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How effective is the Piotroski Screen on Value Stock Selection on the JSE?

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Abstract

This paper investigates the effectiveness of the Piotroski screen on the Johannesburg Stock Exchange (JSE) since it was first published in 2000. Data used covers the 2000-2011 period. For each year since 2000 till 2011, the Piotroski screen is used to select a portfolio of financially strong firms from the value firms on the JSE. Although no conclusive evidence is found that the mean returns from the portfolio of screened financially strong firms are significantly better than the portfolio of value stocks, it is strongly suspected that the small group of firms that are identified as being financially the strongest by the Piotroski screen have a decreased probability of containing firms with negative one year buy-and-hold returns compared to the other portfolios. Although the outcome is inconclusive due to small sample sizes, it is also strongly suspected that the one year buy-and-hold strategy yielded returns that are in the order of almost four times better than the five year buy-and-hold strategy.

Introduction

There is a wide range of financial assets available for investment. However, the best returns in the long run come from share investments (Howe & Mistic, 2003; Firer & Staunton, 2002). As such, a variety of techniques, styles, and theories are employed by share investors in their endeavors to make money. These tools include share valuation techniques, market theories, like the efficient market hypothesis, and investment strategies like value investment (Liu & Wang, 2010), growth investment (Gwilym, Seaton, & Thomas, 2008) and technical analysis (Falbo & Pelizzari, 2011).

Despite the tools available to share investors, there are ample examples of stock mispricing (Chen, Lung, & Wang, 2009). This mispricing is based on waves of pessimistic fear and optimistic greed that constantly swirl through the stock market as the mass of individual participants react to a stream of seemingly random news events. These reactions cause new news events that become integrated in the highly complex set of interdependent actions and reactions by market players as well as the world economy at large. Subjective emotions of fear and greed caused by the constant stream of interdependent news events, in turn, depend on opinions about future prospects which are per definition based on beliefs which cannot be sustained by solid evidence or strong roots of conviction (Desmedt, Piégay, & Sinapi, 2010). Consequently, a random tipping event can cause unpredictable overreactions in the market which may result in mispricing, a view generally agreed upon by supporters of the efficient market hypothesis (Brown, 2011).Inthis herd-like behaviour of share investors, who sometimes overreact as a result of unsustainable optimism or unfounded pessimism, may lay the possibility of an effective strategy for stock investment.

Piotroski (2000) showed that one way of eliminating the emotional behaviour of the market from stock selection is to rely on purely accounting-based information, in picking winners from among the pool of stocks that are suffering from negative market sentiment.

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He reported a significant improvement on portfolio returns when employing his accounting-based fundamental analysis strategy. However, his criteria are specifically based on the properties of small companies and also depend on locking in profits by selling the stocks in the portfolio that were revalued upwards to its true intrinsic value by the market as soon as future profit announcements were issued that are better than those that are implied by the stock price at that moment. Since frequent trading incurs transaction costs and attracts value added tax, stocks should be traded as seldom as possible and, therefore, kept as long as possible. Consequently, if Piotroski's screen could also be utilised to select stocks that can be kept in the portfolio after it recovered in value and still deliver attractive returns in the long run, its value as a stock selector will be increased.

Secondly, Piotroski's screen is based on aspects of the performance of small companies. However, successful value investors like Graham, the father of value investing school, specifically made it one of their criteria that small companies are risky and that value is to be found in under-priced large and stable companies. Therefore, the successful application of Piotroski's screen to large companies, if possible, will be advantageous to value investors who aim to invest in larger, less risky companies for the long run.

Thirdly, once the market discovers that an investment method is successful, the market as a whole adopts that method and negates any advantageous returns that the method could produce. Therefore, a method like Piotroski's screen may tend to be only successful for a while and then lose its effectiveness as the market as a whole adopts the method and, thereby eliminates its advantages. Only if the method is robust over time will it still be a viable investment strategy that produces acceptable returns. Therefore, for South African investors investing on the JSE, it will be advantageous to know if the Piotroski's screen is still effective on the JSE since its publication in 2000 (Piotroski, 2000).

Research Motivation

Graham and Dodd (2006) emphasise the necessity of protecting loss of principle when investing in stocks In order to do that they draw a distinction between investing and speculating. The speculator's view is essentially forward looking and is reflected in his emphasis on trying to profit from betting on anticipated stock market movements. In contrast, investors' views are rearward looking and based on acquiring stocks in good businesses at reasonable prices (Cunningham, 2009).Reasonable prices are found among the pool of businesses with high book-to-market values for instance. However, a proven method for identifying good businesses from the high book-to-market value pool which invariably consists of mediocre businesses too, is required. Piotroski's screen proved to have the capability to identify winning businesses from a pool of businesses that by implication also contain a large number of mediocre businesses (Piotroski, 2000), also known as value traps.

Since an investment strategy also depended on margin of safety as espoused by Graham (Graham & Zweig, 2006) it would be advantageous if the Piotroski screen would result in a diminished possibility of selecting a stock with negative returns especially if an investor only selected one stock in a particular year instead of all high F-score stocks. Logically an investor that buys only one stock would only buy a stock with an F-score of nine, as was done by the Power stocks research (Placeholder1). In order to test the ability of Piotroski's screen to decrease the odds of selecting stocks with negative returns, a quick check was done between the proportion of stocks with negative returns in the portfolio consisting of one year buy-and-hold stocks with an F-score of nine and the high BM one year buy-and-hold portfolio.

One of the attractive attributes of Piotroski's screen is that it relies on rearward-looking quantitative analysis without the need for qualitative analysis. The drawback of qualitative analysis is that it has the potential to introduce behavioral anomalies and requires a good general knowledge of consumer behavior and the economy. For investors interested in investing on the Johannesburg Stock Exchange (JSE) it is therefore useful to research the application of Piotroski's screen for identifying winning companies on the JSE. A compelling reason for this is that the composition of the JSE differs from the American stock exchanges on which Piotroski (2000) based his results. If it appears to have the ability to increase the probability of identifying winning companies from both small and large companies, it can be a useful tool in the toolkit of a value investor. Furthermore, one of Graham's requirements (Graham & Zweig, 2006) for a value stock selection is that the company must be of adequate size. Hence, a screen must also be applicable to sizeable companies with larger balance sheet values.

If it turns out then that Piotroski's screen also increases the return of a portfolio consisting of both small and large book value stocks on the JSE bought for a reasonable price and held over either a short or long investment horizon, its usefulness will increase.

Studies have already been conducted on the usefulness of Piotroski's screen on the JSE for the purpose of devising an investment strategy with positive market adjusted returns (Piotroski long term JSE back test). However, for a value investor intent on accumulating quality firms with a buy-and-hold strategy in mind it is necessary to know if Piotroski's screen is also effective on the JSE for applications slightly outside its intended purpose. In other words, a study into the ability of the Piotroski screen to yield a premium on high book-to-market companies on the JSE which are large for the JSE but still small enough when compared to stocks on the American stock exchanges where the Piotroski screen was initially tested will fill a knowledge gap which is of interest to investors wishing to invest on the JSE. The usefulness of such a study will be further enhanced if it investigates the yields on returns for portfolios consisting of stocks held over long investment periods. Furthermore, since the screen became widely known and since the general adoption of a winning strategy by the market tends to erode its ability to provide superior returns, it is necessary to test Piotroski's screen on the JSE for robustness over the recent past too.

Study objectives

The study employs Piotroski's screen as an investment tool on the Johannesburg Stock Exchange (JSE). In order to span some of the dramatic events on international stock exchanges recently, like the dot-com bubble of 2000 and the bubble in the property market that caused the financial crisis of 2008, only data from 1998 onwards are used for the study. This choice of study period also fits in with the research aim to test the effectiveness of the Piotroski screen on the JSE since it became known in 2000. Therefore, the study seeks to determine whether:

1. The Piotroski screen is still effective on the JSE for its intended purpose of picking winners from losers among financially distressed stocks and thereby improving short-term portfolio returns;
2. The Piotroski screen is effective in picking winners from businesses falling in the high book-to-market value pool when a buy-and-hold strategy is employed;

Theoretical foundations of the Piotroski screen

Research shows that errors in market expectations about long-term earnings growth lead to the ability of contrarian investors and those who make use of the value premium of value stocks, to earn above average returns. These errors are attributed to the naïve expectations of analysts that past growth rates can be extrapolated into the future (Lakonishok, Schleifer, & Vishny, 1994), or that analysts may have biased forecasts of future earnings growth (Dechow & Sloan, 1997). Ir may also be that stocks with depressed prices are inherently more risky than glamour stocks and that the market somehow compensates investors for taking on more risk (i.e. volatility) when they embark on a contrarian investment strategy (Fama & French, 1996).

Frankel and Lee (1998) proposed that undervaluation should be identified by means of analysts' earnings forecasts in conjunction with an accounting-based valuation model. However, research (Barniv, Hope, Myring, & Thomas, 2010) have shown that analysts' earnings forecasts relate negatively or insignificantly to analysts stock recommendations in countries with high investor participation. The opposite is true for countries with low investor participation. In all countries, they found a positive correlation between earnings forecasts by analysts and future earnings. Therefore, Frankel and Lee's (1998) reliance on analyst forecasts of future earnings to identify stocks with good future earnings prospects can be used for firms with a high analyst following. Piotroski (2000) pointed out that high BM firms suffer from a lack of analyst following and that forecast data, therefore, was not readily available. Furthermore, small firms as well as distressed firms have credibility issues when trying to communicate forward-looking information to the market (Schleicher, Hussainey, & Walker, 2007). Hence, an analyst forecast-based approach, such as that of Frankel and Lee (1998) could not readily be applied to value (i.e. high BM) stocks. Investors, therefore, have to rely on financial reports in an effort to determine the difference between the market value and intrinsic value of a high BM firm.

Fundamental financial statement analysis

Financial analysts like Penman (1992) expressed the view that the central role of fundamental financial statement analysis was to predict accounting earnings.

Three features of accounting made it eminently suitable for predicting accounting earnings namely; its measuring system attributes, secondly, its disciplined and rules-bound nature and thirdly, its connection to future dividends.

Before the Piotroski's proposed his stock screen that was based on the fundamental analysis of financial statements, several methods based on financial statement analysis were developed to measure the financial health of a company. These included the Altman bankruptcy risk check (Altman, 1968), Ohlson's bankruptcy risk check (Ohlson, 1980) and Merton's distance to failure (Merton, 1974) amongst others. Boritz, Kennedy, and Sun (2007) tested Altman's and Ohlson's models on the Canadian stock exchange and found that the accuracy of the models depended to some extend on stock market conditions. Ohlson's model was found to be more robust and accurate than Altman's model. While Altman's model heavily relied on the predictive power of EBIT and working capital, Ohlson's model also took cash earned from operations and recent negative earnings into account. Merton's model is based on the Black-Scholes framework. It was found that none of these models could reliably predict improved future earnings and therefore could not be used as a stock selection tool in an investment strategy.

One aspect of financial information that can be utilised is financial signals like post-earnings announcement drift, share repurchases, high or low dividend announcements or omissions, accruals and equity offerings. Another aspect of financial information that can be utilised is fundamental financial statement analysis. Lev and Thiagarajan (1993) took a more indirect approach and studied a set of 12 fundamental financial statement-based signals usually considered by analysts. These signals are related to simultaneous changes in inventories, accounts receivables, gross margins, selling expenses, capital expenditures, effective tax rates, inventory methods, audit qualifications, and labour force sales productivity. Crucially, they found that these signals were positively correlated with changes in future earnings which will eventually be priced by a relatively efficient market.

Further studies by Abarbanell and Bushee (1997) showed that many, but not all, of the collection of signals used by Lev and Thiagarajan(1993) are correlated with short-term changes in future firm earnings growth as well as to a lesser extent, changes in analysts' predictions of earnings. This association between contemporaneous returns and the fundamental signals reflect the importance of these signals to predict value-relevant information. Of particular significance is Abarbanell and Bushee's(1997) finding that not all the information contained in these fundamental signals are contained in analysts' forecasts. They found evidence that analysts tend to generally under react to fundamental financial signals based on recent financial reports. This raises the possibility that investors who rely on analysts' forecasts will also tend to neglect the information contained in basic financial statement analysis. This situation could cause the share prices to lag behind fundamental financial statement information. Abarbanell and Bushee (1997)could not find evidence that all the information contained in the signals was impounded immediately into stock prices. They found a similar under reaction by investors who did not fully exploit the information contained in fundamental signals. Therefore, investors should be able to exploit the information contained in the fundamental financial statement analysis signals of Lev and Thiagarajan (1993) even for growth (i.e. glamour) stocks with large analyst following.

Emanating from their initial research, Abarbanell and Bushee (1998) subsequently investigated the investment question whether the application of fundamental analysis can yield significant abnormal returns. They found that since the collection of signals of Lev and Thiagarajan (1993) provided information about future returns associated with future earnings news, they could form portfolios that yielded an average 12-month cumulative return which outperformed the particular stock market that they researched. They also found that, consistent with the underlying focus of fundamental analysis on the prediction of earnings, a significant portion of the abnormal returns was generated around subsequent earnings announcements. These abnormal earnings were mainly restricted to the first year of portfolio formation however. The strategy also performs better for firms that suffered from bad news. Hence, Aberbanell and Bushee's (1998) strategy worked best for firms that were temporary out-of-favour and were bought and held until the good earnings news predicted by fundamental financial analysis was announced. These announcements usually happened within a year of portfolio formation (Abarbanell & Bushee, 1998).

The Piotroski screen

Properties of distressed firms

Instead of examining the relationships between future returns and particular financial signals, Piotroski (2000) aggregated the information contained in an array of performance measures into an overall signal that provided an indication of the overall quality of a firm's financial position. The performance measures were selected with the particular economic properties of high BM (i.e. value) firms in mind.

As pointed out by Fama and French (1995) the average high BM firm was financially distressed. Financially distressed firms were generally suffering from low or declining profit margins, cash flows, and liquidity as well as rising levels of debt. Therefore, Piotroski (2000) based his performance measures on these aspects of distressed firms. Furthermore, the performance measures are conditioned on the fact that the firms that were measured were financially distressed. A signal that indicated deterioration in the financial health of a distressed firm may indicate a worsening in the financial health of a financially sound firm. Piotroski (2000) gave the increase of leverage as an example.

The screen or signal comprised nine performance measures that evaluate three areas of a firm's financial health. The three areas were profitability, financial leverage/liquidity, and operating efficiency. A performance measure was classified as either good or bad, depending on its implication for future earnings increases. A good performance measure was given the score of one, while a bad signal was given the score of zero. The aggregate signal or screen was the sum of the nine binary performance measures. Piotroski (2000) hinted that these nine performance measures were chosen based on literature studies about the performance of distressed firms and may not necessarily represent the optimum combination of available performance measures. In order to determine the optimum set of performance measures the correlation between all available performance measures and future growth and return performance of a firm needed to be determined statistically; an exercise which was deemed outside the scope of his study.

Profitability performance measures

Recall that distressed firms (i.e. value firms) suffer from low or declining profits and cash flows amongst others. In order to determine if these particular aspects of a business show signs of improvement, Piotroski (2000) used four performance measures namely Return on Assets (ROA), Cash flow from Operations (CFO), changes in ROA (ΔROA) and, the relationship between earnings and CFO (ACCRUAL).These four performance measures indicated a firm's capability to generate funds internally from operations as well as the ability to generate positive future cash flows. ROA and CFO are the net income before extraordinary items and cash flow from operations, respectively, scaled by beginning-of-the-year assets. If the ROA (CFO) is positive, it is deemed to add one to the overall signal, otherwise zero. The ΔROA is the current year's ROA less the prior year's ROA. If ΔROA>0, it is deemed to add one to the overall signal, otherwise zero.

Piotroski (2000) sited literature studies that showed that earnings driven by positive accrual adjustments constituted a bad signal about future profitability and returns. Positive accruals were characterised by profits that were greater than cash flow from operations. In financially stressed firms, the incentive to manage earnings through positive accruals was particularly strong. Therefore, ACCRUAL was defined as the current year's net income before extraordinary items less cash flow from operations, scaled by beginning-of-the-year total assets. If CFO>ROA, ACCRUAL was deemed to add one to the overall signal, otherwise zero.

Financial leverage/liquidity performance measures

Piotroski (2000) assumed that since high BM firm's were financially constrained in general, an increase in long-term debt, a deterioration of liquidity, or the use of external financing was a bad signal about financial risk. Therefore, these three changes were used as performance measures to warn of increased risk in a firm's ability to meet future debt service obligations and negative changes in the firm's capital structure.

An indication of a high BM firm's inability to raise sufficient internal funds to service future obligations was its appetite for external funds. External funds were supplied by means of debt and common equity. Therefore, Piotroski (2000) considered the issuance of common equity and an increase in long-term debt of a high BM firm as warning signals. Furthermore, an increase in long-term debt was likely to hamper a firm's financial flexibility. In order to measure the changes in long-term debt Piotroski (2000) considered the historical change in the ratio of total long-term debt to average total assets (ΔLEVER). An increase (decrease) in financial leverage was considered as negative (positive) signal.

Therefore, if the firm's leverage fell (rose) in the year preceding portfolio formation, ΔLEVER was deemed to add one (zero) to the overall signal. An issuance of common equity (EQ_OFFER) in the year preceding portfolio formation was considered as a signal of financial distress for struggling firms and therefore its binary value was zero. Otherwise, if no common equity was issued in the year preceding portfolio formation it was deemed to add one to the overall signal.

An improvement in liquidity was a good sign about a firm's ability to service current debt obligations. Piotroski measured an improvement in a firm's liquidity by changes in the current ratio between the current year and the prior year (ΔLIQUID). An improvement in liquidity (i.e. (ΔLIQUID>0) was deemed to add one to the overall signal, otherwise zero.

Operating efficiency performance measures

Two measures of operating efficiency were chosen by Piotroski (2000), namely changes in the gross profit ratio and asset turnover ratio. The gross profit ratio was an indication of a firm's price-making ability and its ability to differentiate its products and services in the market place. It may also be indicative of an improvement in factor costs or a reduction in inventory costs. It was also an indication of the contribution of each sales Rand to fixed costs and profits (Higgins, 2009). Therefore, a positive (negative) change in the gross profit ratio diminished (increased) the influence of fixed costs on net profits. An improvement in the asset turnover ratio signaled more cost efficient use of the firm's assets or an increase in sales.

Changes in the gross profit ratio (ΔMARGIN) were defined as the current gross margin ratio (i.e. gross margin scaled by total sales) less the prior year's gross margin ratio. The asset turnover ratio was defined as the total sales scaled by beginning-of-the-year total assets. Changes in the asset turnover ratio (ΔTURN) were defined as the firm's current year asset turnover ratio less the prior year's asset turnover ratio. A positive ΔMARGIN therefore indicated improved operating efficiencies and therefore its performance signal was one in that case. Otherwise, it was zero. Similarly, a positive ΔTURN indicated an improvement in operations and therefore its performance signal was one, otherwise zero. The ratios and trends that are used to determine the performance ratios are shown in Table 1.

Table 1: Definitions of the ratios and trends used in the determination of Piotroski's nine performance measures

Profitability	
ROA_t	$\frac{\text{Net income before extraordinary items}_t}{\text{Total assets}_{t-1}}$
CFO	$\frac{\text{Cash flow from operations}_t}{\text{Total Assets}_{t-1}}$
ΔROA	$ROA_t - ROA_{t-1}$
ACCRUAL	$\frac{\text{Net income before extraordinary items - Cash flow from operations}_t}{\text{Total Assets}_{t-1}}$
Leverage, Liquidity and Source of Funds	
ΔLEVER	$\frac{\text{2*Long-term debt}_t}{\text{Total Assets}_t + \text{Total Assets}_{t-1}} - \frac{2 * \text{Long-term debt}_{t-1}}{\text{Total Assets}_{t-1} + \text{Total Assets}_{t-2}}$
ΔLIQUID	$\frac{\text{Current Assets}_t}{\text{Current Liabilities}_t} - \frac{\text{Current Assets}_{t-1}}{\text{Current Liabilities}_{t-1}}$
EQ_OFFER	$\text{Issuance of equity}_t$
Operating Efficiency	
ΔMARGIN	$\frac{\text{Gross Margin}_t}{\text{Total Sales}_t} - \frac{\text{Gross Margin}_{t-1}}{\text{Total Sales}_{t-1}}$
ΔTURN	$\frac{\text{Total Sales}_t}{\text{Total Assets}_{t-1}} - \frac{\text{Total Sales}_{t-1}}{\text{Total Assets}_{t-2}}$

The Beginning-of-the-year total asset is the same as the End-of-previous-year total assets. This is denoted asTotal Assets$_{t-1}$

Composite signal

The performance measures chosen by Piotroski (2000) are specifically selected to examine the performance issues pertaining mainly to high BM firms which by their nature tended to be smaller and financially distressed. This performance issues included a lack of profitability and the risk to default on debt payments amongst others. Therefore, some of Piotroski's performance measures differ from those used in in previous research (Abarbanell & Bushee, 1998).Piotroski also referred to previous research (Sloan, 1996) that demonstrated the importance of accounting returns and cash flows when assessing future performance prospects of a firm. Therefore, he included performance measures that capture these constructs. The composite signal consists of the sum of the nine binary performance measures. A zero for a performance measure indicated that a specific aspect of a high BM firm posed a risk to the financial health and future prospects of the firm. That was akin to a red flag being raised about the firm's financial health and future prospects. A one for a performance measure was akin to the red flag being eliminated. Finally, the four profitability performance measures, three leverage and liquidity performance measures and two operating efficiency performance measures were aggregated into a final score, known as the F-score. The higher the F-score the fewer red flags about the firm's financial health existed.

Since the F_SCORE comprised binary performance binary measures, it can range from zero to nine. A high BM firm with a low F_SCORE has an almost full complement of red flags that signals that the firm's financial health and future financial prospects are bleak. Conversely, a high F_SCORE indicated that there were few or no remaining red flags concerning the firm's financial health and that the firm's future prospects were healthier. Therefore, a high F_SCORE for a high BM firm should be positively correlated with that firm's future performance and stock returns. The Piotroski screen was applied to investment decisions by calculating the F_SCORE signals of high BM firms and buying those firms with high F_SCORE signals.

Research Contribution

Studies (Thorp, 2011) have shown that the Piotroski screen remained one of the most successful high BM screens available. Apart from being used on stock exchanges of developed economies the screen was also tested on small capitalisation stocks in India by Bhardwaj (2010) who found that six firms passed the Piotroski screen, they all happened to be small caps and the Piotroski portfolio delivered one-year returns of 259% in comparison with that stock exchange's small caps return of 188%. The screen was also applied on the JSE where on average two firms per annum were identified by means of Piotroski's screen for portfolio formation by Power stocks Research (Piotroski long term JSE backtest). The study was done for the period 1994 until 2007. It was found that a strategy of forming portfolios consisting only of high BM firms that had an F-score of 9 (strongest signal) yielded compound annual growth rate (CAGR) of 48%. Significantly, portfolios formed of firms that had an F-score of 8 yielded a CAGR of only 11%.

The abnormally high returns of value stocks was also observed on the JSE for the period of 1983 to 2005 (Cubbin, Eidne, Firer, & Gilbert, 2006). Cubbin, Eidne, Firer, and Gilbert (2006) formed winner (looser) portfolios by dividing shares in high (low) price-earnings (P/E) ratios. Their portfolio of low P/E shares outperformed the high P/E shares and thereby illustrated the tendency of stock prices to revert back to the mean. They reported studies that found that mean reversion led to underperformance during the Great Depression but large profits after the Great Depression as well as during the 1980's. This study makes a contribution to current knowledge by specifically determining if the Piotroski screen has been consistently successful during the recent past too. Furthermore, since the companies listed on the JSE are mainly South African based companies and since South African based companies tend to be smaller than American and international companies based on the New York Stock Exchange, this research will also establish to what extend JSE-listed firms can be included in the high BM and small stock portfolio for which the Piotroski screen was specifically devised.

Data

Secondary data was collected on high BM firms that were listed on the JSE from January 1998 until December 2011. The study focused on the South African registered and dual listed companies with a trading history and balance sheet that were adequate for main board listing.

These companies had to be duly incorporated with a proper corporate governance system in place and had to produce properly audited annual financial statements (Manning, 2011). The time frame from January 1998 until December 2011 was chosen to include enough data to compile significant sample sets. The period chosen also included the significant stock market crash of 2000 led by the crash in technology stocks, the general economic and financial meltdown of 2007/8 with the accompanying stock market crash and the bull market spanning these two stock market crashes. December 2011 was chosen as the end of the period under study since it caused the time frame of the study to encompass a number of full financial years. Since three years' financial statements were needed to calculate the F-scores, portfolios could only be formed and results could only be obtained from the year 2000 onwards.

The financial statement line items that were needed to calculate the Piotroski screen's nine performance measures were obtained from McGregor BFA's database. These line items were from all companies listed on the JSE at October 2012. The data obtained were from January 1998 till December 2011. Monthly share price data were obtained from January 2000 till December 2011.

Sampling method and sample sizes

For one year buy-and-hold portfolios, firms with adequate stock price and book value data with which to calculate the nine performance parameters of the Piotroski screen were identified for each year from 2000 to 2010. Similarly for five year buy-and-hold portfolios firms with adequate stock price and book value data with which to calculate the nine performance parameters of the Piotroski screen were identified from 2000 to 2006. For the sake of consistency between all financial statement ratios and share price based ratios, fiscal year-end share prices were used to form share price based ratios like BM ratios and market values.

The data needed came from financial statements of the years 1998 to 2011 and resulted in observations from the years 2000 onwards because the last three years' financial statements were needed to calculate the input ratios and trends needed to calculate the nine performance parameters on which the Piotroski screen is based. From these nine performance measures a number, called the F-score, was calculated which ranged from zero to nine. An observation was uniquely identified by the combination of the firm's name and the year of portfolio formation. This resulted in several independent observations that contained the same firm but for different years of portfolio formation.

Following Piotroski, share prices were taken at the end of five months after the year-end financial reporting month in order to allow the reported financial information to be fully impounded in the market. Observations with stock splits or mergers were eliminated in order to eliminate errors caused by share conversion between the final share price and dividends and the initial share price. The sample that contained observations with five year buy-and-hold annualised returns consisted of 975 observations. The sample that contained observations with one year buy-and-hold returns consisted of 1877 observations.

In order to obtain the upper quintile of firms on the JSE the variation of the BM ratios of the one year and five year buy-and-hold portfolios was observed. The variations in the 80th percentile varied significantly between the years of portfolio formation as shown in Table 2 and Table 3. Therefore, in order to compensate for the variation in BM-ratio percentiles between portfolio formation years, the upper quintile of each separate portfolio formation year was selected to form the total sample of the high BM firms. This was done separately for the one year and five year buy-and-hold samples. This high BM sample of one year buy-and-hold observations contained 379 observations while the high BM sample of five year buy-and-hold observations contained 199 observations.

Table 2: 80th Percentiles of the sample of one year buy-and-hold observations

Year of Portfolio Formation	BM Percentile 80
2000	1.892198633
2001	1.766637651
2002	1.520774399
2003	1.304856456
2004	0.947184376
2005	0.795456788
2006	0.700539613
2007	0.615630184
2008	0.987425807
2009	1.303854052
2010	1.255348628

Table 3: 80th Percentiles of the sample of five year buy-and-hold observations

Year of Portfolio Formation	BM Percentile 80
2000	1.892199
2001	1.699323
2002	1.581368
2003	1.339599
2004	0.941837
2005	0.782444
2006	0.725473

From the two samples of high BM firms those with an F-score of eight or nine were selected and pooled into the samples of one year buy-and-hold high F-score firms and five year buy-and-hold high F-score firms. These samples consisted of37 and 20 observations respectively. The F-scores of eight and nine were arbitrarily chosen by Piotroski (2000) and was deemed to be the criteria for passing the Piotroski screen's test for firms that were financially strong enough to be included in an investment portfolio.

Calculation of input ratios and trends

The nine performance measures of the Piotroski screen required several financial ratios and trends that needed to be calculated from the last three years' financial statement line items as shown in Table 4. The line items from the McGregor BFA database that were used to calculate the input ratios and trends are shown in
Table 4.

Table 4: Calculation of Piotroski's ratios and trends using financial statement line items from McGregor BFA.

Profitability	
ROA	$\frac{\text{02020101 Profit Attributable To Ordinary Shareholders - 02020075 Discontinued Operations - 02020079 Extra Ordinary Items}_t}{\text{02010050 Total Assets}_{t-1}}$
CFO	$\frac{\text{01030733 Cash From Operating Activities}_t}{\text{02010050 Total Assets}_{t-1}}$
ΔROA	$\text{ROA}_t - \text{ROA}_{t-1}$
ACCRUAL	No calculation required.
Leverage, Liquidity and Source of Funds	
ΔLEVER	$\frac{2*(\text{02010022 Total Liabilities})_t}{\text{02010050 Total Assets}_t + \text{02010050 Total Assets}_{t-1}} - \frac{2 * (\text{02010022 Total Liabilities})_{t-1}}{\text{02010050 Total Assets}_{t-1} + \text{02010050 Total Assets}_{t-2}}$
ΔLIQUID	$\frac{\text{02010034 Current Assets}_t}{\text{02010041 Current Liabilities}_t} - \frac{\text{02010034 Current Assets}_{t-1}}{\text{02010041 Current Liabilities}_{t-1}}$
EQ_OFFER	If ($\text{01080275 New Share Issues}_t$ > 0) then EQ_OFFER = 0, else 1
Operating Efficiency	
ΔMARGIN	$\frac{(\text{02020060 Turnover - 01020053 Cost Of Sales})_t}{\text{02020060 Turnover}_t} - \frac{(\text{02020060 Turnover - 01020053 Cost Of Sales})_{t-1}}{\text{02020060 Turnover}_{t-1}}$
ΔTURN	$\frac{\text{020060 Turnover}_t}{\text{02010050 Total Assets}_{t-1}} - \frac{\text{02020060 Turnover}_{t-1}}{\text{02010050 Total Assets}_{t-2}}$
where t is current year, t-1 is previous year and t-2 is 2 years ago.	

F-score calculation

From the ratios and trends the binary values of the nine performance measures were calculated as shown in Table 5. The composite signal, denoted as F_SCORE by Piotroski (2000) was calculated by summing the individual values of the binary performance scores:

$$\text{F\_SCORE} = \text{F\_ROA} + \text{F\_CFO} + \text{F\_}\Delta\text{ROA} + \text{F\_ACCRUAL} + \text{F\_}\Delta\text{LEVER} + \text{F\_}\Delta\text{LIQUID} + \text{F\_EQ\_OFFER} + \text{F\_}\Delta\text{MARGIN} + \text{EQ\_OFFER}$$

Table 5: Binary value allocation algorithms for Piotroski's nine performance signals

Profitability		
F_ROA	if ROA > 0	F_ROA = 1, else 0
F_CFO	if CFO > 0	F_CFO = 1, else 0
F_ΔROA	if $\Delta\text{ROA} > 0$	F_ΔROA = 1, else 0
F_ACCRUAL	if CFO > ROA	F_ACCRUAL = 1, else 0
Leverage, Liquidity and Source of Funds		
F_ΔLEVER	if$\Delta\text{LEVER} < 0$	F_ΔLEVER = 1, else 0
F_ΔLIQUID	if $\Delta\text{LIQUID} > 0$	F_ΔLIQUID = 1, else 0
EQ_OFFER	If no equity issued	EQ_OFFER=1, else 0
Operating Efficiency		
F_ΔMARGIN	if $\Delta\text{MARGIN} > 0$	F_ΔMARGIN = 1, else 0
F_ΔTURN	if $\Delta\text{TURN} > 0$	F_ΔTURN = 1, else 0

Calculation of returns

Following Piotroski (2000), the firm-specific returns were measured as one-year and five-year returns earned from the end of the fifth month after the firm's fiscal year-end through the entire period of analysis: one year and five years respectively. The fifth month was chosen to ensure that all the necessary annual financial information was available in the market at the time of portfolio formation. The n-year annualised returns were calculated as follows:

$$\text{Yield}\%_n = \left[\left(\frac{(P_n - P_0) + \sum_{i=1}^{n} D_i}{P_0}\right)^{\frac{1}{n}} - 1\right] * 100$$

Where P_0 is the share price at the year of portfolio formation, P_n is the share price n years after portfolio formation and D_i is the total dividends issued to common shareholders during $year_i$ after portfolio formation while n is the length of the buy-and-hold strategy which was chosen as either one or five for this research project.

Results

Since Basu(1977) published evidence of the value premium, numerous studies (Jaffe, Keim, & Westerfield, 1989), (Chan, Hamao, & Lakonishok, 1991), (Fama & French, 1992), (Lakonishok, Schleifer, & Vishny, 1994), (Brouwer, Van der Put, & Veld, 1997) and (Zhang, 2005), concurred that low-priced stocks (value stocks), identified by high Book-to-Market (BM) values, yield better returns than expensive stocks (growth stocks). However, high BM stocks consisted of many poor-performing firms and the superior returns were mainly driven by a small group of firms that recovered from financial distress (Piotroski, 2000). The literature agrees that the Piotroski screen was one of the most effective screens in discerning winning firms from amongst the pool of high BM firms. Nothing in the literature was found that rigorously tested the effectiveness of the Piotroski screen on the JSE by means of the scientific method of hypothesis testing on the basis of the methods used by Piotroski (2000), however. Hypothesis one investigated the effectiveness of Piotroski's screen on the JSE since its publication in 2000. Since the premium obtainable from the application of successful stock selection strategies tend to erode with time in line with the neoclassical financial framework of rational expectations and competitive equilibrium (Long & Plosser, 1983), it was imperative to determine the effectiveness of the Piotroski screen on the JSE post its disclosure in 2000.

Successful stock investors, like Warren Buffet, advocated long investment horizons (Cunningham, 2009). Hypothesis two investigated the most effective investment horizon based on the Piotroski stock selection strategy. The Piotroski screen was conditioned on the properties that characterise smaller firms in financial distress. Since the portfolios of firms that were used for the Piotroski stock screening process were based on high BM-values alone, hypothesis three investigated the propensity of the selection process to cause selected portfolios to be biased toward smaller capitalisation firms without deliberately restricting the selection process to small capitalisation firms in the process. If this was the case, it would not be necessary to deliberately preselect small-cap firms when applying the Piotroski's screen on the upper quintile by BM-values of a particular portfolio forming year.

The effectiveness of the Piotroski screen on the JSE was determined by testing if there was a statistically significant improvement in returns between two portfolios that were chosen in such a way that all sources of variation except for the effect of Piotroski's screen were eliminated. These two portfolios were the high Book-to-Market (BM) firms selected from the upper quintile of each portfolio forming year and the portfolio of all firms that had an F-score of eight or nine that was screened from this portfolio of high BM firms. The conclusion drawn from the bootstrapped independent samples t-test that compared the mean returns of the high F-score portfolio and the high BM portfolio was that there was not enough statistical evidence to reject the null hypothesis in favour of the alternative hypothesis. The null hypothesis stated that there was no difference in the mean annual returns between the high BM and high F-score portfolios consisting of one year buy-and-hold stock investments. The immediate conclusion that could be drawn from this result was that the Piotroski's screen did not select stocks that yielded significantly improved returns in comparison with the returns of the high BM portfolio. However, this result should be seen in the context of the general market conditions.

The study was done amidst one of the most persistent and strongest bull markets on the JSE. The period under study started with a mild bear market that lasted from 2000 till 2003. This was followed by a long bull market that lasted until the dangerous international unravelling of financial markets caused a short, sharp correction on the JSE from 2008 to 2009. The JSE quickly resumed its bull market for the rest of the period under study.

During the time under study, the JSE Indi 25 index had a compound growth rate of 13.5% (rounded) per annum. When the investment returns were calculated on the basis of one year buy-and-hold share price increases and the dividends that were paid out for firms that were selected from the general JSE board, the annual returns increased to 32%. However, due to the fact that the delisted companies were not taken into account in the calculation of the mean returns of the general one year buy-and-hold portfolio, the annual returns of 32% was suffering from survivorship bias. Delistings would have caused investment losses and will have diminished the mean return of 32% for a one year buy-and-hold strategy.

A further remarkable result of the complete one year and five year buy-and-hold portfolios was that there was a statistically significant difference in the returns of the upper quintile of each of the complete portfolios and the returns of the lowest three quintiles respectively. The returns from the upper quintile of each of these two portfolios were markedly better than the returns of the lowest three quintiles. Furthermore, a bootstrapped independent samples t-test also showed that there was enough evidence to infer that the mean returns of the general population of one year buy-and-hold returns on the JSE was significantly lower than the mean returns from the high BM population. This finding corresponds with the findings of other studies that value stocks (high BM stocks) in general give better returns than glamour stocks (low BM stocks)(Fama & French, 1992) and Basu(1977). The firms that were screened by the Piotroski screen and grouped in the high F-score group was selected from the highest BM quintiles of each portfolio forming year. For the period under study, where the general portfolio of one year buy-and-hold stocks on the JSE gave a mean one year return of 32% (rounded), the portfolio formed by selecting the highest quintile by BM of each portfolio forming year, gave a mean return of 42%. Piotroski found that the high BM portfolio consisted predominantly of firms in financial distress (Piotroski, 2000). The positive returns of the high BM group were generally driven by a small number of firms that managed to shrug off their financial difficulties and surprised investors with good results which led the market to correct the prices on the basis of the new positive results.

A significant portion of the returns were outliers with large positive returns ranging from between 200% to 400% which contributed largely to the high mean return of 42.3% of the high BM portfolio. The high F-score portfolio screened from the high BM portfolio by the Piotroski screening method comprised only two positive return outliers. Therefore, the high BM portfolio that resulted from the selection of stocks from the JSE contrasted sharply with Piotroski's high BM samples that predominantly comprised stocks with poor returns (Piotroski, 2000). Consequently, the high BM portfolios from Piotroski's sample selection lent itself ideally to a screening process that was effective in discerning winners from losers. Since the high BM sample that resulted from stocks selected on the JSE during a strong and persistent bull market period comprised stocks with predominantly positive returns already, there was little scope for a screening process to improve returns. This explains why the results from the first hypothesis in determining the effectiveness of Piotroski's screen on the JSE were inconclusive.

The Piotroski screen is also effective in creating long-term investment portfolios

This research specifically investigated a possible stock investment strategy that capitalised on the value premium that was found to exist among high BM stocks and the use of the Piotroski screen to increase the returns from a selection of high BM stocks. One of the aspects of an investment strategy is the frequency with which stocks are traded, or the time frame that a stock is kept in a portfolio. Highly successful stock investors like Buffett proclaimed that "if you are not willing to own a stock for ten years, don't even think about owning it for ten minutes" (Cunningham, 2009). In contrast, Saville (2011) showed that the general trend on the JSE, the London Stock Exchange, and the New York Stock Exchange was a reduction in stock holding periods from about 20 years on average to about one year in 2010.

Buffett's investment style, however, is a mixture of growth and value investing (Saville, 2011). Buffett recommended only investments in firms with extremely stable operations that operate in a business environment that is highly unlikely to experience disruptive developments (Cunningham, 2009) that could jeopardise their net profits. In contrast, Piotroski's screen was developed to discern firms with healthy financial prospects based on fundamental financial statement analysis alone without regard for the underlying conditions in which the firm operated, from amidst a pool of out-of-favour firms. Contrary to Buffett's recommendations, Cheh et. al. (2008) found that more frequent portfolio rebalancing tended to improve the performance of high BM stocks.

Their findings agreed with Buffett's recommendations for high P/E (growth) stocks since they found that frequent portfolio rebalancing tended to lower the performance of such stock.

The contrast between proponents of long-term portfolio holdings and short-term portfolio holdings lie in the underlying basis for future profits. The proponents for long-term buy-and-hold strategies, like Buffett, focus on buying fundamentally sound businesses that operate in stable environments. The obvious lack of any future disruptive technology that could threaten the future profits of the firm and the long established need for the product or service, like Coke sodas or Gillette razors, virtually guaranteed its future growth and income. On that basis, a firm was selected and bought if the price was low enough to eliminate downside risks and guaranteed good future profits. The emphasis was, crucially, on firms with a durable competitive advantage (Cunningham, 2009).

In this way, good growth stock with virtually guaranteed above normal growth was selected from the general pool of stocks. This method of stock selection required astute knowledge of the market and product and these investors therefore strictly limited their investments to their "circle of knowledge." In contrast, the value premium was only observed for short-term buy-and-hold periods (Basu, 1977) and (Cheh, Kim, & Zheng, 2008). The basis for the above-average returns of value stock was the arbitrage opportunities created by discredited firms whose financial statements showed that they are not in financial distress anymore and are about to surprise the market with good future earnings as a result of their sound financial position. This finding was supported by Lev and Thiagarajan (1993) who found that a significant proportion of the abnormal returns obtainable from method of screening out potentially good firms from a pool of unpopular firms by means of fundamental financial statement analysis was generated around subsequent earnings announcements. As a result, these abnormal earnings were mainly restricted to the first year of portfolio formation. The same pattern of short-term abnormal earnings generation was reported by Abarbanell and Bushee (1998).

The five year buy-and-hold sample set contained only 20 observations. Smaller sample sizes cause wider sampling distributions and a higher probability of a Type 2 error (Keller, 2005) which is the failure to reject a false null hypothesis. Although the bootstrapped independent-samples t-test indicated that, there was not enough statistical evidence to reject the null hypothesis which stated that there was no difference in the returns of the populations of one year and five year buy-and-hold portfolios, the sample sizes were extremely small and the probability of a type 2 error commensurably high. The mean returns from the one year buy-and-hold portfolio (Mean = 43.7%) was almost four times more than the mean returns from the five year buy-and-hold portfolio (Mean = 11.9%). The probability of observing a wider gap in returns between these two portfolios was only 13.8% which was considered to be weak to moderate evidence that the null hypothesis should be rejected. Since the probability of a Type 2 error was large and the p-value indeed gave a weak to moderate indication that the null hypothesis could be rejected the consequent high probability that the alternative hypothesis that the returns from short investment horizon population was indeed better than the returns from the longer investment horizon would be commensurate with research findings by Cheh at al. (2008), Abarbanell and Bushee (1998) and Lev and Thiagarajan (1993) as explained above.

Conclusions

The purpose of this research was to determine if the Piotroski screen was still effective on the JSE since it was published in 2000 (Piotroski, 2000). Research indicated that returns from value stocks were mostly better than returns from growth stock (Basu, 1977) and (Fama & French, 2006). Piotroski (2000) found that, due to the propensity of high BM firms to be financially distressed, the superior returns of high BM firms were driven by only a few firms that proved to be financially sound as reflected by their financial statements. Due to poor investor following and neglect by the investor community, this was usually not immediately picked up by the market (Basu, 1977). These market "lags and frictions" allowed investors to use a screen to discern "winners from losers" (Piotroski, 2000) a priori based on fundamental financial statement analysis alone and profit from the subsequent price corrections as the market is surprised by good financial performance which usually happened within the first reporting year after portfolio formation (Abarbanell & Bushee, 1998).

This paper does not find conclusive evidence that, on the JSE, returns from the high F-score portfolio of one year buy-and-hold stocks could be better than the mean returns from thehigh BM one year buy-and-hold portfolio. At least two reasons for this can be adduced. Contrary to the high BM portfolio that Piotroski used for his analysis (Piotroski, 2000) this high BM portfolio contained a large number of firms with positive returns.

Secondly, the high F-score sample size of 37 was small and increased the danger of not rejecting a statement that the high F-score portfolio did not increase the mean returns if it was false. However, indications are that the portfolio of one year buy-and-hold shares with an F-score of nine (the highest F-score) contained less firms with negative returns than the portfolio of high BM one year buy-and-hold stocks. Furthermore, even though no conclusive evidence was found that the mean return of the one year buy-and-hold high F-score portfolio was better than the mean return of the five year buy-and-hold portfolio the conditions of the statistical tests and the borderline p-value aroused suspicions that the returns of the one year buy-and-hold high F-score population may very well be better than the five year buy-and-hold high F-score portfolio. The mean return of the one year buy-and-hold sample is almost 400% better than the mean returns of the five year buy-and-hold high F-score sample. This finding is consistent with previous research Chehet. al (2008).

Finally, it is found that the mean firm size by market value of the high BM population of the one year buy-and-hold stocks is significantly smaller than the general population of one year buy-and-hold stocks. Therefore, it is not considered necessary to divide the high BM portfolio into small cap stocks and large cap stocks for the purpose of selecting winners from losers by means of the Piotroski screen.

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