'*, with the ALSI, PE and PB constructed portfolios.

CHAPTER 4: RESEARCH METHODOLOGY

Chapter 4 rationalises the methodology used in the research, stipulates the population, explains the sample selection, defines the research instrument and discusses the analysis of the data. The chapter concludes with a specification of the limitations of the research.

4.1 Research method and design

Exploratory research was conducted to determine whether a Tobin's *q* index exists for the JSE and if Tobin's *q* is used as an investment style. The research found that an index does not exist for the JSE and that Tobin's *q* is not currently used as an investment style. Tobin's *q* as an index is calculated for other global markets but not for South Africa. The hypotheses were tested using historical ALSI data.

4.1.1 Tobin's *q* index for the ALSI

The analysis of the first research hypothesis was both quantitative and descriptive since the index is an indicator for overall market sentiment.

An index was calculated for the ALSI dating back to 1990 and is presented graphically. The graphical representation indicates relativeness to the long-term average when the market was overvalued and when the market was undervalued. The identified dates were then compared to historical lows and highs of the JSE to determine the extent of Tobin's *q* as an accurate measure for valuing the JSE. The calculated *q* index was also compared with the popular ratios as an index for similarity and differences. In determining annual Tobin's *q* values for the index, currency adjustments were made if the company did not report in South African Rands. The market capitalisation used was at calendar year-end and not on financial year-end because the analysis sought a real-time indication at calendar year-end.

4.1.2 Tobin's *q* as an investment style

To determine whether Tobin's *q* constructed investment portfolios yield different investment returns, cumulative returns of each portfolio are graphically presented over the comparison time frame. The method is therefore quantitative and experimental. In this case the market

capitalisation used to estimate Tobin's *q* was delayed by three months to prevent forward bias.

The expectation is that the cumulative returns of the different portfolios separate, thereby indicating that there is a significant difference between the portfolios. Over time the expectation is that the relative difference between the portfolios increases, thereby concluding that there is a relative benefit in investing in certain Tobin's *q* constructed investment portfolios.

4.1.3 Adjusted *q* as an investment style

Adjusted *q* constructed investment portfolios yield different investment returns if Tobin's *q* is established as an investment style.

Cumulative returns of each portfolio are graphically presented over the comparison time frame. Therefore, the method is quantitative and experimental to investigate the persistence of an investment style and is causal in nature to determine whether adjusted *q* performs differently to Tobin's *q* as the selection variable.

As with Tobin's *q* the expectation is that there are relative differences between the compounded returns of the different portfolios. In order to establish whether the cost function indeed has an effect, the cumulative returns of adjusted *q* were compared against Tobin's *q*.

Microsoft Excel Solver was used to ascertain the optimal values for the slope and curvature parameters. The slope and curvature parameters were determined per industry sector with the goal to calculate a more accurate adjusted *q* per sector that would enable an investor to identify better investment opportunities.

4.1.4 Justification for time series approach

Cumulative returns have a compounding component that can significantly influence the returns of long-term investments. Many investment studies compare portfolio returns using the t-test to test for significant difference. Using the t-test excludes the compounding component and might lead to drawing conclusions from the wrong outcome. Therefore the same approach was employed as performed in the recent South African study by Muller and

Ward (2013), using a time series. The cumulative value of each portfolio was plotted against the analysed time frame.

Significant and persistent differences between the different portfolios and the competitive index ideally need to be identified. To assist with this interpretation, a relative index between the highest and lowest ranked portfolio was added to the time series graph. The slope of the relative graph represented the difference in cumulative returns between the highest and lowest ranked portfolio. The selected benchmark index is also illustrated on the graph for comparison.

4.2 Sample selection and justification

4.2.1 Data population

All the shares listed on the JSE.

4.2.2 Sample

Historically the JSE has had more than 350 companies listed, and on average 160 of the listed companies represented 99% of the total market capitalisation. The All Share Index (ALSI) represents the 160 largest companies (Muller & Ward, 2013). Companies excluded from the ALSI are subsequently excluded for the research because these companies are considered too small in comparison, and are also classified as too illiquid.

Except for the market capitalisation consideration, the specific type of company needed to be consistent with Tobin's *q* definition, where a company purchases strategic assets and forms a value chain for the purpose of revenue generation. Therefore, property companies, financial institutions and insurance companies were excluded from the analysis. The sample construction is congruent with the research completed by Andrew Smithers, where *q* is calculated for U.S. non-financial stocks only (Tower, 2012).

Mining companies were excluded because mining companies' values are significantly influenced by currency fluctuations, commodity price fluctuations and the value of the actual ore body. Published financial statement data was populated by McGregor BFA from 1988 and standardised from 1971. In order to compare the standardised and published

information over the same time series, the year 1990 was selected to commence the analysis of data.

4.2.3 Integrity of the data used for analysis

The data base that was used for the analysis consisted of 24 years of JSE share price data and company financial statements dating back to 1990 from McGregor BFA. The data include all listed, delisted and newly listed companies for the time period. Backward adjustments were made for share splits or consolidations in the time series data (Muller & Ward, 2013).

If a company unbundled a subsidiary, returns of the newly listed subsidiary were included with the original holding company for the remaining quarter. Thereafter, the entities were treated separately (Muller & Ward, 2013). Dividend proceeds can influence investment yields significantly and were therefore included in the share return data. The same argument holds for scrip dividends. Share buybacks were treated as capital reduction and were therefore excluded. Furthermore, shares issued to company management were ignored (Muller & Ward, 2013).

Newly listed companies were only added to the data base the next quarter and delisted shares were removed at the end of the quarter at their last price, prior to the cessation of trading. Name changes were corrected to the inception date of the data basis. Daily share price data errors were treated by setting the daily share price returns to be equivalent to zero (Muller & Ward, 2013).

4.2.4 Standardised financial statement format of data used in analysis

Companies apply account settlements and classifications inconsistently because General Accepted Accounting Practices are interpreted differently. Due to this practise, it is unrealistic for analysts to draw meaningful conclusions from analysis and comparisons purely from published financial statements. In order to resolve this matter McGregor BFA developed a standardised system or a standardised financial statement format (INET BFA Research Domain, 2014a).

The standardised financial database format adjusts published line items by applying consistent rules to all released published financial statements. The detail required for the

conversion is disclosed in the notes of the published financial statements. Effectively, McGregor BFA converts the statements to a comparable format. This process enables analysis to be consistent in order to create valuable and reliable interpretations from analysis.

For this reason, the data used for analysis in this research was primarily in the standardised format. The published format was used to determine whether there is a benefit in applying the standardised format in comparison to the published format. The results of these comparisons are discussed in CHAPTER 5: Results.

4.2.5 Unit of analysis

The unit of analysis is Tobin's *q* ratio, calculated as defined by the hypotheses.

4.3 Research instrument

The research instrument for data manipulation was developed in Microsoft Excel by using Visual Basic code and Microsoft Excel add-in formulas developed by Chris Muller, who is the research supervisor at the Gordon Institute of Business Science for this particular research project.

4.4 Research limitations

Because large market capitalisation companies were used to construct Tobin's *q* investment portfolios, inferences cannot be concluded for theoretical small market capitalisation constructed investment portfolios.

The data sample was limited to certain sectors in the economy and consequently the hypothetical investment portfolios were constructed based on these sectors. Therefore, inferences cannot be made for theoretical constructed investment portfolios that include all shares on the JSE.

Transaction costs for re-balancing the portfolios were ignored on the basis that the transaction costs would be approximately similar between the constructed portfolios and the difference in costs would therefore be irrelevant. Subsequently, the final compounded returns did not included transaction costs.

CHAPTER 5: RESULTS

Chapter 5 presents the results with sparse commentary of the research analyses according to the objectives that were formulated in Chapter 3.

5.1 Tobin's *q* index for the JSE

The initial objective was to create an annual Tobin's *q* index for the ALSI, and calculate the LTA Tobin's *q* for the ALSI and to present it graphically relative to the ALSI. The results of the initial research objective are presented in both McGregor BFA Tobin's *q* estimates.

5.1.1 Tobin's *q* index based on the published financial statements

Figure 6: Tobin's q index for the J203 based on published estimate

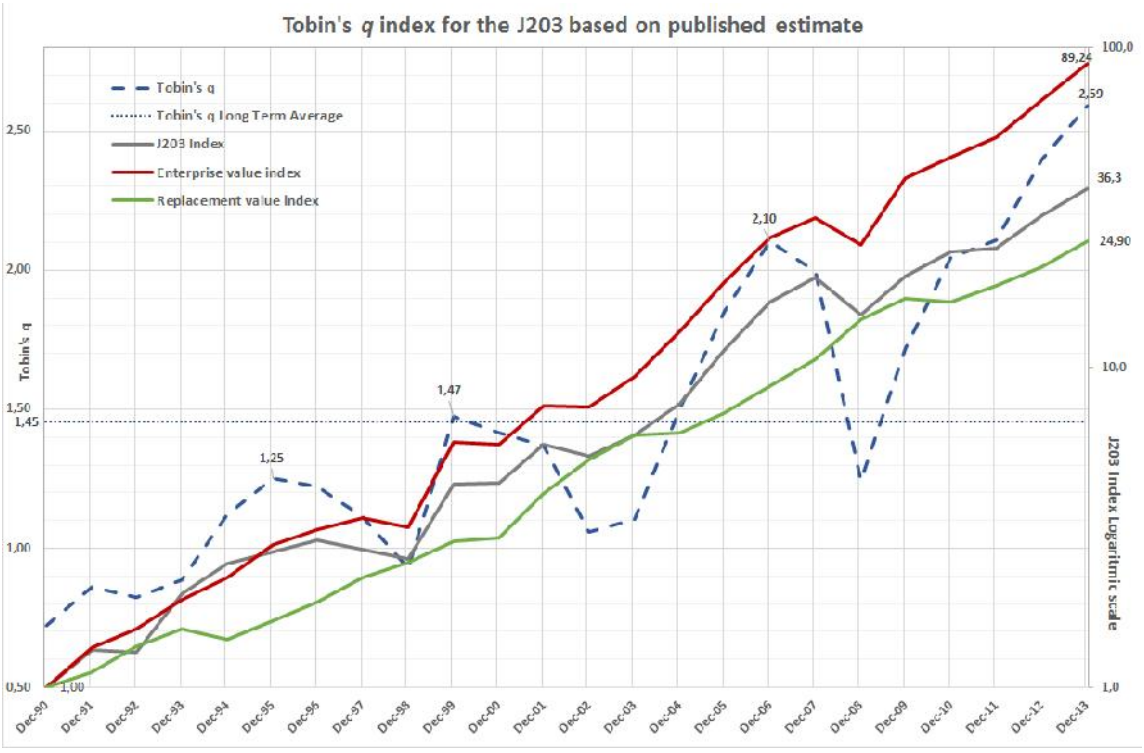
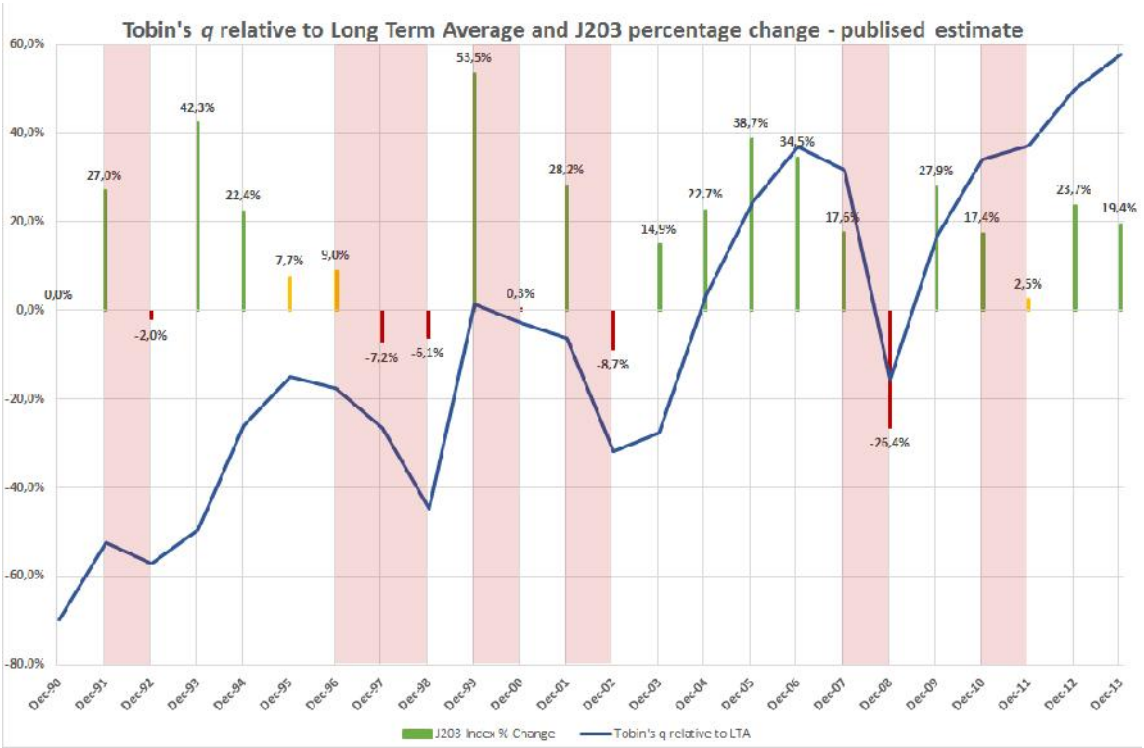


Figure 6 presents Tobin's *q* calculated by using the published data estimation from 1990 until 2013 in relation to the ALSI. The LTA for Tobin's *q* is 1,45. Tobin's *q* numerator or enterprise value is presented as an index by the red line and the replacement value as an

index by the green line. Replacement value seems to almost increase linearly, contrary to the enterprise index line. The enterprise line correlates more with the ALSI indicating that the *q* ratio's fluctuations originate from the market fluctuations. The relative value between the numerator and denominator increased and explains the consistently raising *q* value of 2,59 in December 2013. Given the LTA, Tobin's *q* marginally peaked above the LTA in 1999, remained above the LTA from 2004 until late 2007, before increasing again to the high of December 2013. Rather disturbingly, the index indicates that the market was almost 60% overvalued in December 2013.

According to Figure 6 the ALSI was overvalued in slightly in 1999, the again from 2004 until late 2007, and from mid-2008 the ALSI has been overvalued. Figure 7 presents the relative percentage between the annual Tobin's *q* value and the LTA. Furthermore Figure 7 presents the annual increase or decrease of the ALSI in the form of colour bars. Highlighted gridlines indicate the year over which the market contraction occurred. For instance, from 2007 to 2008 the index market capitalisation reduced by 26,4%.

Figure 7: Tobin's q relative to LTA and J203 annual percentage change – published estimate



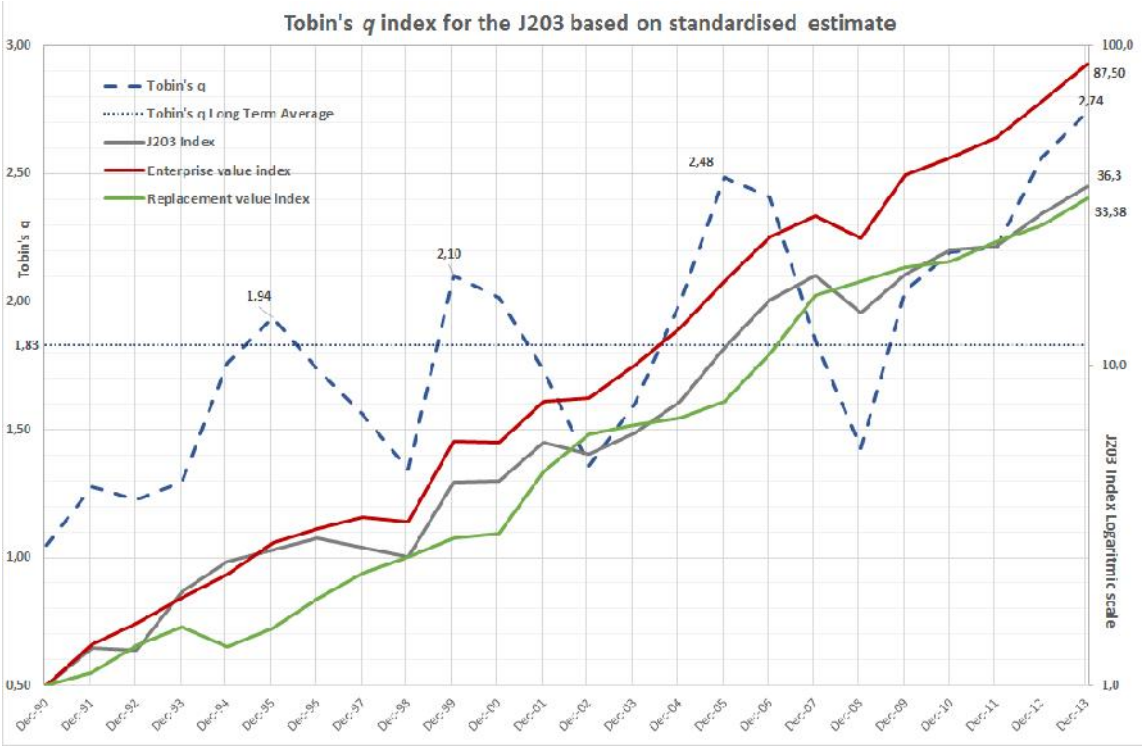
From Figure 7 it is apparent that a peak was followed by slower market returns and contrary for a base, which was followed with subsequent years of positive returns. Using the

published Tobin's *q* estimate indicates relative to its own LTA time periods when the market was overvalued or undervalued because the index is mean reverting. However, it is not a timing instrument but merely an indicator that the probability for a market correction increases relative to the increase of Tobin's *q*, and displays the time the index has been higher than the LTA. For instance, from 2004 Tobin's *q* remained above its LTA until the major value reduction in 2007.

5.1.2 Tobin's *q* index based on standardised financial statements

Interestingly determining the *q* ratio using the standardised estimate, the LTA average is increase to 1,83 from 1,45, and a third peak is indicated in 1995 as presented in Figure 8.

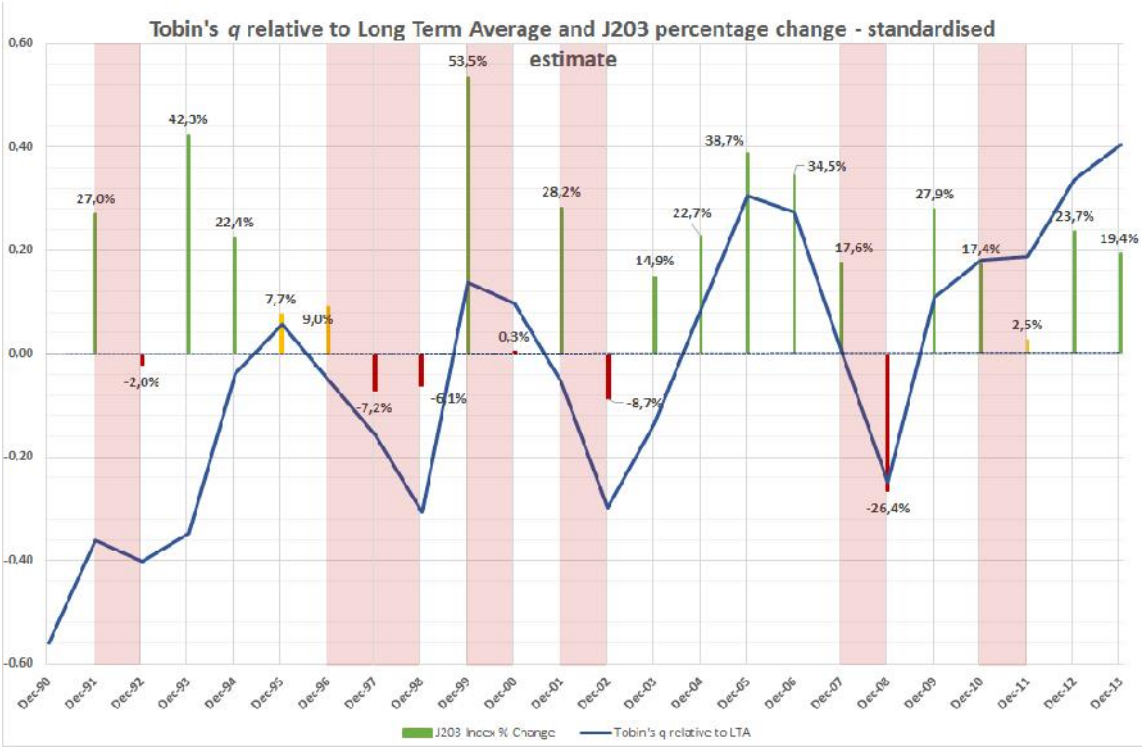
Figure 8: Tobin's q index for the J203 base on standardised estimate



Tobin's *q* index peaked in 1995, 1999 and 2005 based on standardised data. The index initiated low and was at a base in 1998, 2002 and 2008 from which it continued to rise to the current historic highest level of 2,74. Similar to the published estimate, the disconnection between the enterprise value and replacement value seem to increased, especially from 2008 until the current over valuation of 40,03% based on the index.

In comparison to Figure 7, Figure 9 emphasises a peak in 1995 with subsequent years of slow growth and market contraction. Other than the additional peak the graphs are very similar, although the value and importance of the additional peak should not be underestimated. Importantly, a low Tobin's *q* is followed by many years of positive return in all occurrences.

Figure 9: Tobin's q relative to LTA and J203 annual percentage change – standardised data



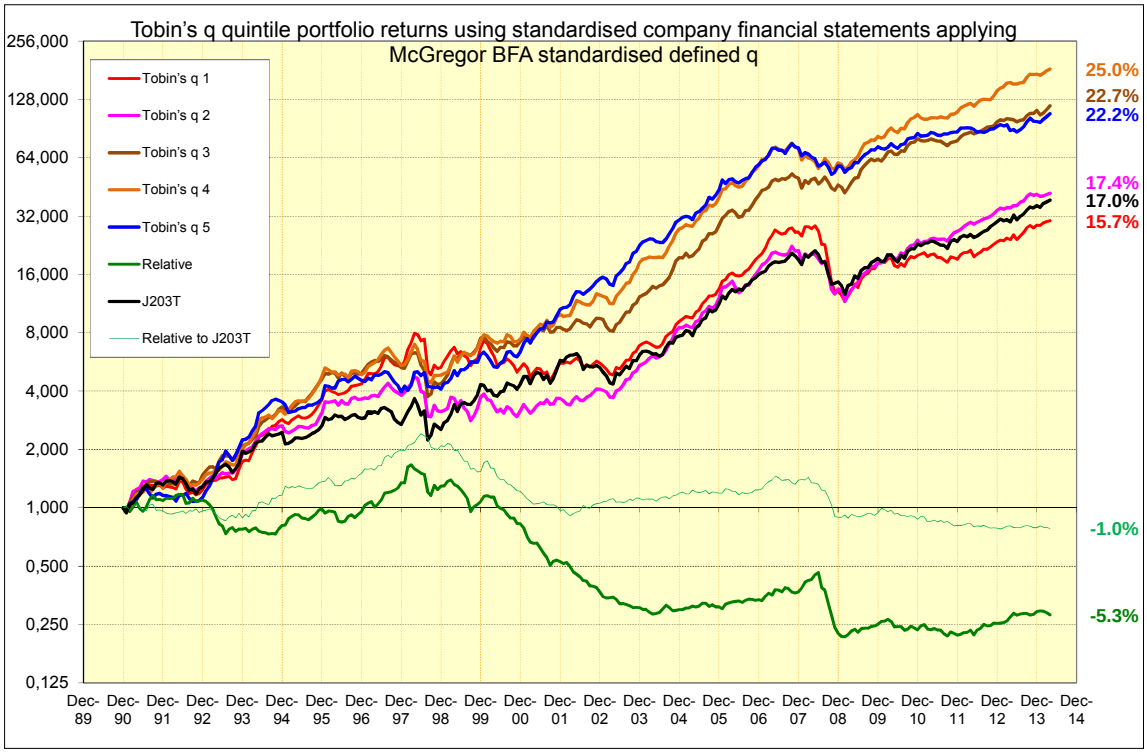
The objective was that Tobin's *q* index presented durations when the market was potentially overvalued or undervalued. Because Tobin's *q* index is mean reverting around its own LTA, this requirement was partly satisfied. More importantly, occurrences in the peak of Tobin's *q* index were followed by lower market growth and a Tobin's *q* index bottom was followed with substantial years of market growth. Given the results presented, the standardised format indicated an additional occurrence and is selected as the format of choice because the index better indicated the potential market adjustments.

5.2 Simple Tobin's *q* portfolio returns

The second objective was to test whether Tobin's *q* was an investment style by defining *q* as the variable for portfolio composition, while testing different holding periods and portfolio sizes for optimal yields.

The initial *q* tested was a very simple estimate for Tobin's *q*, as described in Belo *et al.* (2013), with enterprise value equivalent to the sum of market capitalisation at financial year-end and total prior liabilities. The denominator used was prior total assets that included intangible assets. Figure 10 presents the annual average quintile portfolio results if such an investment strategy was followed. The percentage numbers displayed on the right hand side of the graph represent the annual average percentage for the portfolio.

Figure 10: Simplistic Tobin's q quintile portfolio returns from published company financial statements



The low quintile portfolios seem to cluster with better performance in relation to the two portfolios formed with higher *q* values. The style functioned from 1997 until 2003, then the style reversed until mid-2007 and in 2008 the relative difference between the high quintile and low quintile portfolio was absent. The high quintile portfolios clustered to yield similar

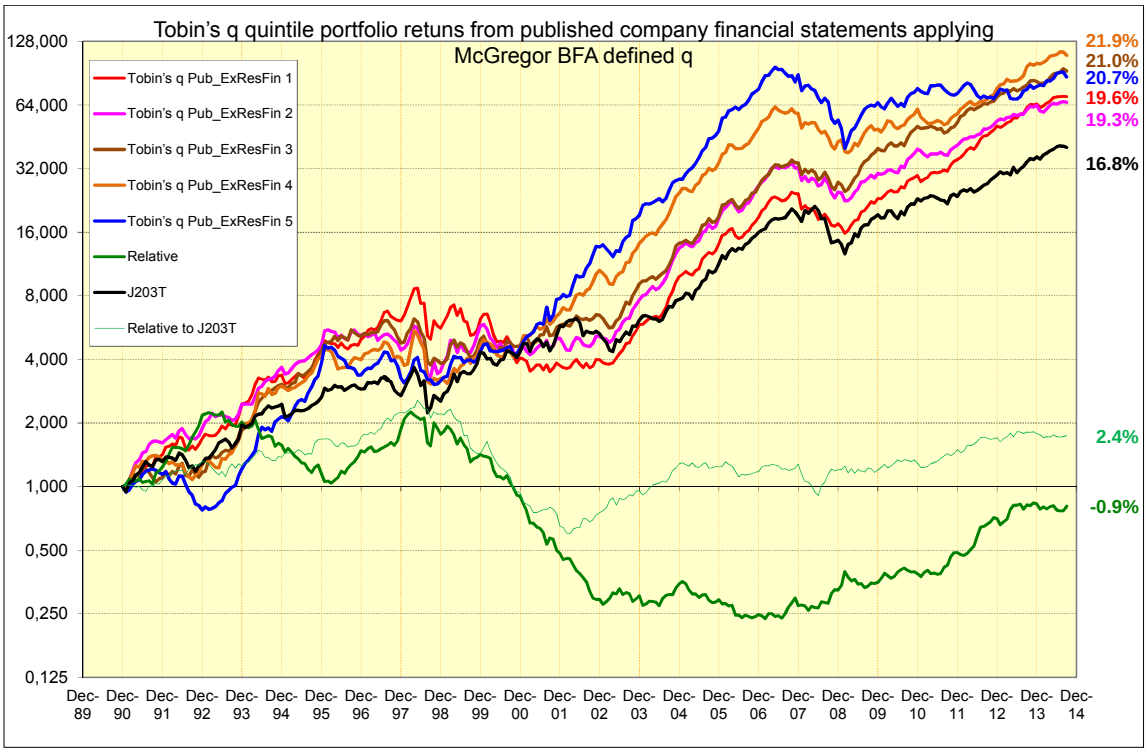
results as the ALSI. The spread between the portfolios indicates that portfolio selection improvements could be made. For the investment style to manifest, the spread between portfolios has to be widened, indicating that the optimal shares were selected per quintile. Thus, is seems apparent that an investment style might exist for Tobin's *q,* but forming investment portfolios based on a simple *q* had definite optimisation potential.

Further analysis of the actual *q* values calculated indicated that some of the *q* values ranged beyond realistic limits and were very unstable for many of the firms included in the sample. These initial empirical results supported the argument from the literature review that a more complex *q* formulation is required to estimate "true" *q* values for listed firms.

5.3 Portfolio returns using published financial statement defined *q*

The "published" *q* defined by McGregor BFA is very similar to the simplistic *q* tested. The numerator consists of: preference shares; outside shareholders interest; convertible debentures and long-term interest bearing debt. The denominator included: total assets excluding intangible assets; inflation adjusted other fixed assets and balance sheet LIFO adjustment. Figure 11 presents the annual average quintile portfolio results if such an investment strategy was followed.

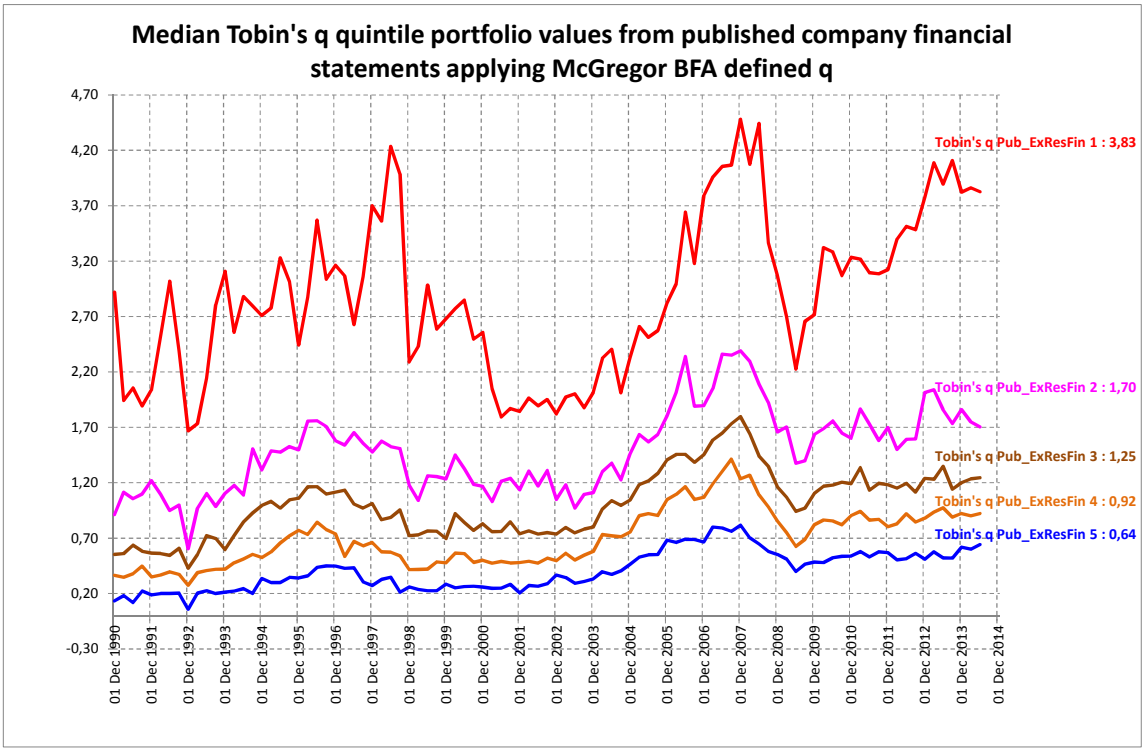
Figure 11: Tobin's q quintile portfolio returns from published company financial statements applying McGregor BFA defined q



Quintile portfolios formed based on McGregor BFA's published financial statements defined that Tobin's *q* creates a better spread between the different portfolios. However, the investment strategy completely reversed in some instances. The investment style was extremely lucrative from 1998 until 2002; unfortunately the relative yields remained stagnant and reversed from around 2008 until Sep 2014. It could potentially be an indication that investment sentiment changed in the early 2000s from following a value approach to a growth approach. All portfolios however outperformed the ALSI, meaning that more optimal selection can be done to filter for shares to increase portfolio yields.

Figure 12 presents the annual median *q* values of the analysed quintile portfolios over the time period. The values seem fairly stable with the exception of the highest quintile portfolio. The rising values also support the trend of the *q* values calculated in Figure 8. It can also be inferred that the high quintile portfolio seem systematically higher than the other four portfolios, implying that these shares are not marginally but rather significantly overvalued.

Figure 12: Median Tobin's q quintile portfolio values from published financial statements applying McGregor BFA defined q



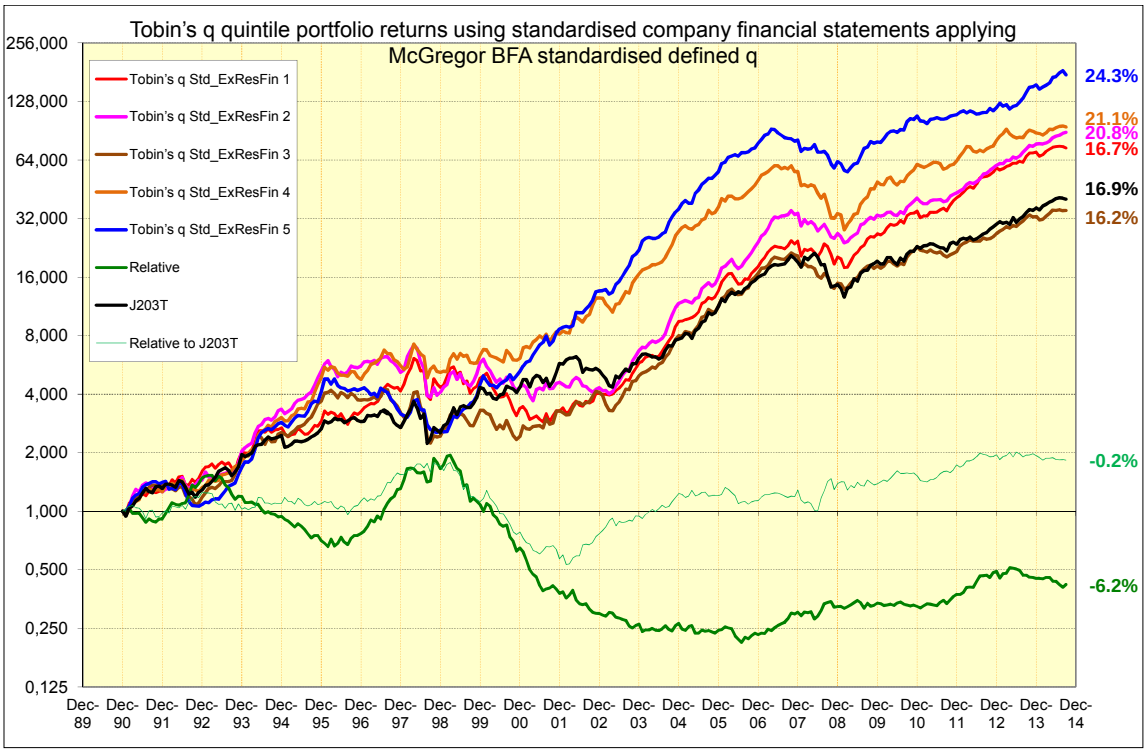
In conclusion, although this investment strategy produced better evened spreads, the strategy had two significant reversals. An investor selecting firms based on this estimate for Tobin's *q* could potentially select suboptimal firms because the value indicator did not produce consistent results over the time analysed. Alternatively, the investor requires the knowledge of when to switch from a value approach to a growth approach. For instance the low Tobin's *q* portfolio declined in performance from 2008, which could potentially indicate a period where growth stocks were the strategy of choice. Thus, due to this reversal, Tobin's *q* as an investment style based on the published data formulation is not a desired investment style.

5.4 Tobin's *q* portfolio returns using standardised financial statement defined *q*

McGregor BFAs' standardised financial statement format applies consistent accounting rules and adjustments to improve firm financial statement analysis. Consequently these adjustments alter the portfolio selecting variable *q* and the investment style results. It creates

uncertainty regarding the benefit of an investor who analyses Tobin's *q* with the adjustments as the portfolio selection variable. The formula applied for portfolio selection is discussed in Section 2.4.3 entitled "McGregor BFA's Tobin's *q* estimate and adjustments~~McGregor BFA's Tobin's *q* estimate and adjustments~~". Figure 13 presents the annual average quintile portfolio results if such an investment strategy was followed.

Figure 13: Tobin's q quintile portfolio returns from standardised company financial statements applying McGregor BFA standardised defined q

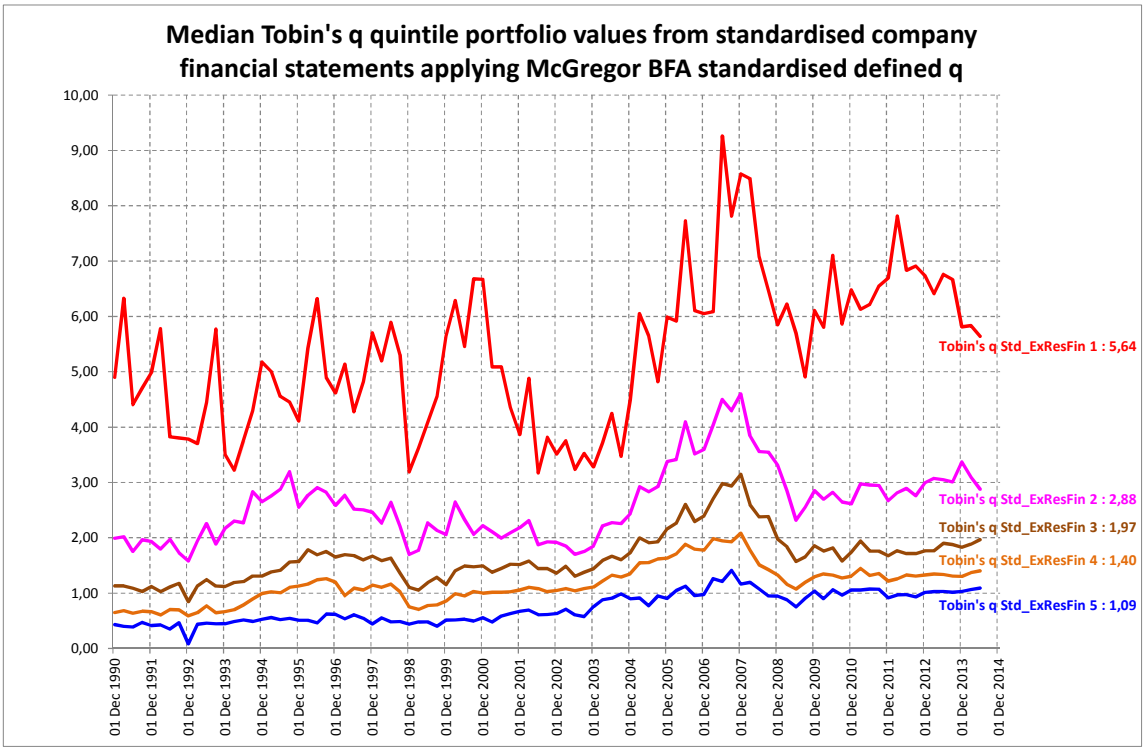


Standardised Tobin's *q* as an investment style reversed from 1995 until 1998, but after 1998 the low *q* selected portfolio's returns indicated constant style effects. The investment style worked exceptionally well from 1998 until mid-2004. During the ensuing years the high quintile portfolio performed slightly better after which the yields were similar. From 2012 the style continued such that the low *q* selected shares yielded higher returns than the high *q* selected shares. Relative to the other selection estimates for Tobin's *q*, the standardised style ends with best spread between the portfolios and the highest relative difference between the high quintile and low quintile portfolios.

Figure 14 presents the annual median *q* standardised defined values of the analysed quintile portfolios over the time period. Similar to Figure 12 all portfolios' *q* values are increasing and

it can also be inferred that the high quintile portfolio seems systematically higher than the other four portfolios.

Figure 14: Median Tobin's q quintile portfolio values from standardised financial statements applying McGregor BFA standardised defined q



Before the benefits, if any, of the cost function could be established the best estimate for Tobin's *q* had to be verified and the selected method had to present the most persistent investment style. Following the results presented and analysed, the standardised format generated the most persistent investment style with the greatest spread between the ranked portfolios. Standardised Tobin's *q* as an index for the JSE also provided a better estimate of overall market valuation supporting the argument for estimating Tobin's *q* using the standardised method. Consequently, the selected format to determine whether there were benefits of adding a cost function to Tobin's *q* is the standardised estimate.

5.5 Adjusted *q* as an investment style

In order to fulfil the requirement of the final research objective the curvature parameters for each industry sector had to be determined. The shares in each sector were clustered to determine the optimal parameters for the particular sector to estimate adjusted *q* values, similar to Belo *et al.'s* (2013) research. Detailed results of the actual parameters were calculated and these are presented in APPENDIX A: SUMMARY OF CURVATURE PARAMETERS.

5.5.1 Correlation between Tobin's *q* and adjusted *q*

The adjusted *q* expression appears to determine rather different *q* values per firm as opposed to the selected Tobin's *q* estimation method. In order to verify this assumption, the correlation coefficients between the *q* values were calculated. Because the adjustment cost function parameters were determined per industry sector, the correlation coefficients between the adjusted *q* values and Tobin's *q* values were determined for each industry sector. A summary of the results is presented in Table 3. Features of the correlation coefficients are presented in APPENDIX B: CORRELATION STATISTICS.

Table 3: Correlation coefficient between Tobin's q and adjusted q

Correlation coefficient per industry	
Oil & Gas	R^2
Construction & Materials	7,34%
Industrial Goods & Services	3,11%
Automobiles & Parts	0,14%
Food & Beverage	14,77%
Personal & Household Goods	1,74%
Health Care	7,75%
Retail	14,49%
Media	10,41%
Travel & Leisure	0,03%
Telecommunications	1,66%
Technology	16,31%
	0,16%

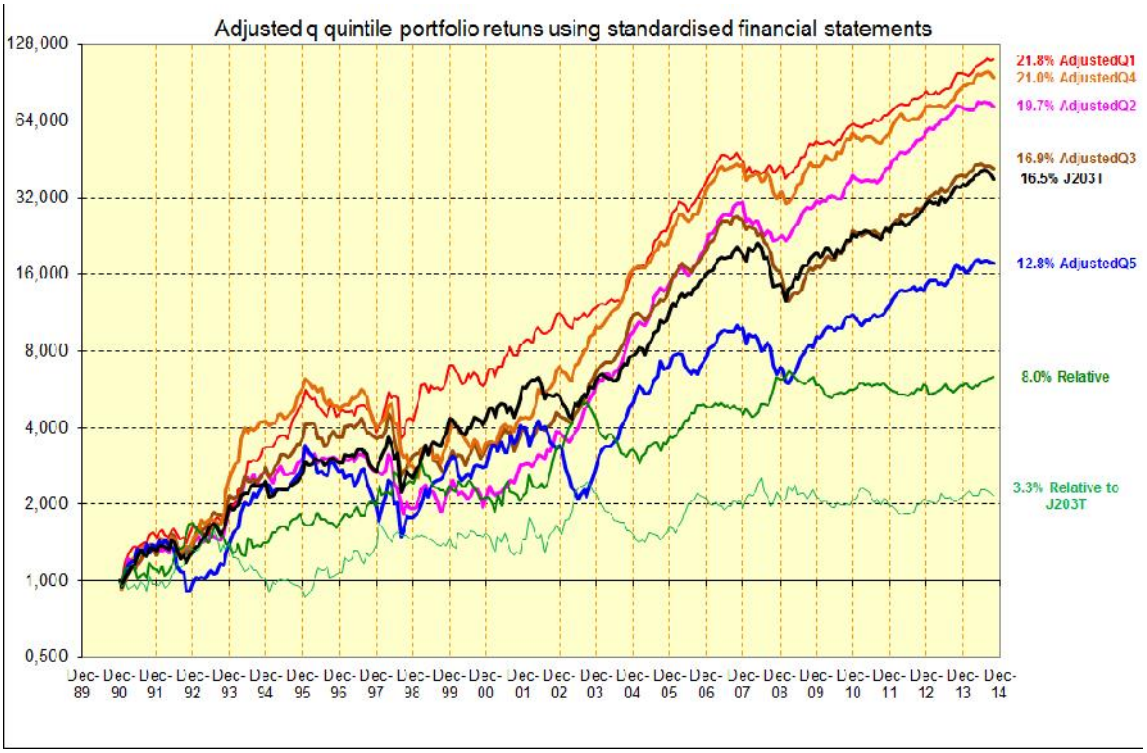
Table 3's results verified the assumption that the adjusted *q* is a different value in relation to Tobin's *q* because all the correlation coefficients are well below any explanatory percentage. In many of the industry sectors that were investigated, only one firm constituted the sector, for example, the oil and gas industry only constituted of only one major business entity. Even with one firm in the sector, the adjusted *q* estimated Tobin's *q* completely differently; in the oil and gas sector the correlation coefficient is 7,34%. However, this difference in *q* ratio estimates does not conclude that the adjusted *q* might not yield a better investment style.

5.5.2 Adjusted *q* portfolio returns

The new adjusted *q* values were used to construct adjusted *q* portfolios with the aim to improve investment yields relative to the standardised Tobin's *q* selected portfolios. Figure

15 presented the annual average quintile portfolio results if such an investment strategy was followed.

Figure 15: Adjusted Tobin's q quintile portfolio returns from standardised company financial statements

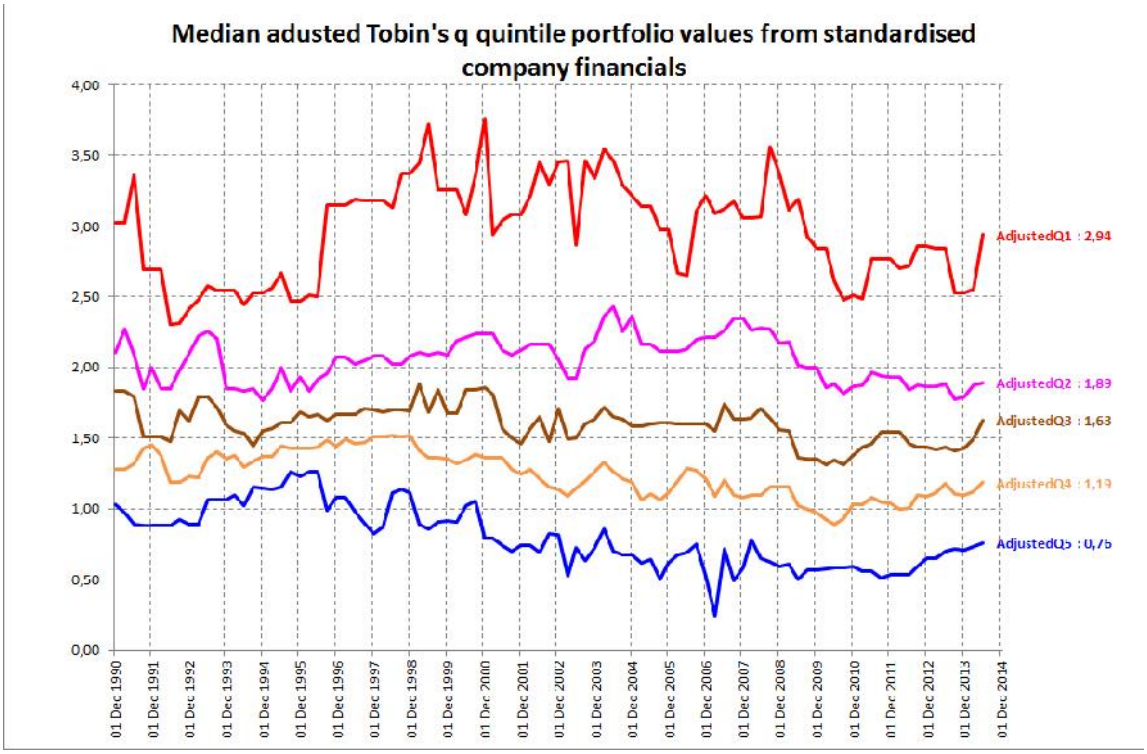


The primary aspect that was noticed was an inversion between standardised Tobin's *q* as an investment style and the adjusted *q* as an investment style. In this instance the portfolios with the high adjusted *q* values returned a higher yield relative to the low adjusted Tobin's *q* portfolios. The style appears to be fairly consistent as presented by the relative line. Furthermore, adjusted *q* concludes with a good spread of 8,0%, between the high and low portfolio, which is higher than any of the other styles tested for *q*. It must be observed that the spread between the high and low portfolios are consistent from inspection. However, from 1993 until 1997 portfolio four outperformed portfolio number one. From 2001 portfolio number four generated momentous annual yields, so much that in 2004 portfolio number four yielded more return than portfolio one.

Figure 16 presents the annual adjusted median *q* values of the analysed quintile portfolios over the time period. In contrast to the other median portfolio values, the portfolio median values seem to decrease gradually instead of constantly rising. Furthermore, the spread

between the median values are closer than any of the other estimates, creating concern about portfolios four's results in the style analysis.

Figure 16: Median adjusted Tobin's q quintile portfolio values from standardised financial statements



This chapter presented the chronological order in which the study was conducted to ascertain the predetermined objectives. This chapter concluded that the McGregor BFA standardised financial statement defined as Tobin's *q* ratio estimate, provided a better index for the JSE. The results concluded that a sophisticated estimate for Tobin's *q* yields better style effects. Statistical evidence was provided to confirm that adjusted *q* is a different estimate for Tobin's *q*. Finally, this chapter concluded that adjusted *q* has some style effects.

CHAPTER 6: DISCUSSION OF THE RESULTS

Chapter 6 analyses and interprets the selected results in order to comprehensively answer the research hypotheses. The relevant figures presented in Chapter 5 are repeated for the readers' convenience.

6.1 Tobin's *q* index for the ALSI

The initial hypothesis aimed to identify time frames where the ALSI, based on Tobin's *q* index, was above or below the long-term average of Tobin's *q*, representing times of possible market over valuations and under valuations. The hypothesis stated:

H_{10}: Tobin's *q* is a representative measure of market value.

H_{1A}: Tobin's *q* is not a representative measure of market value.

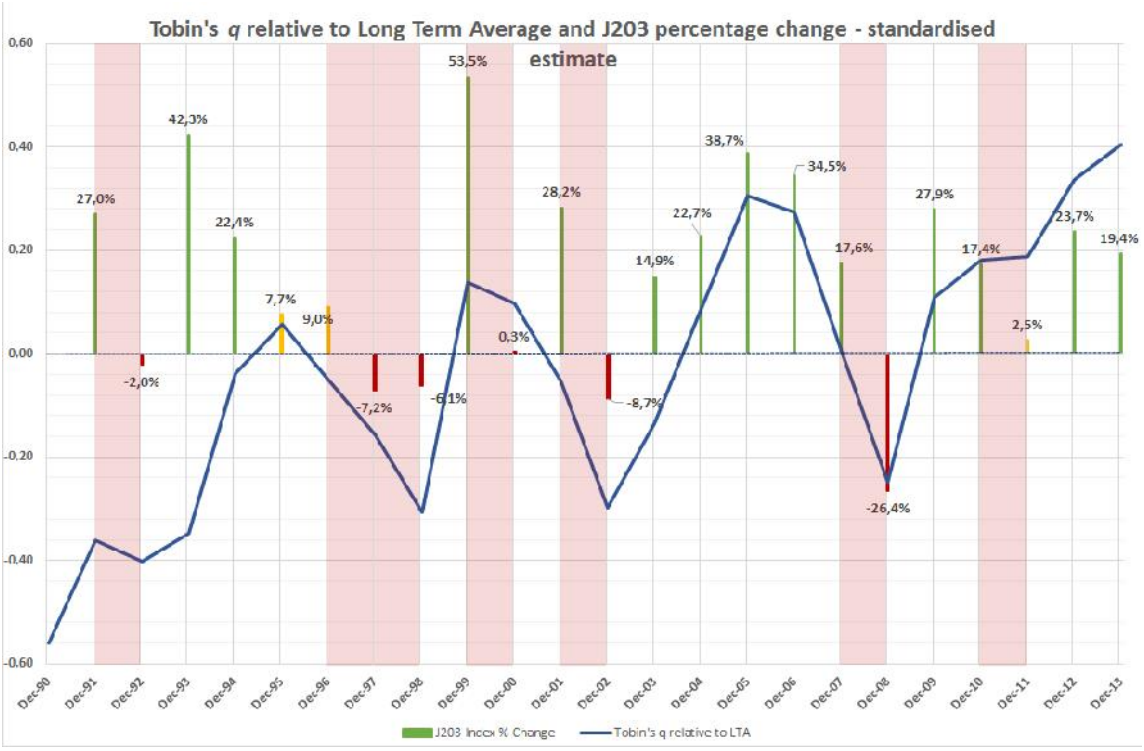
In order to assess the hypothesis the index had to fluctuate relative to its own LTA to indicate time periods of market overvaluation and undervaluation. Essentially, the index should include mean reversion. Peaks and bottoms of the index have to be followed by years of market contraction or growth. The purpose is not to be a market timing instrument but rather to indicate that the market might be too optimistic or pessimistic about the fundamental value of the organisations in the index. Finally the Tobin's *q* index has to respond fairly similarly to other established value indicators on the JSE.

With reference to Figure 17 the index peaks of 1995, 1999 and 2005 were followed with subsequent years of slower growth and market contractions. The case of 1995 is a perfect example of a peak followed by slow growth and two years of negative growth. In 1999 the market almost stagnated, had growth the following year of 28,2% and then contracted again. Over this time period Tobin's *q* declined consistently, mainly due to the increase in replacement costs of assets as presented in Figure 8. The peak of 2005 was followed by another two years of growth before the major market contraction of 2008. Therefore, a Tobin's *q* peak followed by a declining index, in some cases two years of slower market growth, is followed by a market correction.

More interestingly is the market growth subsequent to an index through. In the case of the early 1990s, the market grew except for 1992. The bottom of 1998 was followed by the

highest growth of 53,5% and in the case of 2002, five years of consecutive growth. From 2008 the market continued to grow with a corresponding all-time-high Tobin's *q* index value.

Figure 17: Tobin's q relative to LTA and J203 annual percentage change – standardised estimate

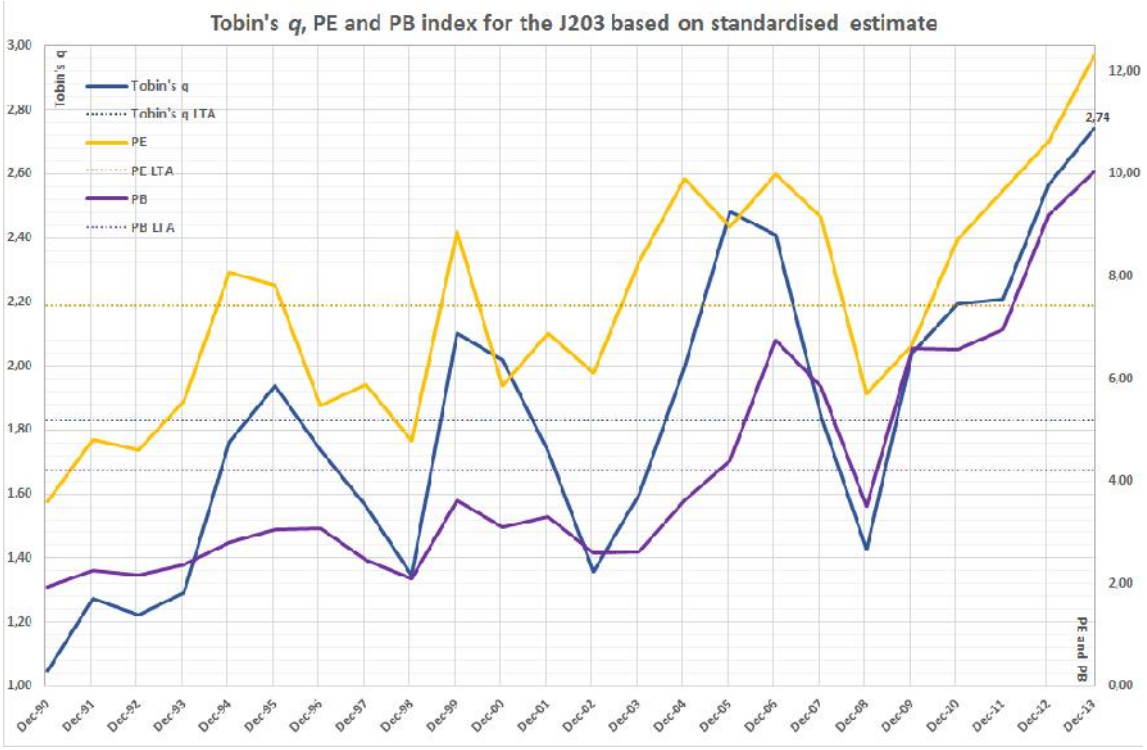


Fundamentally the index cannot deviate excessively in either direction from the index's LTA because of the inherent building blocks that establish Tobin's *q*. If the replacement value does not consistently increase in relation to the market value, the market becomes exuberant about the actual cashflow generating capabilities of the assets in the businesses. For this reason a market correction follows in the form of slower growth or even negative growth. Conversely, in cases of market undervaluation the continuous increase of replacement value determines upward market valuation. In the case of the latest bull market experienced from 2008, the replacement value increased by 60% and the enterprise value by 125%. At some stage slower growth has to follow or the actual value of the underlying assets will be completely understated.

PE and PB are popular market value indicators and for this reason the Tobin's *q* index was plotted with these indices on the same graph, as demonstrated in Figure 18. PE correlate very well with the Tobin's *q* index, in fact the correlation coefficient, R^2, is 0,780 (Refer to APPENDIX B: CORRELATION STATISTICS) Although the exact dates of peaks and

troughs do not correspond, the time frames of market over valuation and under valuation correspond well. The PE ratio indicated in December 2013 that the market was overvalued by 50%. PB almost reacts as a restrained version of Tobin's *q* but without clear market peaks and bottoms in relation to its own LTA. The correlation coefficient is much less with a R^2 of 0,698. PB indicated in December 2013 that the market was overvalued by 87%, relative to its own LTA.

Figure 18: Tobin's q, PE and PB for the ALSI



From the above analysis, Tobin's *q* index fluctuates relative to its own LTA and indicates time periods of market over valuation and under valuation. As such, the index mean reverts. Tobin's *q* index responds similarly to other market value indicators; in both comparisons the correlation coefficients are high. For this reason the null hypothesis is accepted and the alterative hypothesis rejected. Thus:

H_{10} = Tobin's *q* is a representative measure of market value.

$H_{1A} \neq$ Tobin's *q* is not a representative measure of market value.

6.2 Tobin's *q* as an investment style

Secondly the research intended to investigate whether Tobin's *q* reacts as an investment style and outperforms the ALSI, the PE investment style and the PB investment style. The hypothesis stated:

H_{20}: Tobin's *q* displays a significant and persistent investment style.

H_{2A}: Tobin's *q* does not display a significant and persistent investment style.

Therefore the simulated investment portfolios using calculated Tobin's *q* as the portfolio selector had to return a clear cumulative annual difference between the highest and lowest ranked portfolios. Furthermore the style had to be persistent, meaning that the low quintile portfolios cannot yield less returns than the high quintile portfolios over prolonged time periods. In order to establish relative performance, the cumulative investment returns were compared to the ALSI, PE and PB selected portfolios.

Figure 19: Tobin's q quintile portfolio returns from standardised company financial statements applying McGregor BFA standardised defined q

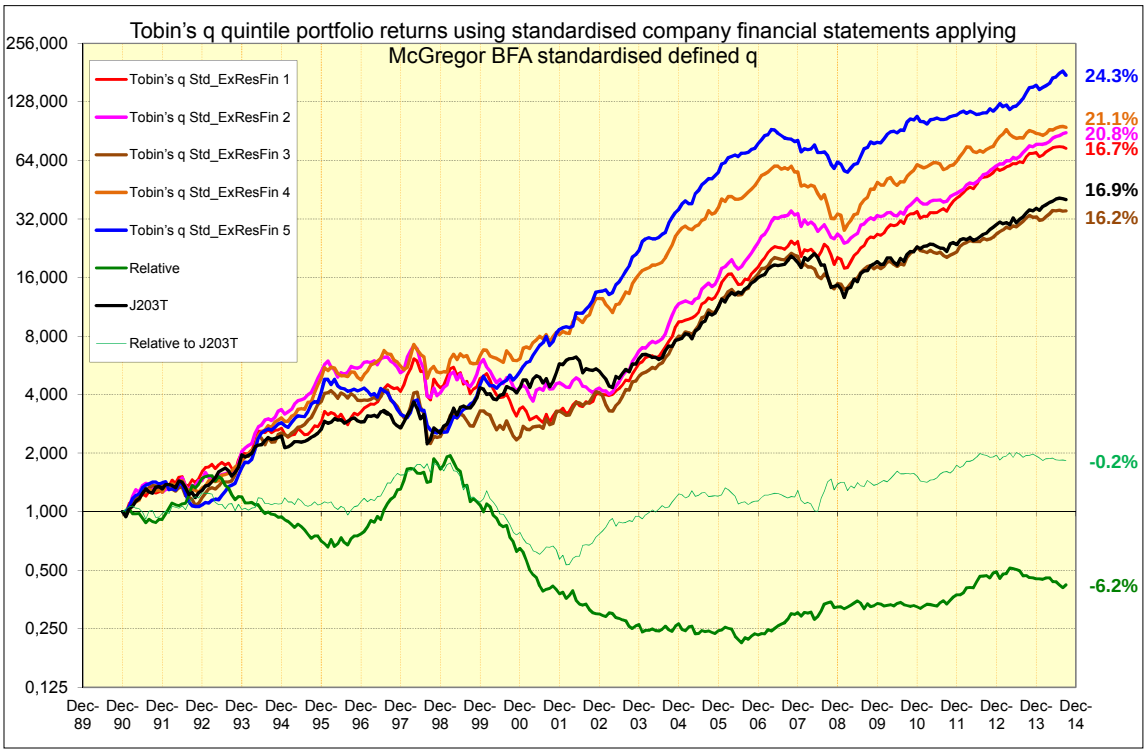


Figure 17 demonstrated the functioning investment style from the early 1990s and from 1998 until mid-2004. From 1996 to 1998 the high quintile portfolios performed better than the low quintile portfolios, and from mid-2005 the high quintile portfolios performed slightly better until mid-2008. From this point, the quintile portfolios yielded the same annual return until mid-2010. From mid-2010 the high quintile portfolios outperformed the low quintile portfolios until 2012. From this point the low quintile portfolios once again outperformed the high quintile portfolios. As a style, from 1998 the low quintile portfolio mostly outperformed the high quintile portfolio.

Tobin's *q* relative difference over the 24 years is 6,2%, for PE the relative difference was 13,4% and for PB 9,5%. PE had two style switches in the late 1990s and in 2007, and compared to almost similar time periods of the Tobin's *q* investment style. These switches seemed to occur when the market growth tapered. PB never switched but the returns were stagnant from 2004. The holding period was consistent with the strategies applied in PE and PB of three months, the only difference was that PB and PE was tested over slightly longer time frames, thereby increasing the annual average return spread.

Interestingly four of the portfolios formed with *q* outperformed the ALSI. This indicated that further selection optimisation might be possible such that the high quintile portfolios underperform relative to the ALSI improving the relative difference between the extreme ranked portfolios. The only risk with Tobin's *q* as an investment style remains that the style might reverse if the market loses positive momentum. However, this phenomena seems present in other investment styles.

From the above analysis the research concluded that an investment style does exist with Tobin's *q* as the portfolio selection variable. Low quintile *q* investment portfolios most likely outperform high quintile *q* portfolios with expected outperformance in the region of 6%. The style however is not as persistent as PE that continued to display significance with possible slight style reversing if the market tapered. Tobin's *q* as an investment style is currently considered more significant than PB because the relative returns of the PB ranked portfolios remained stagnant from 2004. However, Tobin's *q* top yielding portfolio returned the second highest average annual returns, marginally less than PB, from the three styles compared. Thus, even if there was a time of reversal in the late 1990s, Tobin's *q* as an investment style mostly resulted in a relative return concluding that the style does exist. Therefore:

H_{20} = Tobin's *q* displays a significant and persistent investment style.

H_{2A} ≠ Tobin's *q* does not display a significant and persistent investment style.

6.3 Adjusted *q* as an investment style

The final part for the research was to establish whether the Cobb-Douglas production function improves the portfolio selection and consequently investment returns. Based on the findings that Tobin's *q* displays, an investment style similar to other market based styles, the hypotheses stated:

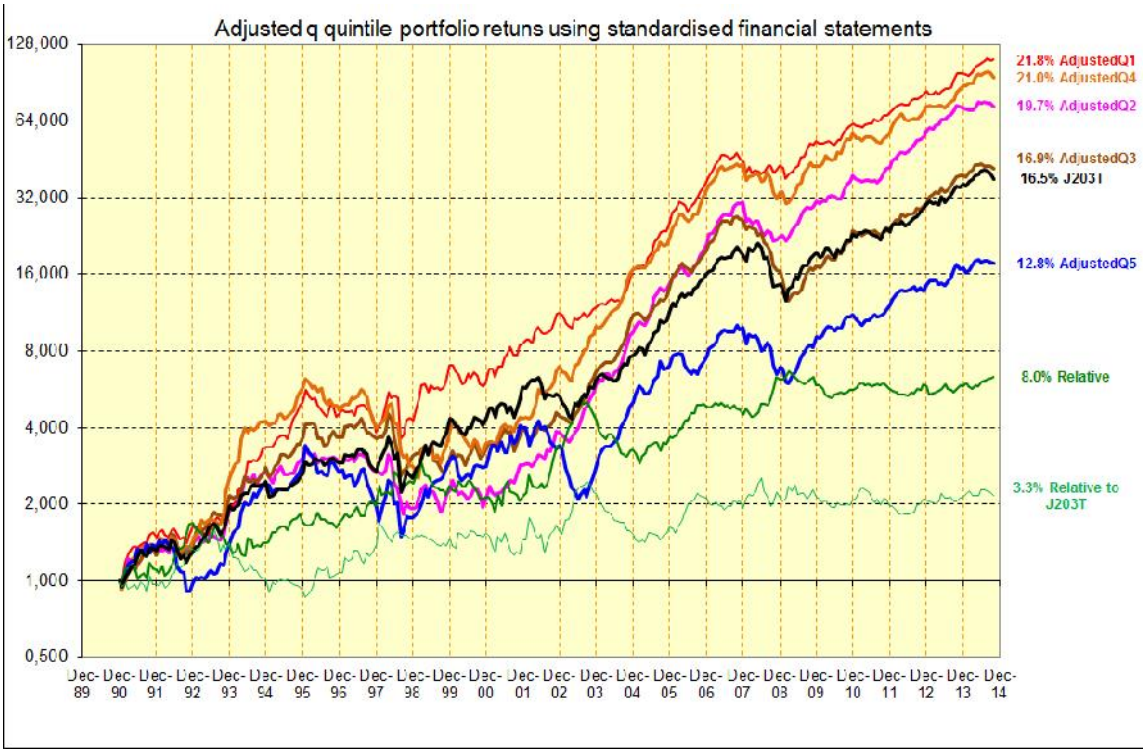
H_{30}: Adding a Cobb-Douglas production function improves investment returns.

H_{3A}: Adding a Cobb-Douglas production function does not improve investment returns.

The hypotheses holds true if the spread between the ranked portfolios is improved, if the annual cumulative returns of the best performing portfolio is improved and if the relative difference between ranked quintile portfolios are more persistent.

Figure 20: Adjusted Tobin's q quintile portfolio returns from standardised company financial statements

Figure 20



From the different Tobin's *q* investment styles analysed the adjusted *q* yields the best spread of 8% between the high arranged and low arranged adjusted *q* portfolios, even if the annual average return per portfolio is less than standardised *q* as an investment style. The spread is consistent for the portfolios except for portfolio four that outperformed portfolio one from 1993 to 1997 and started to track the high quintile from mid-2003. Ideally, portfolio four has to yield returns slotting in-between portfolio three and portfolio five. In case the ranked portfolios do not arrange in perfect order, the portfolios with fairly similar medians have to cluster. Portfolio four obscures this requirement. Given the difference in actual adjusted *q* values, presented in Figure 16, the fact that portfolio four yields similar results to portfolio one does not present a good case for adjusted *q* as an investment style. The implication is that value from portfolio four should have been transferred to portfolio one, increasing portfolio one's yields.

Contrary to the other investment styles, adjusted *q*'s high *q* quintile portfolio outperformed the low *q* quintile portfolio. Standardised *q* low quintile portfolios resulted in an annual average return of 24,3%, with adjusted *q*'s high quintile portfolio achieving a return of 21,8%. Apart from the reversal, the highest yielding adjusted *q* portfolio did not outperform the highest yielding standardised *q* portfolio.

In comparison the relative difference between the ranked quintile portfolios seems more persistent for adjusted *q*. However, the relative difference seems to fluctuate more than standardised *q*. This indicates that there is constant reversal between the different portfolio's yields. Therefore, although the relative difference seems more persistent in the long-term, it is not the case in the short-term.

From the above analysis, adjusted *q* results in a better spread between the portfolios, albeit with inconsistent and obscure yields from portfolio four. The annual cumulative returns are less for adjusted *q* relative to standardised *q*; the relative difference is more consistent in the long-term with constant fluctuations. Therefore, adjusted Tobin's *q* as an investment style yields a weaker result than standardised *q*. For these reasons the null hypothesis in not rejected:

H_{30} ≠ Adding a Cobb-Douglas production function improves investment returns.

H_{3A} = Adding a Cobb-Douglas production function does not improve investment returns.

CHAPTER 7: CONCLUSION

The final chapter of this research aims to emphasise the insights garnered from the research, and attempts to integrate the discoveries into a cohesive set of findings to provide insight regarding the practical investment implications. Finally, this research study is concluded by providing suggestions for further research opportunities.

7.1 Significant findings

7.1.1 Correct interpretation for Tobin's *q*

Smithers and Wright (2002) concluded that the *q* ratio is mainly influenced by the market valuation of the stocks relative to the other variables of the ratio. Thus, a high or low *q* value indicates that the stock market or specific firm might be overvalued or undervalued. In a more recent study, Wright *et al.,* (2011) argued that *q* could typically be interpreted as comparing assets in different markets. If *q* is high or low, the implication is that the stock market prices are high or low relative to purchasing the assets directly. Essentially, Tobin's *q* is a value indicator indicating overvalued or undervalued firms in the stock market, or in the case of the index, the entire stock market as an inclusive entity.

This research conducted empirical investment style analyses for different estimates of Tobin's *q*. Not in any of the estimations did the highest quintile Tobin's *q* portfolio provide higher yields than the lowest quintile Tobin's *q* portfolio. In many of the different Tobin's *q* did some of the quintile portfolios varied in annual yields; visually the portfolio annual return lines crossed in the time series analysis. Nevertheless, for the standardised financial statement Tobin's *q* estimate, the low ranked portfolio provided attractive returns from 1998. Given the analyses conducted, higher Tobin's *q* valued firms have a high probability to decline in share price value instead of rising. Consequently, low ranked Tobin's *q* firms have a high probability of rising in share price value.

However, *q* was also considered to be as a wealth creation indicator. The empirical evidence however does not support this view, in fact the evidence indicated the contrary. If this was the case then the high ranked quintile portfolios had to outperform the low ranked quintile portfolios consistently over the time series analysis. Not in any of the different estimates was this interpretation evident.

These empirical results therefore support the argument that a high or low *q* value indicates that the stock market or specific firm might be overvalued or undervalued. The results do not imply that Tobin's *q* is a timing instrument. Tobin's *q* is a value indicator and the market might take long to respond to the miss-valuation, thereby providing investment opportunities.

7.1.2 Value of Tobin's *q* as an index

Considering the definition of Tobin's *q,* the index value is expected to mean revert around one. For the ALSI, presenting the JSE, the LTA is 1,83, applying the standardised financial statement estimate. This is almost twice the theoretical value, indicating a consistent upward bias. Thus, theoretically one of the variables or a combination of the variables forming Tobin's *q* is consistently incorrectly stated.

Considering the variables in Tobin's *q* and the LTA value, corporate debt or replacement value might be understated in company financial statements. Alternatively share prices have been overvalued. Smithers and Wright (2002) concluded that the *q* ratio is mainly influenced by the market valuation of the stocks, relative to the other variables in the ratio. This implies that share prices are overvalued in general on the JSE.

In Figure 8 the index for market value, relative to replacement value, grew exponentially from December 2008. Note that peaks and troughs of Tobin's *q* follow the market index line closely and not the replacement value index line. This disconnect between market value and replacement value support the conclusion of Smithers and Wright (2002) that Tobin's *q* ratio is mainly influenced by market valuation. Thus, based on Tobin's *q*, share prices on the JSE might be overvalued for a large majority of the firms on the stock exchange.

7.1.3 *q* Effect

Badrinath and Kini (1994) concluded that low *q*-formed portfolios outperformed high *q*-formed portfolios by an average of 8,17% per annum, eloquently labelled the *q* effect. Badrinath and Kini (1994) referred to the results as "stock market anomalies", and concluded that on average, the "low Tobin's *q* ratio stock outperformed stocks with high Tobin's *q* ratios." (p. 1). Lewellen and Badrinath (1997) concluded that the "extant procedures for estimating *q* are flawed in design, are unstable in application, produce downward-biased measures, and are prone to rank incorrectly and thereby misclassify firms by their *q*'s." (p.2).

The time series analysis compounded the annual returns, providing a 24 year investment analysis. The results supported the market anomaly findings of Badrinath and Kini (1994) such that a *q* effect exists on the JSE for the extreme ranked portfolios yielding an outperformance of 6,2%. Inasmuch, the most recent Tobin's *q* estimate is Lewellen and Badrinath's (1997) view concerning misclassification, and it is still evident because the spread between the ranked quintile portfolios did not remain consistent throughout the time serious analysis; nor did the ranked quintile portfolios consistently stack in order. This implied that the *q* ratio should have ranked firms into different portfolios such that the spread and order between the portfolios remained more consistent, as is evident with the PE model.

7.1.4 The benefit of the cost function

Adjusted *q*, did not yield the desired results as an investment style due to the poor style effects and inconsistent portfolio orders. Given the fact that the extreme portfolios yielded the complete opposite results and low correlation coefficients implies that adjusted *q* value the firms entirely differently. For this reason the adjusted *q* should rather be classified as an alternative *q* instead of merely an adjustment. Thus, there is not benefit of adding a cost function to Tobin's *q* as an investment style.

7.2 Implication of the findings

Investment strategies could be developed using Tobin's *q* as an indicator to invest in the stock market and when to exit due to the mean reversion characteristic. From an overall market perspective, using Tobin's *q* index as a selling and buying signal would serve an investor well especially considering the market growth after a trough in the index. An investment strategy could potentially set entering and exiting points based on the Tobin's *q* LTA value setting selling limits at 80% of the LTA and buying signals at 20% of the LTA.

This principle could be applied at firm level to construct portfolios consisting of firms with individual low Tobin's *q* values. Creating such a portfolio and superimposing it with the time to enter and exit the market might lead to attractive investment returns. Once again, it is not a precise timing technique but a value investment approach with a medium- to long-term investment horizon.

7.3 Future research opportunities

The original idea of valuing companies from a supply approach was to complement the current discounted cashflow analysis and only evaluate the current investment made relative to current installed assets to value a firm. Given the slope and curvature parameters calculated in this research, this firm valuation method can be empirically tested to determine whether this valuation method could be an alternative to the current discounted cashflow method with its reliance on future cashflow forecasts. A note of caution is that there is a survival bias in the calculated parameters. However, when the valuation is performed, it should be based on parameters established from companies that are sustainable at a certain investment rate. Including unsustainable firms in order to calculate the parameters will most certainly influence the valuation result incorrectly. Lastly, the parameter estimates might be improved by using the method applied by Belo *et al*. (2013) known as the generalised method of moments instead of Microsoft Solver.

The estimation for Tobin's *q* creating the index can be further refined to include the resources and financial sectors, which were excluded in the index. A different *q* estimate for resources is recommended by McGregor BFA and can be investigated against other estimates in global financial markets. The concern regarding the influence of commodity price fluctuations, currency fluctuations and the actual remaining ore body value has to be estimated in some form because it significantly influences future cashflow.

The financial sector has a large intangible asset value and the correct means can be researched to create a more accurate Tobin's *q* for the financial sector. The *q* values for the financial sector were sporadic and unrealistic. For example, Standard Bank had a *q* ratio of 730 in 2013, which is utterly unrealistic. Consequently the formula used to estimate Tobin's *q* for the financial sector has to be further researched, especially since these firms have a large market capitalisation and influence the index *q*.

Tobin's *q* estimate might be further improved by changing the estimate of corporate long-term debt as performed by Lewellen and Badrinath (1997). In addition, there might be other research available with an improved estimate for long-term debt that can be used. These changes could possibly improve the investment style's cumulative annual returns and portfolio rankings for Tobin's *q* as an investment style.

REFERENCES

Arends, B. (2014, January 17). 3 signs stocks are overpriced Brett Arends's ROI. Retrieved April 22, 2014, from http://www.marketwatch.com/story/3-signs-that-stocks-cost-too-much-2014-01-16

Asness, C. S., Moskowitz, T. J., & Pedersen, L. H. (2013). Value and Momentum Everywhere. *The Journal of Finance*, *68*(3), 929–985. doi:10.1111/jofi.12021

Authers, J. (2014, April 7). Hindsight shows that q is the best guide to valuations. *Financial Times*.

Badrinath, S. G., & Kini, O. (1994). THE RELATIONSHIP BETWEEN SECURITIES YIELDS, FIRM SIZE, EARNINGS/PRICE RATIOS AND TOBIN'S q. *Journal of Business Finance & Accounting*, *21*(1), 109–131.

Balke, N. S., & Wohar, M. E. (2001). Explaining Stock Price Movements: Is There a Case for Fundamentals? *Economic & Financial Review*, 22.

Belo, F., Xue, C., & Zhang, L. (2013). A Supply Approach to Valuation. *Review of Financial Studies*, *26*(12), 3029–3067. doi:10.1093/rfs/hht067

Brainard, W. C., Shoven, J. B., & Weiss, L. (1980). The Financial Valuation of the Return to Capital. *Brookings Papers on Economic Activity*, *1980*(2), 453–511. doi:10.2307/2534328

Campbell, J. Y., & Shiller, R. J. (2001). *Valuation Ratios and the Long-Run Stock Market Outlook: An Update* (Working Paper No. 8221). National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w8221

Erickson, T., & Whited, T. M. (2006). On the Accuracy of Different Measures of q. *Financial Management (Wiley-Blackwell)*, *35*(3), 5–33.

Frazzini, A., & Pedersen, L. H. (2014). Betting against beta. *Journal of Financial Economics*, *111*(1), 1–25. doi:10.1016/j.jfineco.2013.10.005

Harney, M., & Tower, E. (2003). Predicting Equity Returns Using Tobin's q and Price-Earnings Ratios. *The Journal of Investing*, *12*(3), 58–70. doi:10.3905/joi.2003.319555

INET BFA Research Domain. (2014a). Understanding Standardised Financial Statements. INET BFA Research Domain. Retrieved from http://0-secure.mcgbfa.com.innopac.up.ac.za/ManualDownload.aspx?Token=Fecs5%2fhFVWhRZxj6PClCxA%3d%3d

INET BFA Research Domain. (2014b). Understanding the value performance indicators. INET BFA Research Domain. Retrieved from http://0-secure.mcgbfa.com.innopac.up.ac.za/ManualDownload.aspx?Token=Fecs5%2fhFVWhRZxj6PClCxA%3d%3d

Investment Style Definition. (2014, February 9). Retrieved April 28, 2014, from http://www.investopedia.com/terms/i/investing_style.asp

Lee, D. E., & Tompkins, J. G. (1999). A Modified Version if the Lewellen and Badrinath Measure of Tobin's Q. *Financial Management*, *28*(1).

Lewellen, W. G., & Badrinath, S. G. (1997). On the measurement of Tobin's q. *Journal of Financial Economics*, *44*(1), 77–122. doi:10.1016/S0304-405X(96)00013-X

Muller, C., & Ward, M. (2013). Style-based effects on the Johannesburg Stock Exchange: A graphical time-series approach. *The Investment Analyst Society of South Africa*, *77*.

Q Ratio (Tobin's Q Ratio) Definition. (2014, February 9). Retrieved February 9, 2014, from http://www.investopedia.com/terms/q/qratio.asp

S&P 500 PE Ratio. (2014, May 4). Retrieved May 4, 2014, from http://www.multpl.com/

Shen, P. (2000). The P/E Ratio and Stock Market Performance. *Economic Review (01612387)*, *85*(4), 23.

Smithers, A. (2010). *The Future of Finance* (The LSE Report). London School of Economics and Political Science.

Smithers, A., & Wright, S. (2002). Stock Markets and Central Bankers. *World Economics*, *3*(1).

Sturgess, B. (2012). When to buy and when to sell. *World Economics*, *13*(3).

Tobin, J. (1969). A General Equilibrium Approach To Monetary Theory. *Journal of Money, Credit and Banking*, *1*(1), 15–29. doi:10.2307/1991374

Tower, E. (2012). Tobin's q versus CAPE versus CAPER: Predicting Stock Market Returns Using Fundamentals and Momentum. *Journal of Investing*, *21*(1), 97–108.

Wright, S., Smithers, A., Warburton, P., Pepper, G., Goldberg, J., Brodie, H., … Napier, R. (2011). *Practical History of Financial Markets*. Edinburgh Business School.

APPENDIX A: SUMMARY OF CURVATURE PARAMETERS

Table 4: The curvature parameters for the cost functions per industry sector

Curvature parameters per industry		
Oil & Gas	η	ν
	0,618	0,666
Construction & Materials	η	ν
	2,077	0,865
Industrial Goods & Services	η	ν
	2,027	0,905
Automobiles & Parts	η	ν
	1,342	1,785
Food & Beverage	η	ν
	3,229	1,139
Personal & Household Goods	η	ν
	2,570	1,276
Health Care	η	ν
	1,287	0,735
Retail	η	ν
	5,629	1,147
Media	η	ν
	2,519	1,169
Travel & Leisure	η	ν
	3,501	1,071
Telecommunications	η	ν
	4,283	1,226
Technology	η	ν
	4,424	1,187

APPENDIX B: CORRELATION STATISTICS

Figure 21: Correlation coefficient between Tobin's q and adjusted q for the oil and gas sector

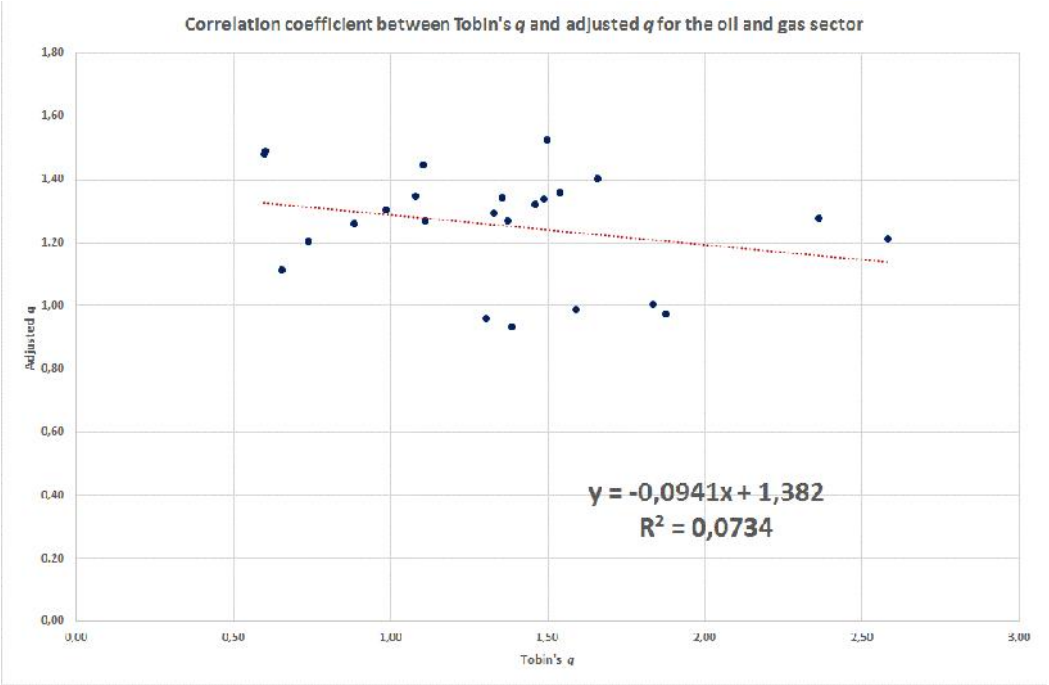


Figure 22: Correlation coefficient between Tobin's q and adjusted q for the construction and material sector

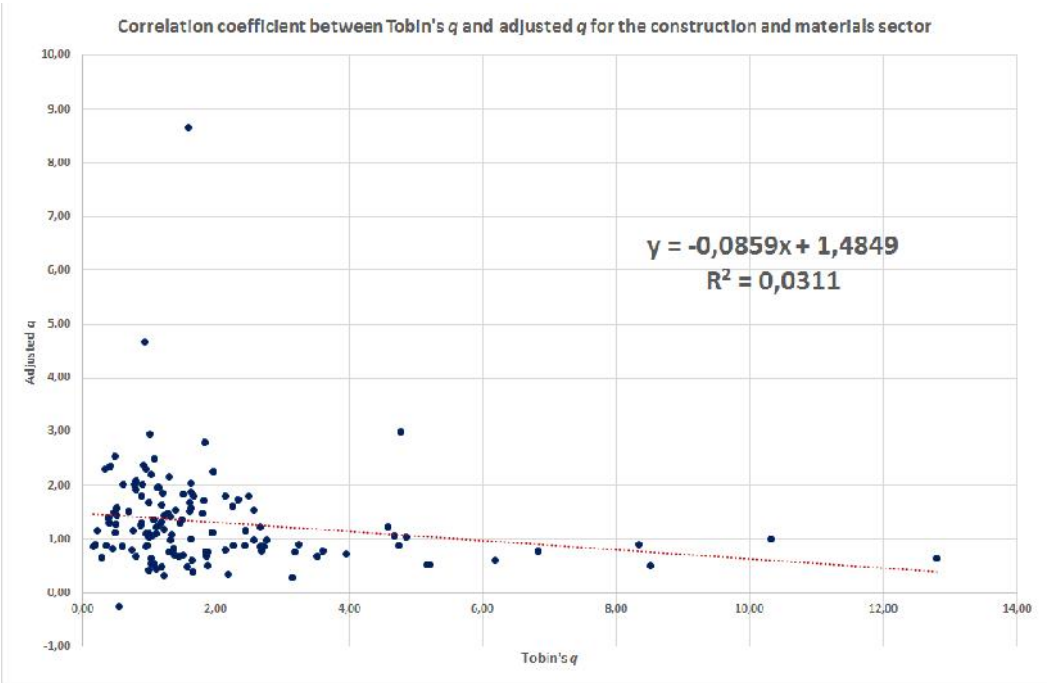


Figure 23: Correlation coefficient between Tobin's q and adjusted q for the industrial goods and service sector

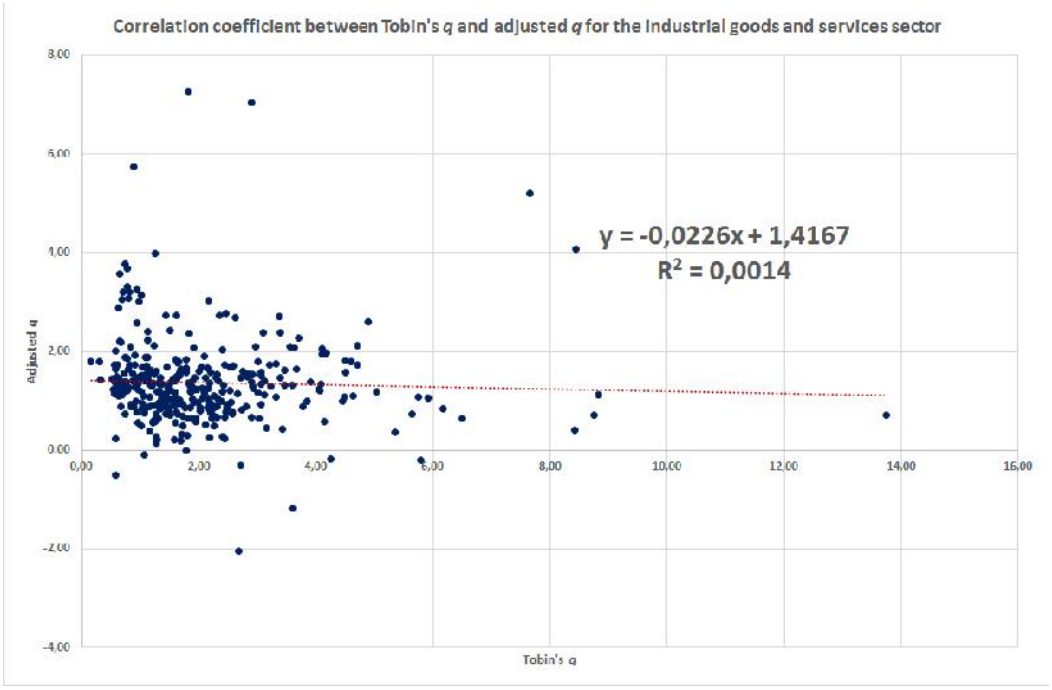


Figure 24: Correlation coefficient between Tobin's q and adjusted q for the automobile and parts sector

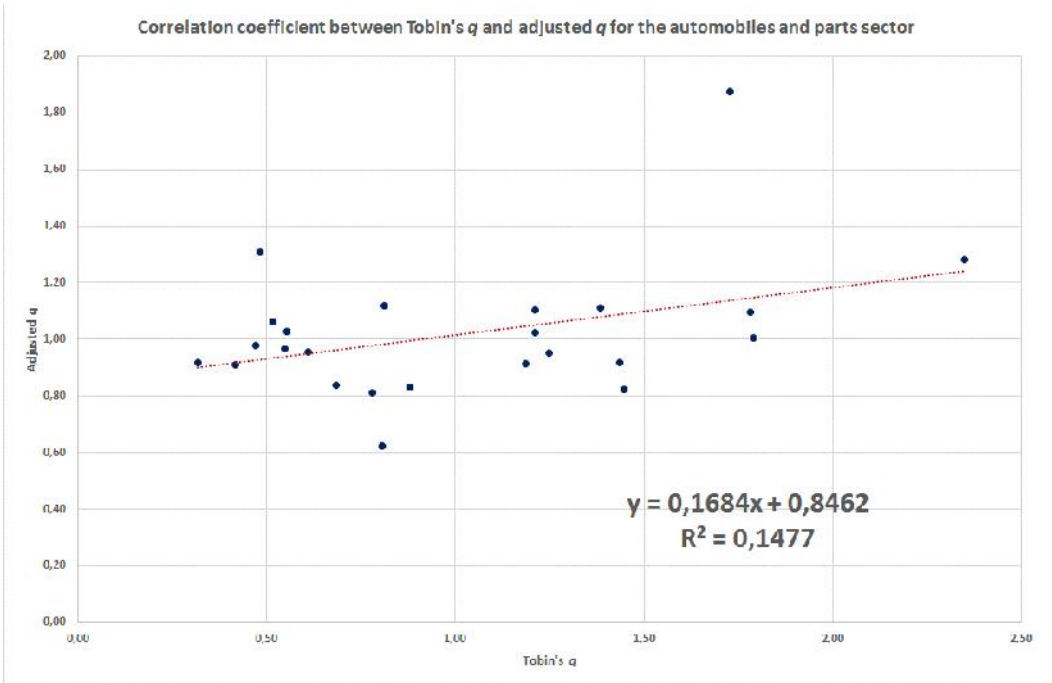


Figure 25: Correlation coefficient between Tobin's q and adjusted q for the food and beverages sector

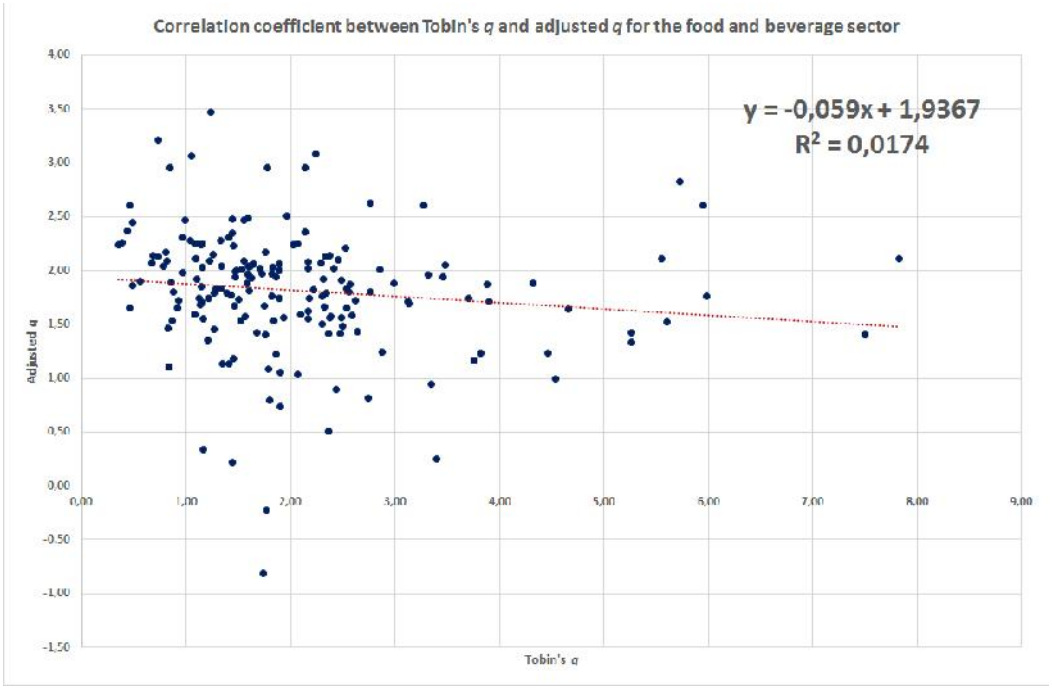


Figure 26: Correlation coefficient between Tobin's q and adjusted q for the personal and household goods sector

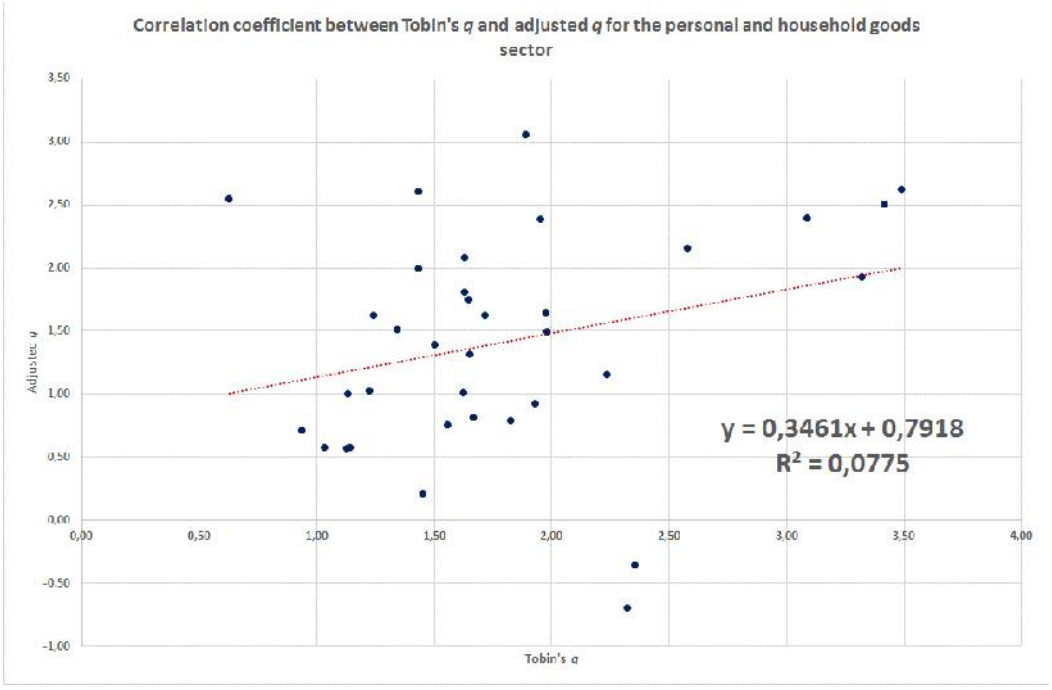


Figure 27: Correlation coefficient between Tobin's q and adjusted q for the health care sector

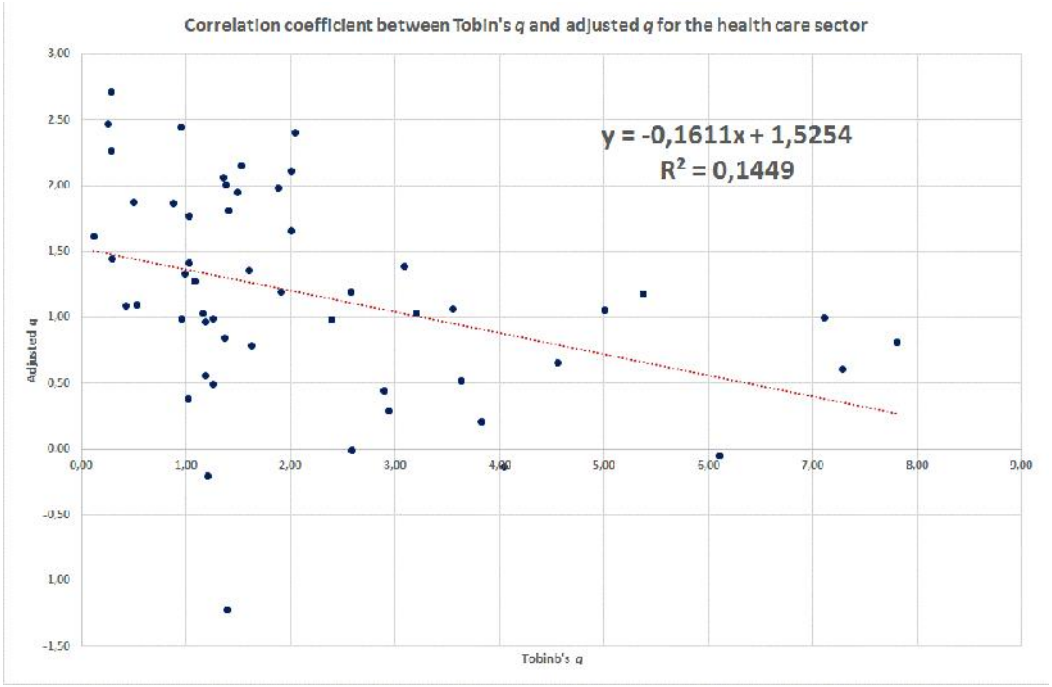


Figure 28: Correlation coefficient between Tobin's q and adjusted q for the retail sector

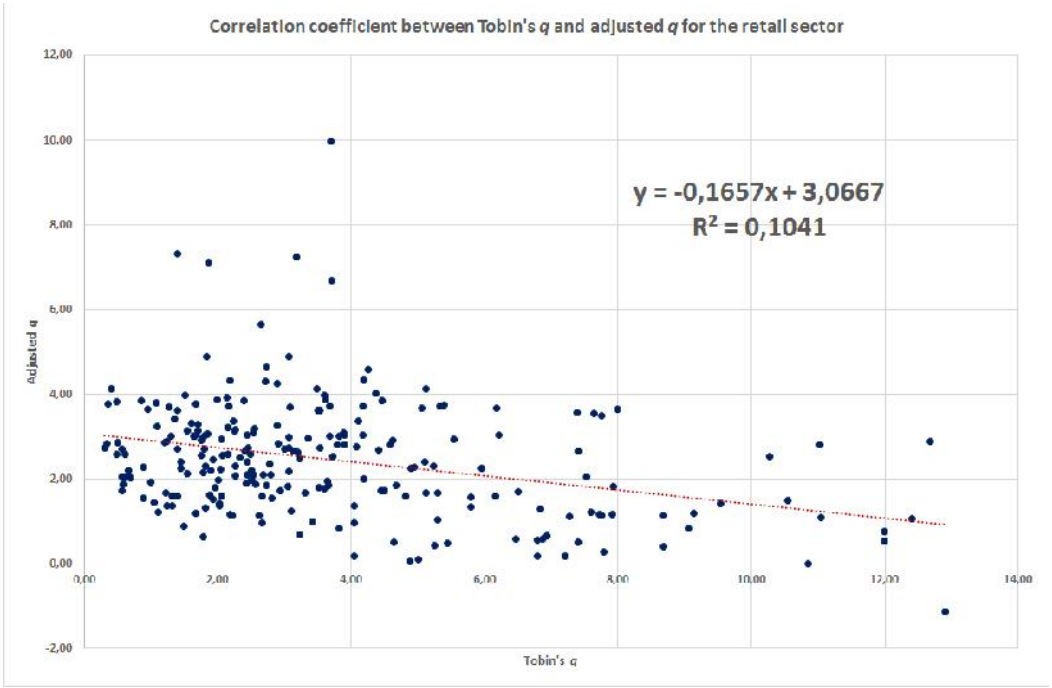


Figure 29: Correlation coefficient between Tobin's q and adjusted q for the media sector

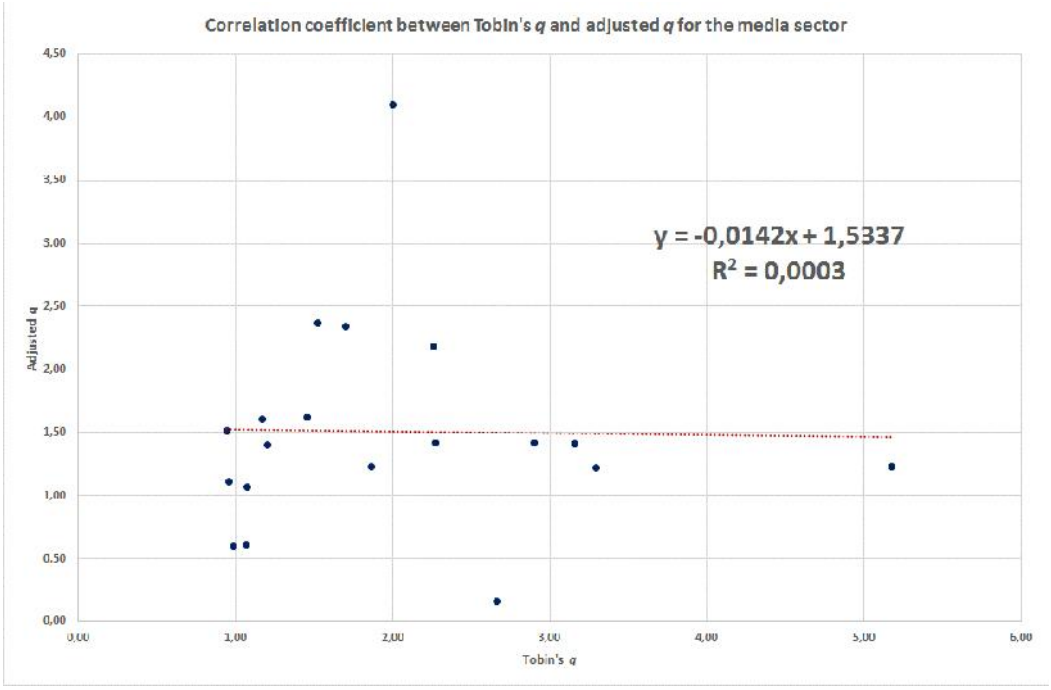


Figure 30: Correlation coefficient between Tobin's q and adjusted q for the travel and leisure sector

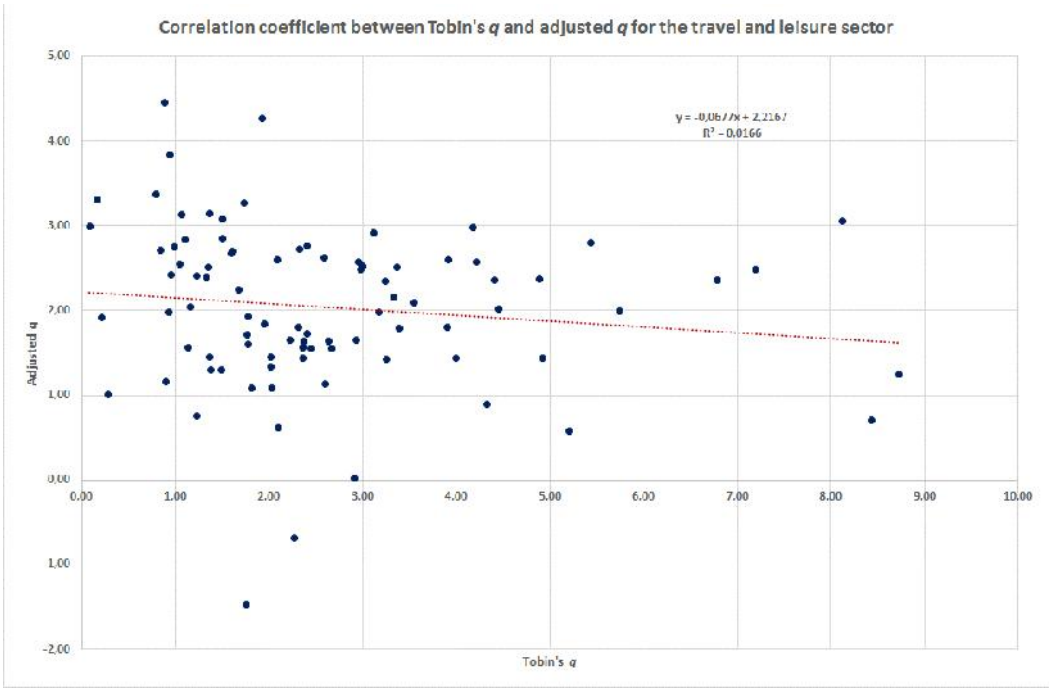


Figure 31: Correlation coefficient between Tobin's q and adjusted q for the telecommunications sector

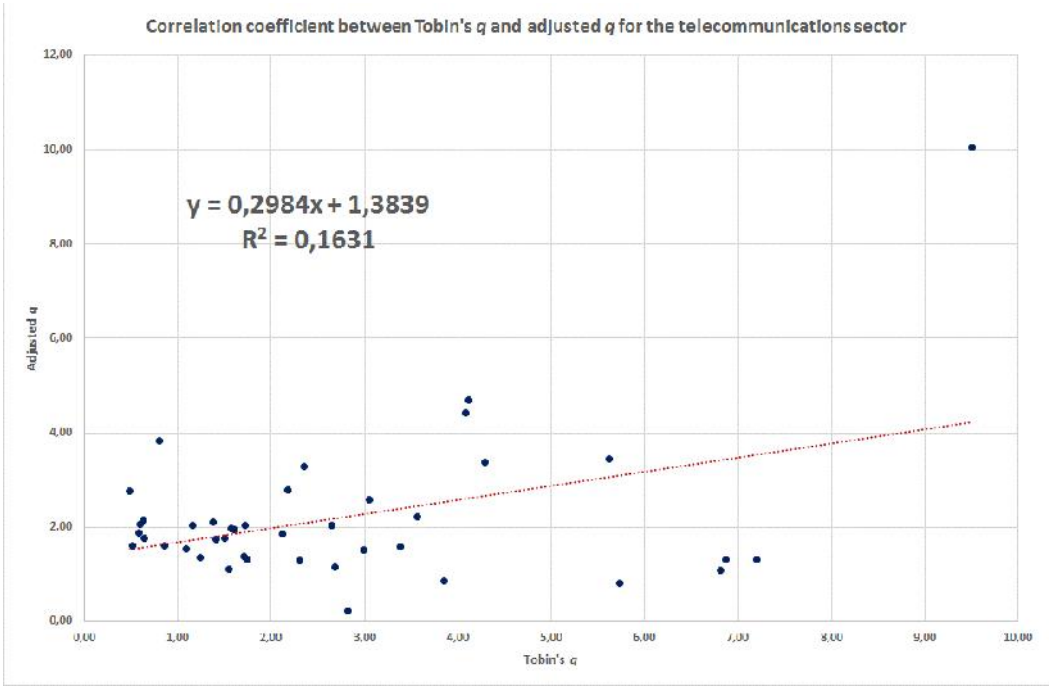


Figure 32: Correlation coefficient between Tobin's q and adjusted q for the technology sector

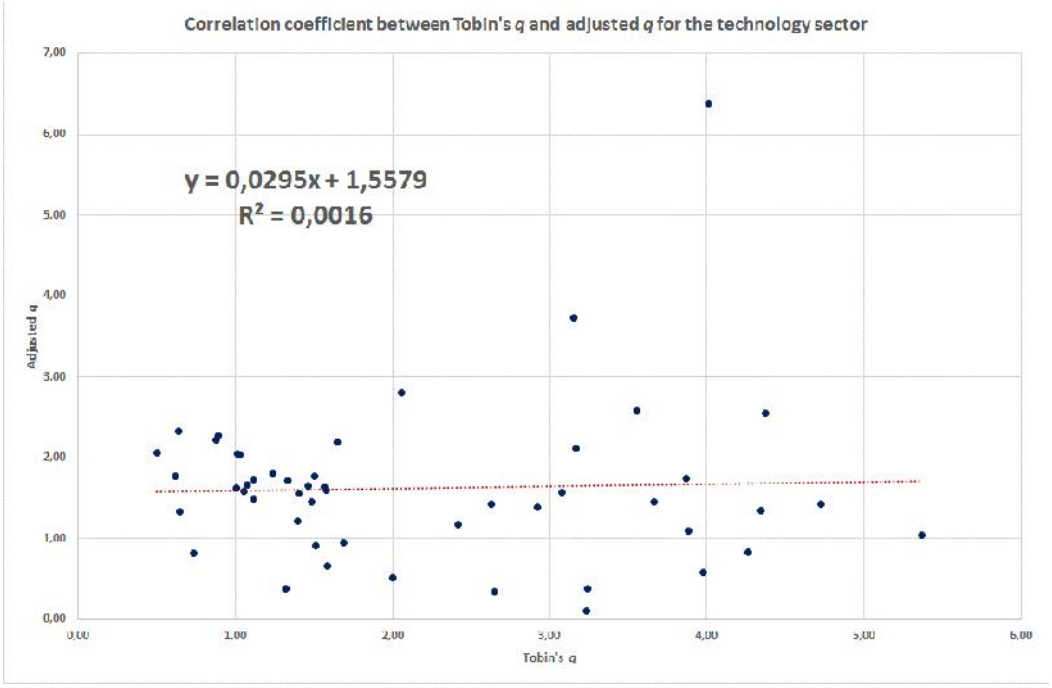


Figure 33: Correlation coefficient between Tobin's q and PE

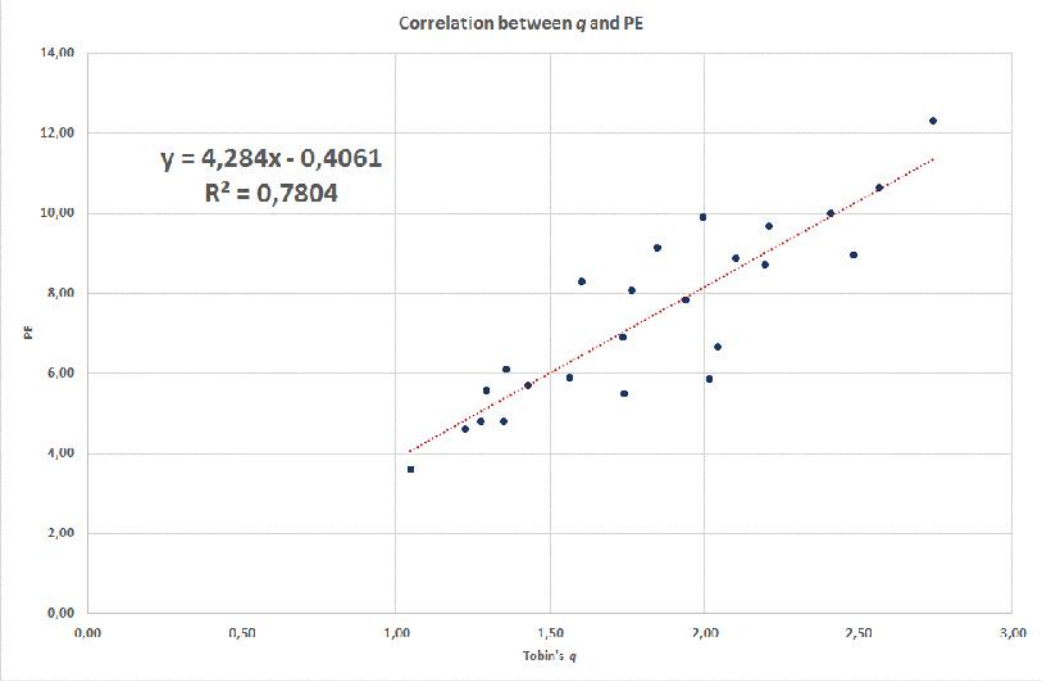


Figure 34: Correlation coefficient between Tobin's q and PB